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TAX REFORM AND SOCIAL WELFARE IN INDONESIA:

An empirical investigation

Thesis submitted by

Johanna Maria Kodoatie

SE (*Diponegoro University, Indonesia*),
G. Dipl. Ec., MEc. (*Monash University, Australia*)

For the degree of Doctor of Philosophy
in Department of Economics
School of Business,
Faculty of Law, Business and Creative Arts
James Cook University, Townsville, Queensland
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Johanna Maria Kodoatie

ABSTRACT

The Indonesian tax system has undergone a series of reforms since 1983. Ongoing tax reforms will need to deal with the basic tax principles of equity and efficiency, in addition to revenue adequacy. As is typical in a developing country, a significant proportion of Indonesia's taxes are collected via an indirect system, so there is a critical link between the prices of the consumer goods to which taxes are applied, the welfare of households, and government revenue. Accordingly, the major challenge facing Indonesia's tax reformers is to determine how best to collect revenue in an efficient and equitable manner.

This thesis examines whether the trade off between efficiency and equity occurs in tax reform in Indonesia. More specifically, the study aims to answer the following research questions: (1) *Can Indonesia's commodity tax system be reformed in a way that maintains revenue while improving social welfare? (2) Which commodity taxes should be altered so as to increase overall tax revenues at (the) least social cost?*

To address these questions, the way in which demand for different commodities change in response to changes in tax rates must first be determined and the degree of inequality aversion in Indonesia must be assessed. The estimated demand elasticities and the estimated inequality aversion can then be used to answer these research questions.

Data from a survey of 64,422 households across 26 Indonesian provinces was obtained from the 2002 SUSENAS and this data was used to estimate demand equations for 13 different food groups using two different models. The basic model of tax reform analysis used in this study including the relevant variables involved is mainly derived from the approaches outlined by Olivia and Gibson (2005), by Deaton (1997) and by Ahmad and Stern (1984, 1991). The first model (Model I, Hicksian Model), where the budget share of any commodity group is assumed to be a function of total expenditure and family size was one commonly used by other researchers. The second model (Model II, Marshallian model) uses total food expenditure as a denominator of the budget share (instead of the total expenditure) of the regressand and includes an income variable to reflect quality variations and high income earner behaviour. The Unit Value Index approach is used for computing unit values for the observed commodity groups and Ordinary Least Squares (OLS) regression is used in Deaton's three stage procedure to calculate price elasticities. "Lambda" (the Benefit

Cost Ratio of Ahmad and Stern) is used to estimate the relative welfare costs of raising revenues from different commodities, providing guidance on directions for tax reform. To do this, two different tax rate regimes are considered: the MIX tax rate regime (which assumes a 10% uniform tax rates across commodity groups, except for Cereals and Prepared foods and drinks); and the MAX tax rate regime (which assumes higher tax rates on some commodity groups).

This study demonstrates that Model II produced "better" outcomes compared to Model I in terms of not only the correct signs on own price elasticity estimates but also more plausible estimates of the marginal welfare impacts of tax changes. Furthermore, income elasticities and / or expenditure shares were found to be small, indicating that, essentially, the Marshallian welfare estimates associated with Model II are likely to provide reasonable approximations to compensating and / or equivalent variation.

Overall, the findings of the study suggest that a trade – off between efficiency and equity aspects exists in tax reform in Indonesia. Accordingly, this research sought to determine the level of inequality aversion evident in Indonesia. This study used the modified Atkinson Index approach to estimate a unique inequality aversion parameter of 1.5 (instead of using a series "trial and error" numbers as previous studies have mostly done).

Using Model II and an inequality aversion parameter of 1.5, the recommendations of tax reform policy that arise from this analysis are that policy makers should raise tax on Meat, Fruits, and Other consumption and lower taxes on Tubers, Beverages, and Eggs and milk. These products were generally identified as being price elastic of demand and as both the most expenditure elastic and the most income elastic commodities for the majority of Indonesians, especially for villagers and low income groups. Hence, an increase of the tax on the suggested goods, excluding Meat and Other consumption, may be relatively inefficient (since most of the goods are price elastic) but more "equitable". Similarly, lower taxes on Tubers, Beverages and Eggs and milk are likely be offsetting towards a shift of Tubers, Eggs and milk and Beverages Demand.

Recommendations derived from Model II using (a) only urban areas; (b) only rural areas are also considered in this thesis. When the analysis focuses only on urban areas, the analysis indicates that policymakers should increase tax on Cereals and Pulses and lower tax on Meat and Vegetables if considering only efficiency.

However, policymakers should raise tax on Pulses and reduce tax on Vegetables if equity considerations are important. When rural areas are the focus for the tax reform policy, then the analysis suggests that policy makers should increase tax on Fruits and Prepared foods and drinks and lower tax on Tubers and Meat. More commodity groups are subject to the reform when allowing for more variation in the tax rates applied in the tax system. This regime suggests that apart from the former recommendation, the policymakers should also raise tax on Fish and reduce tax on Beverages when equity aspect is also considered.

It is important to note that the policy recommendations are likely to differ if analysing different commodity groups and / or if analysing different regions. It may therefore be important to conduct further research using smaller commodity groups as well as to analyse regional variations of consumption patterns among households. In addition, the unit values used in this study may not accurately represent true prices Accordingly, further research could usefully test the techniques used to estimate unit values by comparing estimates with market prices that have been collected 'in the field'. Finally, this study was unable to include non-food commodity groups within its analysis (due to an absence of quantity data; that would allow for the calculation of unit values). Further research should aim to include these commodity groups to ensure that the analysis relates to a complete demand system (using econometric estimation technique appropriate to complete systems of demand).

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Chapter 1
Introduction

1.1 Background and Motivation

It has been widely recognised that many governments in developing countries frequently generate their revenues from indirect taxes (Olivia, 2002, Ahmad and Stern, 1991). This is due to the fact that a majority of their citizens are engaged in the informal sector and their administrative capacity is too poor to permit extensive utilization of income taxes as their revenue sources (Olivia, 2002). This also means that developing countries have limited capacity to carry out income transfers to the poor, so the option of subsidizing necessities is an attractive means for realizing one of their functions, namely income redistribution.

Since the Indonesian government experienced a decrease in revenues from oil in the mid 1980s, the Indonesian government has been forced to seek alternative sources of revenue. Tax reform is likely to be a popular option. As pointed out by Islam (2001) and requoted by Olivia (2002), there are substantial demands for developing countries to undertake policy reform for indirect taxes and subsidies partly due to their effects on fiscal deficits.

Indonesia's tax system has experienced a series of tax reforms since the mid 1980's notably in 1983, 1994, 1997, 2000, and 2005 (Pandiangan, 2002; Uppal, 2003; Setiyaji and Amir, 2005; Ikhsan, Trialdi and Syahrial, 2005a). Each reform had a different background and sets of objectives. For example, the 1983 tax reform was not only to replace the previous *official assessment system* with a *self assessment system*, but also to reduce the reliance of government funds on oil revenues and to promote efficiency and competition. The 1994 tax reform was aimed at readying the economy to meet global competition, so technology and environmental considerations become the focus of the tax reform. For example, costs for waste disposal and research development were made tax deductible. The 1997 tax reform was prepared to meet the currency (Rupiah depreciation) crisis and the *self reliance movement* whereas the 2000 reform focused on religious considerations. The idea here was to encourage people to make donations by making taxpayers' Zakat (donations for the poor based on the Islamic religion) tax deductable.

Amendments were made to taxation laws in 2005 – specifically focusing on the *self assessment system*. This reform sought to increase tax revenues since they were seen as the main source of funds with which to finance development projects. The 2005 reform included at least 3 main amendments affecting excise taxes, income taxes and the general rules and procedures of taxation. The amendments were intended to meet the following objectives:

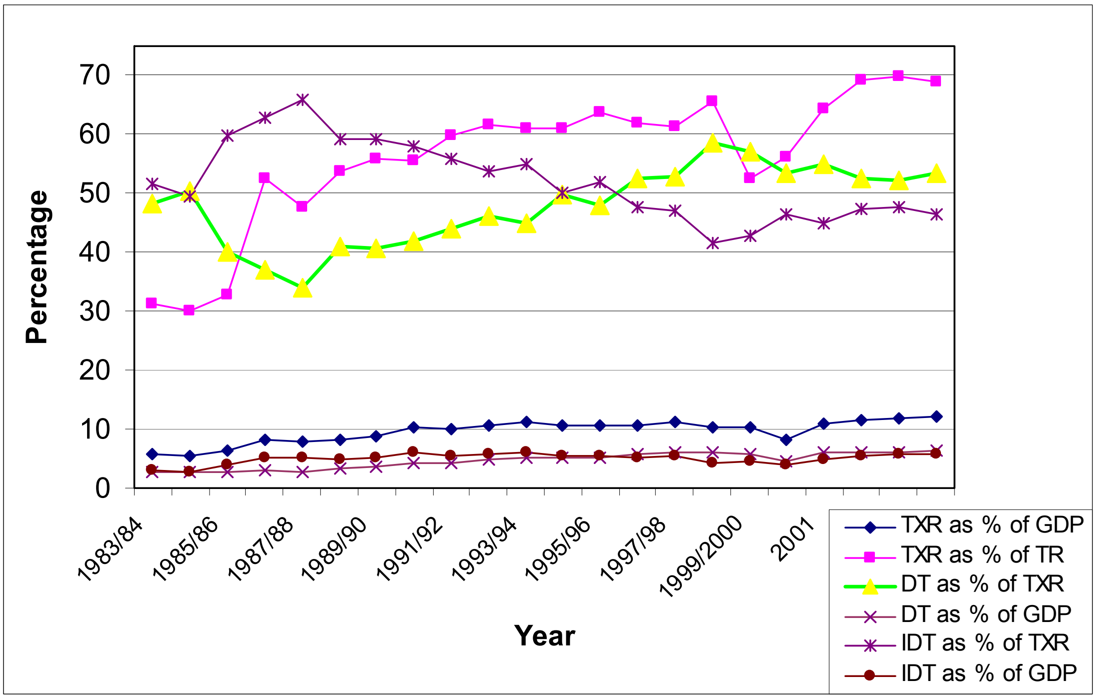
1. to promote fairness and legal certainty,
2. to improve taxpayers' service in terms of administrative simplification, efficiency, consistency and transparency
3. to explore revenue potentials in order to expand sources of government funding
4. to anticipate development of information and technology
5. to support government policy in promoting business and investment in prioritised areas and regions.

Despite this history of repeated tax reforms some of their outcomes have been disappointing**. First**, although tax revenues (TXR) as a share of total revenues began to increase in 2000, tax revenues as % of GDP are much lower than they were in the late 1990s and have levelled off since 2001. More specifically, the figures presented in Figure 1-1 suggest that the tax reforms adopted by Indonesia during 1983-2004 have led to a change in both the ratio of tax revenues (TXR) to total revenues (TR) and that as a share of GDP. For example, tax revenues as a share of GDP rose from 5.8% in 1983/84 to 11.1% in 1993/94, but since 2001 the ratio seemed to be levelled off within a range of 10.9% - 12.1%. Over the same period, the contribution of tax revenues to total revenues has significantly increased: almost doubling. from 31.2% in 1983/84, to 60.9% in 1994/95. However, in 1999/2000 the ratio dropped to 52.5% before continuing to rise, reaching 70% (its highest ratio) in 2003. These figures indicate that there has been a tendency to increase reliance on tax revenues as a main source of government income.

Figure 1 – 1 also suggests that indirect taxes were a significant contributor to tax revenues until the Asian financial crisis in 1997. Since then, direct taxes have dominated tax revenues. This implies that the 1997 reform carried out by the Indonesian government had a significant impact on the tax system: as observed by

Ikhsan et.al (2005a), the Indonesia government introduced a modern VAT and income tax system to improve its overall taxation structure. Accordingly, it is not surprising to see that since the economic crisis in 1997, income taxes have begun to be the dominant source of tax revenues in Indonesia. This means that direct taxes have contributed more than indirect taxes to tax revenues. As noted by Uppal (2003), income taxes and VAT are not only the two main sources of government revenues – they also serve as powerful fiscal tools to achieve the national social and economic objectives of stabilisation.

Figure 1-1
Tax Revenues (TXR) as a ratio of Total Revenues (TR) and as a Share of GDP, including Direct (DT) and Indirect Taxes (IDT), 1983-2004

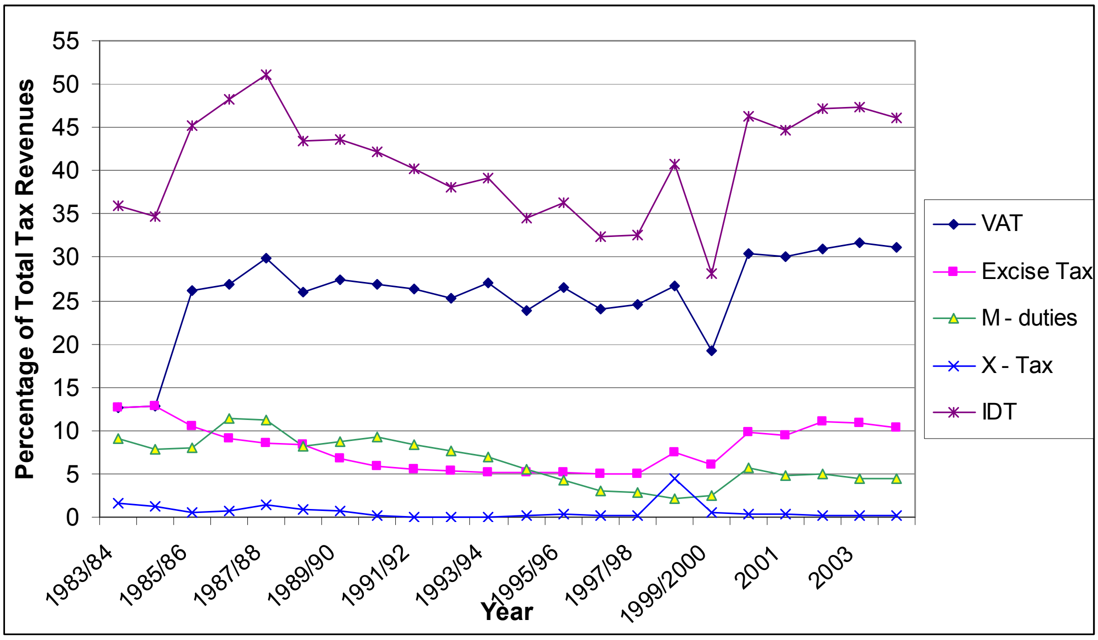


Source: Data of 1992-1994 quoted from Table 1 and 4, Anwar Nasution, Survey of Recent Development, BIES, vol. 31 No. 2 August 1995, Data 0f 1995-1999 collected from Statistics Bureau, data of 2000-2003 collected from Nota Keuangan dan UU RI no. 29/2002 tentang APBN Tahun Anggaran 2003. Data of total revenues, GDP and the recent data were collected from Key Indicators of Developing Asian and Pacific Countries, published by Asian Development Bank in various years.

Yet despite the fact that these tax reforms seem to have had some positive effects, not all of their impacts have been positive and the new tax laws incorporated a number of features that resulted in unnecessarily complicated administration (see for details in Brondolo, J., C. Silvani, E. Le Borgne and F. Bosch, 2008). Consequently, some aspects of the tax policy regime made the challenges of administering the tax system that much greater for the DGT.

Furthermore, there have been significant fluctuations in the growth of tax revenues that have been collected via indirect taxes. Figure 1-2 shows an overall declining trend in indirect tax revenues: from 1989 onwards, the percentage of total tax revenues collected by indirect tax revenues have continuously decreased until a period of crisis in 2000. Since then, indirect tax revenues have increased to reach about 48% of total tax revenues. By looking at each component that contributes to indirect taxation revenues, it is clear that fluctuations in VAT revenues dominate overall fluctuations whereas declining import duties and excise tax seem to be largely responsible for the declined (total) trend in indirect tax revenues.

Figure 1-2
Types of indirect taxes as a percentage of Tax Revenues (VAT, Excise tax and Import Duties), 1983 – 2004



Source: Ministry of Finance, Indonesia

As observed by Marks (2005), Indonesia also has very low revenue efficiency of VAT; behind that of Singapore and Thailand. VAT revenue is one of the indirect tax types which can be used to indicate the tax reform performance in terms of revenue adequacy (Marks, 2005). Table 1.2 depicts a relative performance of the VAT systems in various countries which is expressed by both the ratio of VAT revenue efficiency to GDP and that to total consumption. These ratios are both divided by the standard VAT tax rate, as computed by Marks (2005). The VAT revenue efficiency to GDP ratio for Indonesia was 32% in 2000. This means that VAT revenues made up 3.2% of

GDP. This figure places Indonesia in third place together with Vietnam but behind Thailand and Singapore.

Table 1-1
VAT Revenue Efficiency, Various Southeast Asian Countries (%), 2000 [a]

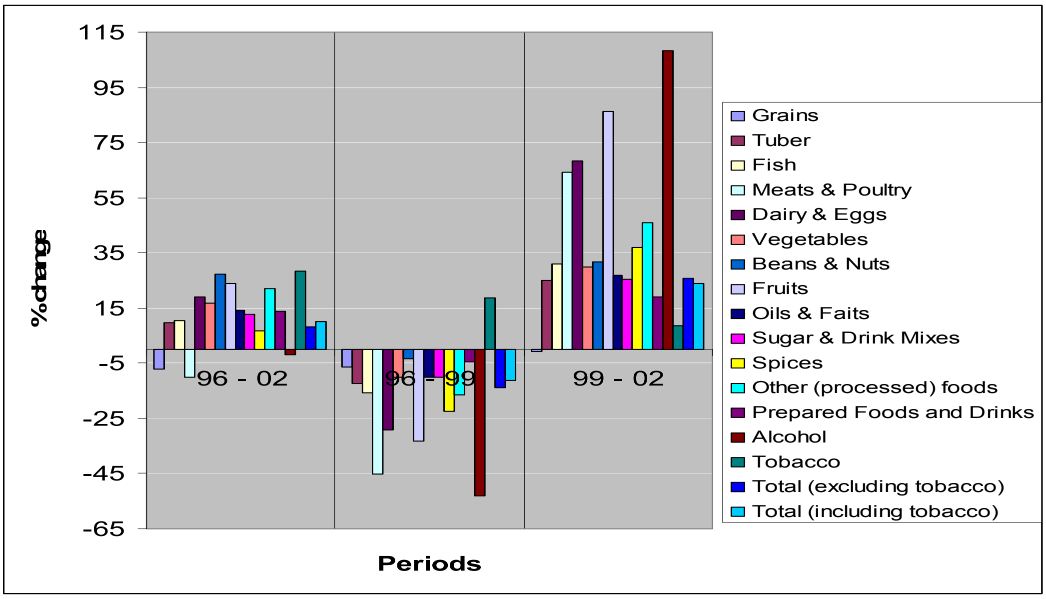
Countries	VAT Revenue efficiency relative to			
	GDP [b]	Rank [c]	Consumption[b]	Rank [c]
Indonesia	3.2	3	4.3	4
Philippines	1.6	4	1.9	5
Singapore	4.4	2	8.7	1
Thailand	4.5	1	6.7	2
Vietnam	3.2	3	4.5	3

Sources: Table 1, Marks, 2005. Proposed changes to the VAT: implications for tax revenue and price distortion, p.83. [a] Figures include general sales taxes and turnover taxes as well as VAT. [b] The ratios are divided by the standard VAT tax rate (10%). [c] Ranked by the author

It is argued that the VAT is typically more a tax on consumption than a tax on GDP. Accordingly, the VAT revenue efficiency to consumption ratio as an alternative measure; for Indonesia was 43% in 2000. In other words, VAT revenues constituted 4.3% of consumption. As a result, Indonesia is again ranked behind Singapore, Thailand and Vietnam although ahead of the Philippines.

Finally, a study by Molyneaux and Rosner (2004) adds to the list of the disappointing outcomes of the reforms by demonstrating a declining growth of real expenditure for most commodities, except tobacco, between 1996 and 1999; although increasing in 1999 – 2002. Interestingly, Figure 1.3 below indicates that in the period 1996 – 1999 the growth rate of real expenditure moved in the opposite direction with the indirect tax revenues trend. The Figure infers that in that period it shows a negative growth rate in real expenditures, with an exception for tobacco expenditure showing a positive trend. It should be admitted that this adverse trend is partly a result of the 1997 crisis.

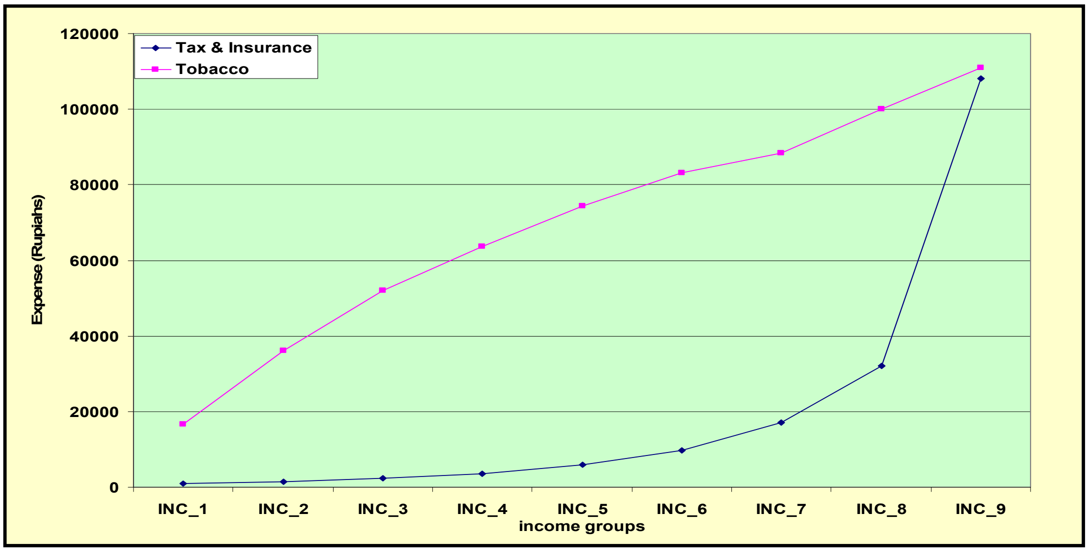
Figure 1-3
Growth of real expenditures of commodities observed, 1996 – 2002



Source: Table 1, Molyneaux, 2004, p. 21

Interestingly, as a preliminary finding, this study observes that the average monthly expense for tobacco is larger than that for tax and insurance according to income groups in 2002, although the expenditure on both commodities is positively related to income (see Figure 1.4 for details).

Figure 1-4
Average monthly expenses for tobacco and tax & insurance According to income groups in year 2002



Source: primary data of the 2002 SUSENAS

In summary, despite the fact that multiple reforms have been made there are clearly still some problems with the Indonesian tax system. The ongoing tax reforms will demand the basic tax principles of equity and efficiency, in addition to revenue adequacy. As is typical in a developing country, Indonesia's taxes are primarily collected through an indirect system, which means that there is a critical connection between the prices of the consumer goods to which taxes are applied, the welfare of households, and government revenue. For this reason, the main challenge of the Indonesian tax reforms is to determine how to raise revenues in an efficient and equitable manner (i.e. at the least social cost).

1.2 Brief discussion of important economic issues in tax reform analysis

It is widely accepted that every policy reform or policy change will affect not only economic variables, but also the behaviour of economic agents, including their wellbeing or welfare, both individually and aggregately. Tax reform is one of the examples for policy reform. As suggested by Ahmad and Stern (1991), *tax reform concerns the search for, and analysis of, systems that are improvements on the existing state of affairs* (p. 2). Improvement in this context is related to improvement in the indicators of welfare. Unfortunately, welfare is unobservable. However, changes in welfare can be identified by changes in welfare indicators, namely changes in income, in inequality, and in expenditure. Subsequently, these changes cause changes in utility or in "welfare". Therefore, the task of the present study is to link the change in taxes to changes in income, inequality, and expenditure as indicators of welfare.

It has been suggested that any tax reform proposal should deal with the basic tax principles of equity and efficiency (Deaton, 1997, Deaton and Grimard, 1992). In fact, any change in taxes, in particular indirect taxes, generates benefits and / or costs to society according to demand and supply patterns, and the effects of tax changes on government revenue, will also depend on the way in which demand (and supply) responds to changes in price that result from the changes in tax rates.

The effect of tax reform on social welfare has been extensively discussed not only by public economists and labour economists, but also by econometricians and welfare economists. Public economists and labour economists are concerned with how taxes affect the behaviour of economic agents in a choice between working and leisure whereas econometricians concentrate on methods for analysing these effects and welfare economists focus on the welfare i.e. utility or happiness of the economic agents.

However, welfare or wellbeing is difficult to measure and involves value judgements by economists in their analysis. In general terms, welfare means utility or happiness. As pointed out by Just, Hueth and Schmitz (1982), the economic welfare of an individual is formally known as his or her utility. The term "utility" is used interchangeably with happiness or satisfaction. For this reason, they argue that the level of the individual's utility is determined by the goods and services the individual can purchase in the market as well as non-market or non-priced goods.

Since welfare is cardinally unmeasurable it is difficult to produce good and appropriate indicators for welfare. The problem becomes more complicated when social welfare is involved. Even if happiness or welfare could be measured, a question of how to add the "smiles" of all individuals within a society is another complicated task for welfare economists. Therefore, it is not surprising to find that there are a variety of different approaches to trying to draw inferences about the changes in social welfare that occur in response to changes in tax.

As many studies have observed, although actual levels of welfare are unmeasurable, it is still possible to comment on changes in welfare. In order to measure the changes of welfare, the microeconomic notion of utility is employed; in which a society's utility is determined by the utilities of all its individuals, as noted by Morton (2003). Morton argues that as a proxy for utility, the notion of willingness to pay is utilised; the higher the willingness to pay the greater utility he / she can obtain. With this proxy, a Pareto improvement of welfare can be considered to have taken place at least one individual's utility rise and nobody else's utility falls.

As further identified by Morton, if one wishes to use the Pareto criterion to draw inferences about changes in social welfare that occur when there are changes in states of individual preferences or utilities, then one must adopt certain assumptions: (1) that social welfare is determined positively by the welfare of individuals; (2) that the welfare of individuals is determined by the goods and services they consume; and (3) that individuals are the best judge of their own welfare and act in their own self interest.

Accordingly, it is possible to use changes in the goods and services that an individual consumes as an indicator of changes in that individual's welfare or utility. Consumption of goods and services is different from utility but increases in consumption will lead to increases in welfare or utility.

Unfortunately, it is rarely ever possible to identify a policy that is a pure Pareto Improvement; every economic policy will unavoidably favour some persons to the disadvantage of others, as recognised by Suzumura (1987). Fortunately, the compensation criteria by Kaldor (1939), Hicks (1940), Scitovsky (1941), Samuelson (1950) and Little (1950), as recorded by Suzumura (1987), provide guidance. The general idea of this approach is to develop the Pareto principle applicability by introducing hypothetical compensation payment between gainers and losers. The compensation principle suggests that state A is preferable to state B if, in making the move from A to B, the gainers can, at least potentially, compensate the losers such that everyone can be made better off (***Potential Pareto Improvement***).

Other attempts to more formally consider changes in the welfare of multiple individuals were made by Bergson in 1938 and Samuelson in 1947 when they introduced the idea of a "Social Welfare Function" (SWF). This effort started from a belief that

> *"to examine the logical consequences of various value judgements, to say nothing of whose ethical belief they represented, whether or not they were shared by economists, or how they were generated, was a legitimate and important exercise of economic analysis" (quoted from Suzumura, 1987, p.418).*

Based on that belief, Bergson and Samuelson introduced a function that characterized an ethical belief, "which was required only to be rational in the sense of enabling complete and transitive welfare judgement over alternative social states, i.e. a social welfare function" (p.419). Specifically, their SWF was related to the Pareto Principle. Therefore, Bergson and Samuelson's SWF is well known as a Paretian (or individualistic) SWF (For a more detailed discussion of Social Welfare Functions see Chapter 2 of Literature Review). Further, as noted by Gans, King and Mankiw (2003, p. 448), Bergson and Samuelson note that *social welfare is a function of the levels of* *utility of members in society*. In this idea, there are fundamental assumptions which should be considered, namely, that utility is cardinally measurable and additive, and it is possible to compare welfare across individuals. For this reason, they believe that the SWF determines the socially preferred point on the utility possible frontier (UPF), which characterises the full set of Pareto efficient allocations although it needs an aggregation rule for the utility functions of all individuals. [1]

Mishan proposed an alternative definition of the SWF. As quoted by Just, Hueth, and A Schmitz. (1982, p.45), Mishan pointed out that:

> *"The SWF ...more narrowly defined,* ***as a ranking of all conceivable combinations of individual welfare………*** *although analysed in abstract terms, can be translated into practical propositions. Modern societies do seek to rank projects or policies by some criterion* ***of economic efficiency and to take account of distributional consequences".***

The above definitions imply that the SWF can be expressed both as a function of all combinations of individual welfare and as a statement of a society's objectives in terms of efficiency and equity aspects.

In order to utilise a SWF for measuring welfare, it is vital to understand what the indicators of social welfare are. For example, Sen (1974) and Mukhopadhaya (2002) make use of the mean of income and of an index of inequality to represent social welfare in terms of efficiency and equity aspects, whereas Francois and Romagosa (2003) approach social welfare as a function of per capita income, consumer prices and income inequality. Alternatively, Younger, Sahn, Haggblade, and Dorosh, (1999) propose that one should use household expenditures (per capita) rather than income as a measure of welfare. They provide two reasons for this. **First**, practically, households tend to report their expenditures more accurately than they report their incomes. They are more sensitive to disclosing incomes than expenditures. **Second,** theoretically, the life-cycle/permanent income hypothesis suggests that "expenditures are more stable representation of a household's long-term welfare than is income, because households try to smooth their expenditures given income fluctuations over time" (Younger et.al, 1999, p.307). As a result, they argue, expenditures reflect households' own estimates

[1] However, the Paretian SWF has been criticized in the sense of not allowing for the existence of losers (Morton and Andrew John, 2003).

of their permanent income over time and are thus a better proxy for their long-term welfare.

In brief, all the indicators and functions noted above are important to the proposed study because, by looking at the change in the behaviour of these indicators, which resulted from the introduction of tax reforms, a measure of the welfare improvement and detriment can be evaluated.

The key point to note here is that a SWF offers a framework in which the distributional consequences of a policy may be assessed by specifying the increase in an individual's utility that is needed to pay off a decrease in another individual's utility (Stiglitz, 2000). By utilising the SWF, the effects can be summed up first and subsequently, the net gains of different groups are weighted in order to obtain a summary of the impacts in a single number.

In other words, there are two key aspects to social welfare, namely economic efficiency and income distribution. Economic efficiency largely deals with the "size of the pie", whereas income distribution deals much more with "dividing up the pie". Broadly speaking, an increase in efficiency relates to an increase in the size of the pie, whereas an improvement in income distribution relates to more fairness in dividing the pie. Haveman (1970) provides a good example for this with regard to the impact of tax imposition. He argues that the tax imposition or the alternation of their levels does influence both size and the composition of GNP of a particular nation, the economic welfare of its people and the economic efficiency of its market system. He also examines a number of different types of taxes in terms of these perspectives. He concludes that the commodity tax is a regressive tax as poor people spend a higher proportion of their income on retail purchases than the rich. At the meantime, sales taxes take a proportionately bigger portion of the income of the poor than the rich - so that one can favour progressive taxation simply on the grounds that, it reduces inequality (pp. 79).

Economic theory provides tax reform researchers with powerful tools, suggesting the types of behavioural responses that are likely or feasible in response to a particular tax change. Yet much of what is known about the effects of tax reform is in fact based mainly on economic theory, rather than direct observation (Auerbach, 1996). Even though the theory is useful it does not always offer clear predictions, requiring convincing empirical evidence for further clarification. In addition, as observed by Van de Gaer et al (1997), the welfare evaluation of tax reform requires a combination of empirical facts and normative judgments; in which the analysis deals with a computation of the effects of changes in the instruments on the relevant economic variables.

Yet even when data is available, it is frequently not easy to determine what it tells us about the impact of tax reform. For example, it is not always easy to measure substitution and income effects separately, and changes in utility are not immediately observable although theoretically ideal for evaluating the tax reform impact.

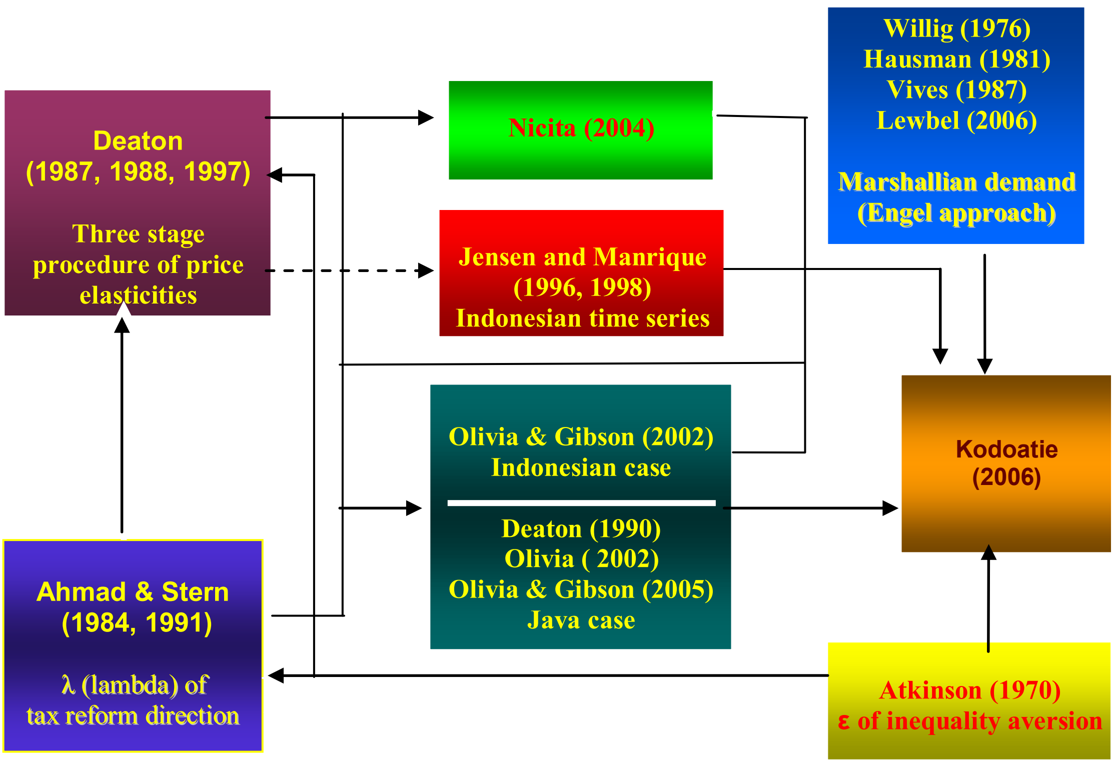
Accordingly, Auerbach (1996) suggests that to determine the impact of a tax reform, it is necessary not only to develop theories of that tax reform's impact, but also to test the theories. The lack of controlled experiments and of the ability to measure economic changes limits the scope for performing such evaluations. Thus even potentially important economic effects may be difficult to uncover, particularly within a period of time when such information would be most useful. In fact, most tax reform studies lack time series data. Accordingly, this makes it more difficult for tax reform analysts to do their work. Fortunately, some studies pioneered by a series of Deaton's studies attempt to circumvent this difficulty, dealing with cross-sectional data.

Many previous studies have focused on the marginal welfare cost of tax reform. The idea was introduced and initiated by Ahmad and Stern (1984, 1991) and has been popularised by Deaton with his series of studies (1987, 1988, 1990, 1997). However, to estimate the change in welfare that results from tax change, one must have knowledge of each household's response to price change for two important reasons (Nicita, 2004, p.3): (1) there is a direct relationship between changes in prices and household's welfare (Mc Culloch, Winters & Cirera, 2002 in Nicita, 2004); (2) the link between the prices of taxed goods and government revenues is critical in developing countries where taxes are mainly collected via an indirect system taxing consumer goods (Ahmad and Stern, 1991 in Nicita 2004). Accordingly, it is undeniable that one of the main motivations for demand studies in particular in estimating demand systems is to facilitate welfare analysis of tax policy reform in capturing the consumer's reactions to prices and incomes changes.

1.3 Links between present study and previous studies

Most relevant to this thesis are the studies of Deaton (1990, 1997), Ahmad and Stern (1984, 1991), Nicita (2004), Olivia (2002), Olivia and Gibson (2002), Jensen and Manrique (1996, 1998) and Olivia and Gibson (2005). Their studies provide a valuable justification for the importance of the current study. They inspire the inclusion of income variable, a new method for obtaining an inequality aversion parameter (Atkinson Index utilisation); and they provide guidance in the handling of missing variables in aggregate data. The Deaton contribution is to introduce a method of computing price elasticities when price is unobservable, whereas Ahmad and Stern provide a way of conducting a cost benefit analysis of tax reform of lambda and subsequently provide information about whether the tax rates on different commodities should be altered to increase either efficiency or equity. A detailed review of their studies can be found in Chapter 2.

Figure 1-5
Links between present study and previous studies



Ahmad and Stern (1991) introduce the concept of welfare weights to aggregate or to compare monetary gains and losses for individuals. The welfare weights came in via the concept of the social marginal utility of income related to a policy tool. Ahmad and Stern (1991) define the welfare weight as "the effect on social welfare of a marginal tax change divided by the effect on revenue of the marginal change – hence it is the social cost of raising an extra unit of tax revenue via that tool" (p.320). They further elaborate the idea in the context of indirect tax analysis. They suggest that for an indirect tax this could be computed in a fairly simple way making use of welfare weights and consumption patterns for the numerator and effective taxes and demand responses in the denominator. Once these marginal social costs are computed then it is easy to identify the improving directions of tax reforms "since one should shift revenue-raising on the margin from the higher to the lower cost instruments" (p. 320). This concept becomes the central issue of tax reform studies since their study of Indian cases carried out in 1984. The concept is later known as lambda (λ) (Ahmad and Stern, 1984, 1991; Olivia, 2002, Olivia and Gibson, 2002 and Nicita, 2004).

The lambda ratio or Pigovian ratio, using Nicita (2004) terminology, is theoretically expressed by the following formula:

$$\lambda_i = -\frac{\partial V/\partial t_i}{\partial R/\partial t_i} \qquad \textbf{1-1}$$

Where λ_i measures the marginal social cost of raising one unit of revenue from increasing the tax on good *i*. The formula 1.1 above implies that an increase in the tax rate on good *i*, will cause a change in welfare $(\partial V/\partial t_i)$ and a change in revenue $(\partial R/\partial t_i)$.

In practice, as observed by Nicita (2004) and Olivia (2002), the ratio of 1.1 can be computed by the following expression as follows Deaton (1997).

$$\lambda_i = \frac{w_i^{\varepsilon} / \tilde{w}_i}{1 + \frac{t_i}{1+t_i}\left(\frac{\theta_{ii}}{\tilde{w}_i} - 1\right) + \sum_{k \neq i} \frac{t_k}{1+t_k}\left(\frac{\theta_{ki}}{\tilde{w}_i}\right)} \qquad \textbf{1-2}$$

The numerator of equation 1.2 is a pure distributional measure of the good *i* which can be varied according to a variation of the "inequality aversion" parameters, ε, focusing more on the poorer households, whereas the denominator is the tax factor multiplied by the income elasticity of good *i* with respect to its price, quality and quantity effects taken together. The first term of the denominator measures the own-price effect of the tax whereas the last term is the cross-price effect capturing the effect on other goods due to the change in tax on good *i.* In fact, the lambda ratio is, in essence, the equity effect of tax change divided by the efficiency effect.

The interesting feature in this study is that the equity effect will be computed by making use of Atkinson Index for demonstrating the variation of the parameter of inequality aversion, whereas the efficiency effect of the price effects of tax, both in terms of own price and cross price effects, will be calculated according to the three stage procedure suggested by Deaton. In this context, the study offers an alternative demand model to the standard Deaton demand model usually used by the previous studies. The alternative model is the Marshallian - Engel demand model with income inclusion to capture household demand response to income changes (The completed discussion of the models and the justification are provided in Chapter 4).

Most previous studies have used compensated 'Hicksian' demand function to facilitate both their demand and tax reform analyses. Apart from utilising the same function as the previous studies, this study also employs an uncompensated 'Marshallian' demand function as an alternative to estimate price elasticities. In terms of policy prescription, the Marshallian demand function considers both the substitution and income effects and will reach the same conclusion as the compensated 'Hicksian' demand approach if income elasticities and / or the expenditure share for the goods are small enough to make the income effect negligible. Consequently, Marshallian demand function will provide reasonable demand approximations of Hicksian demand (Willig, 1976, Hausman, 1981, and Vives, 1987). This study is motivated to prove this thesis statement for the case of Indonesia.

1.4 Research questions and aims of the study

The key questions arising from the foregoing are:

1. *Can Indonesia's commodity tax system be reformed in a way that maintains revenue while improving social welfare?*

2. *Which commodity taxes should be altered so as to increase overall tax revenues at least social cost?*

To answer these questions, one must complete three 'tasks', which also outline the general approach of the study:

(a) To determine the way in which demand for different commodities changes in response to:
   a. Changes in price
   b. Changes in income

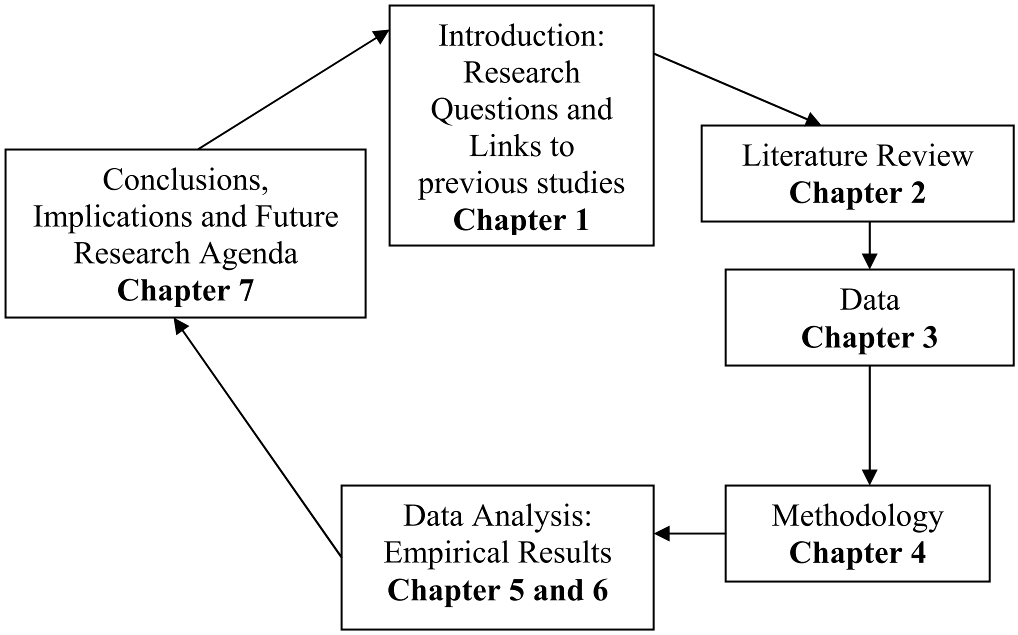
(b) To obtain a unique estimate of inequality aversion in Indonesia (using Atkinson Index)

(c) To investigate a direction for indirect tax reform by employing the estimated demand elasticities and the inequality aversion parameter combined with information on existing tax rates for future tax policy recommendations

1.5 Organisation of Thesis

The rest of the thesis is organised as follows. **Chapter 2** reviews the literature on demand and tax reform studies, so as to provide a theoretical framework for model development and to identify an appropriate analytical methodology. **Chapter 3** describes the data used in this study. **Chapter 4** discusses the analytical methods employed in this study, specifically outlining the methods used to compute price elasticities; to estimate the inequality aversion "ε" parameter (utilising Atkinson Index); and to conduct the tax reform analysis of lambda. **Chapter 5** and **Chapter 6** present Empirical Results for Demand Elasticities and Tax Reform Analysis using the 2002 Indonesian Data and compare these findings to similar previous studies. Finally, **Chapter 7** presents conclusions, implications and future research agenda guided by the research questions. This chapter also discusses some of the limitations of the research in order to provide incentives for conducting future research. **Several appendices** give details on matters that readers may need to refer to the specifics of some of the procedures used. In short, the full chapters can be diagrammatically illustrated as Figure 1.6 below.

Figure 1-6
Links between Chapters and the contents



Chapter 2
Literature Review

2.1 Introduction

Tax is often a source of heated political debate, as tax imposes a cost on the taxpayer. As noted by Rosen (2005), a tax levies a cost which is not simply equal to the amount of money paid in tax; it goes beyond that. This is clearly elaborated by Haveman (1970) who notes that taxes impose costs on the private sector – by foregoing some of their income, taxpayers give up benefits which they could have realized if they were able to freely spend their income. Accordingly, he argues that the social cost of taxes to the private sector is the foregone opportunity to produce, consume, and enjoy some goods and services. It is important to search for these lost opportunities in determining the true cost of taxes.

In addition, most public finance and tax policy experts agree that taxes should have a minimal or neutral effect on the behaviour of consumers, satisfying economic efficiency principles. As almost all taxes result in some loss of economic efficiency, the challenge for economic policy, in particular tax policy, is to limit the extent of the efficiency losses and at the same time provide a fair tax system that treats people in similar situations similarly and treats people of different economic means differently, while keeping the government revenue neutral (Stiglitz, 2000; Sandmo, 1976). Accordingly, it is important to fully understand these basic tax principles in order to produce a rational tax policy accepted by the majority of society (see appendix A for the detailed discussion of tax principles)

In relation to the tax policy, any effort to reform or change a tax rate, in particular a change in indirect tax, requires knowledge of the taxable commodities (more specifically, the elasticities). At the same time, this knowledge should be in line with knowledge of income distribution existing in the society. For this reason, the present study will use the following questions to examine whether the trade – off between efficiency and equity occurs in the tax reforms in Indonesia. They are:

1. *Can Indonesia's commodity tax system be reformed in a way that maintains revenue while improving social welfare?*

2. *Which commodity taxes should be altered so as to increase overall tax revenues at (the) least social cost?*

The aim of this chapter is to identify an appropriate methodology for computing demand elasticities and conducting tax reform simulations, in order to answer the those central questions of tax reform analysis similar to those conducted by Deaton (1990), Deaton (1997), Manrique and Jensen (1998), Olivia (2002), Olivia and Gibson (2002, 2005), and Nicita (2004). To achieve this aim, this chapter seeks to accomplish three specific tasks: namely (1) to discuss how taxes affect households' behaviour and hence their welfare by looking at the two important tax principles of efficiency and equity aspects; (2) to discuss relevant theory of demand functions and the empirical issues; (3) to critically review former studies in relation to demand analysis as well as tax reform analysis in various countries including Indonesia. These tasks will give background information and provide a justification for the focus of the study and for the models selected for analysis.

The rest of the chapter will be organised as follows. This introduction will be followed by Section 2.2 outlining definitions and the guiding principles of tax reforms. Section 2.3 presents theoretical considerations regarding the efficiency aspect of tax in relation to welfare change. Specifically, this section highlights the effects of tax imposition in terms of substitution and income effects, and outlines an inference of a money measure of welfare change and an excess burden resulting from the imposition of a tax in terms of equivalent variation, compensating variation and consumer surplus. This section also briefly reviews various demand models which focus on relevant concepts of how the current study follows Deaton's procedure for computing price elasticities as an early step to tax reform analysis. Section 2.4 addresses an equity aspect of tax, and how the Social Welfare Function (SWF) helps solve the equity problem arising, due to the existence of non-constant marginal utility of income (MUY). Section 2.5 presents a brief review of empirical studies on demand analysis in various selected countries, including Indonesia, as well as on tax reform analysis. This section underlines the importance of demand elasticities as well as an inequality aversion parameter to the current tax reform analysis. Research gaps of the former studies will be presented in Section 2.6. The methodological approach chosen for this study (including a new approach to obtaining a unique value of inequality aversion) will be briefly summarised in Section 2.7.

2.2 Tax reforms: definitions and guiding principles

The following sub-sections are devoted to providing a preliminary overview of tax reform analysis. To begin with, some definitions of tax reforms including some overall guiding principles will be presented, in order to have a better understanding of the motivation of the current study. The proposed definitions refer to scholars such as M Feldstein (1976), Ahmad and Stern (1991), and Deaton (1997).

Feldstein (1976, pp. 90-93) suggests that "tax reform is a change from the existing tax structure" (p.90). In line with Feldstein, Ahmad and Stern (1991) suggest that at least two basic tax principles of equity and efficiency should be taken into consideration in conducting the tax reform analysis (see Appendix A for more detailed). They state that economic theory helps make up the analysis, and the models they introduce provide an integrated framework for examining these issues. They further argue that a number of related roles in tax analysis can be performed by economic theory:

> *"First, it can provide basic principles for the design and reform of taxes, by pointing to the appropriate bases for taxation and indicating which taxes are likely to cause efficiency problems, and by giving guidance on how to set rates. Second, it can provide benchmarks in terms of simple models in which policy implications are clear. Third, it can provide methods for organising data and making calculations". (p.52)*

In addition, Ahmad and Stern (1991) suggest that there are at least three particular instruments which have played a central role in analysing tax reforms, namely: effective taxes, the use of household survey data, and the social marginal cost of public funds.

First, the effective taxes calculation was originally motivated by the estimation of the revenue effects of tax changes flowing through demand movements. The main constituents in the computation of effective taxes were tables of input-output and commodity tax collections and these would be available for many countries.

Second, household survey data are very useful for working out the distributional impact of policy change. It is especially desirable for the investigator to have the data made available at the household level, to look into the impact of the changes on categories of households chosen by the policy-maker, as the classifications are crucial for observing the impact of policy changes in detail. Due to the concern in evaluating the effects of changes in prices and money incomes, Ahmad and Stern suggest that the indirect utility function (the expenditure function) which expresses household utility as a function of the prices it faces, and the income at its *disposal,* is a convenient instrument for analysis. In other words, they suggest that the welfare impact of marginal tax reforms for each household is simply computed from the expenditure patterns.

Third, it is important to introduce a concept of welfare weights to aggregate or to compare monetary gains and losses for individuals. The welfare weights came in via the concept of the social marginal utility of income related to a policy tool. Ahmad and Stern (1991) define a welfare weight as “the effect on social welfare of a marginal tax change divided by the effect on revenue of the marginal change – hence it is the social cost of raising an extra unit of tax revenue via that tool” (p.320). They further elaborate the idea in the context of indirect tax analysis. They suggest that for an indirect tax this could be computed in a fairly simple way making use of welfare weights and consumption patterns for the numerator, and effective taxes and demand responses in the denominator. Once these marginal social costs are computed then it is easy to identify the improving directions of tax reforms “since one should shift revenue-raising on the margin from the higher to the lower cost instruments“ (p. 320). Since their study of Indian cases carried out in 1984, this concept has become the central issue of tax reform. The concept was later known as lambda (λ) (Ahmad and Stern, 1984, 1991; Olivia, 2002, Olivia and Gibson, 2002 and Nicita, 2004).

The lambda ratio or Pigovian ratio (using Nicita terminology) is theoretically expressed by the following formula:

$$\lambda_i = -\frac{\partial V / \partial t_i}{\partial R / \partial t_i}$$

Where λ_i measures the marginal social cost of raising one unit of revenue from increasing the tax on good *i*. The formula above implies that an increase in the tax rate on good *i*, will cause a change in welfare $(\partial V/\partial t_i)$ and a change in revenue $(\partial R/\partial t_i)$.

As observed by Nicita (2004) and Olivia (2002), in practice, the ratio can be computed by the following formula following Deaton (1997).

$$\lambda_i = \frac{equity}{efficiency} = \frac{w_i^{\varepsilon} / \tilde{w}_i}{1 + \frac{t_i}{1+t_i}\left(\frac{\theta_{ii}}{\tilde{w}_i} - 1\right) + \sum_{k \neq i} \frac{t_k}{1+t_k}\left(\frac{\theta_{ki}}{\tilde{w}_i}\right)} \qquad \textbf{2-1}$$

Where,

$$w_i^{\varepsilon} = \frac{\left[\sum_{h=1}^{H}\left(\frac{x_h}{z_h}\right)^{-\varepsilon} x_h w_{ih}\right]}{\sum_{h=1}^{H} x_h} \quad and \quad \tilde{w}_i = \frac{\left[\sum_{h=1}^{H} x_h w_{ih}\right]}{\sum_{h=1}^{H} x_h}$$

In fact, equation 2-1 practically expresses two basic tax principles, namely the equity and the efficiency aspects. The numerator of the equation demonstrates the equity aspect of the tax reform analysis, where the inequality aversion parameter showing how people value equality and clearly care about poor society members, plays an important role. In other words, the numerator of equation 2-1 is a purely distributional measure of the good *i* which can be varied according to a variation of the “inequality aversion” parameters, ε, focusing more on the poorer households.

In the meantime, the denominator of the equation 2-1 expresses the efficiency aspect of the analysis, in which a measurement of demand elasticities in terms of own-price and cross-price effects (for other goods) because of the tax change on good *i,* is considered, given that the information of the existing tax rates of the commodities observed are available. Ideally, the efficiency analysis of the welfare impact of tax reform depends on the elasticities of the compensated demand.

The denominator is the tax factor, multiplied by the elasticity of good *i* with respect to its price, quality and quantity effects taken together. The first term of the denominator measures the own-price effect of the tax, whereas the last term is the cross-price effect capturing the effect on other goods due to the change in tax on good *i.* A detailed discussion for a derivation of this ratio will be discussed thoroughly in Chapter 4.

Interestingly, as observed by Fane (1991a), Ahmad and Stern’s Marginal Social Cost of Revenue has a similarity to a concept of tax inefficiency, the marginal deadweight burden, which is initially, in fact, introduced by Diamond and Mc Fadden (1974 in Fane 1991). Fane (1991) further argues that the tax inefficiency is equal to the compensated radial elasticity (CRE) of the base of that tax, meaning that there is a percentage reduction in that base because of a compensated 1 percent radial increase in all tax rates. This elasticity concept suggests that *'the highest taxes should be levied on the activities with the lowest elasticities'; and the highest taxes should be levied on the activities which are complementary with activities which are not directly taxable'*. These two rules seem to be similar to a piecemeal policy reform recommended by Hatta (1977), suggesting that efficiency can be increased by increasing taxes on bases with relatively low CRE's, while reducing taxes on bases with relatively high CRE's.

2.3 Efficiency aspects of tax reform analysis

As suggested by many text books, tax imposes a cost on the taxpayer in terms of opportunity to consume, produce, and enjoy goods and services. Most public finance and tax policy experts agree that taxes should have a minimal, or neutral, effect on the behaviour of consumers, thereby satisfying the economic efficiency principle. In other words, how demand responds to price changes that occur as a result of a change in tax determines the efficiency effects.

Due to distorting economic decisions on income and consumption which may subsequently affect the individual's welfare – sometimes referred to as a welfare cost or deadweight loss (DWL) – an introduction of the concepts of 'income effects' and substitution effects' becomes important in measuring the excess burden of the tax.

2.3.1 Price changes caused by taxes

Stiglitz (2000) elaborates on the concepts of income and substitution effects, noting that taxes affect individuals in two ways. First, the tax makes the individual worse off by leaving him /her with less money to spend. Normally, when an individual is worse off, the individual consumes less of all goods. The amount by which his/her consumption of the taxed good is reduced ,due to a fall in his/her real income is called the income effect of the tax. Second, the tax makes a good relatively more expensive than other goods. When the good becomes relatively more expensive, individuals find a substitute. The extent to which consumption of the taxed good is reduced because of the increased relative price is the substitution effect (see Appendix A for more detailed discussion).

For normal goods, an increase in price leads to a fall in consumption. This is because the substitution effect causes less to be purchased (altering the pattern of consumption) as the individual moves along an indifference curve and the income effect also causes less to be purchased as purchasing power (a consequence of a decrease in 'real' income) falls – movement to a lower indifference curve. For inferior goods, substitution and income effects are in opposite directions – *a priori* the overall effect is unknown.

2.3.2 Measuring the welfare effect of a tax

It has been discussed in the previous section that tax imposition resulted in increase in price and subsequently it makes households worse-off in terms of purchasing power and altering their consumption patterns against their wishes. In brief, the tax imposition leads to a reduction in welfare. Unfortunately, welfare is unmeasurable and unobservable because it involves subjective consideration. This means that a variety of welfare definition can be subjectively proposed. Therefore, it is not surprising to link that there are a variety of approaches to social welfare (Robledo et al, 2007):

1. **Marshallian consumer surplus** (CS) - developed by Marshall in the 1890s by making use of demand curve analysis. For the individual, consumer surplus is defined as the area under the Marshallian demand curve above the current price. The associated deadweight loss of a tax is defined as the change in consumer surplus minus tax revenue (assuming a perfectly elastic supply).
2. **Hicksian concepts of compensating and equivalent variations** (CV and EV) developed by Hicks in the 1930s by utilising indifference curve analysis. The compensating variation is defined as the minimum amount of income that the consumer should receive (i.e. compensation) to keep his/her utility unaffected by the price change so that he/she is as well off as before, whereas the equivalent variation can be expressed as the maximum amount the individual would be prepared to pay to circumvent the subsequent tax – associated price change (Creedy, 2001, Lavergne et al, 2001). The Hicksian concepts have

It has been observed that almost all empirical studies share the common feature of utilising the Marshallian surplus to evaluate deadweight losses (Lavergne et al, 2001). Indeed, the analysis is intuitively simple, easily calculated and understood, but not quite accurate as several drawbacks have been identified (Lavergne et al, 2001):

1. When there are multiple price changes, the size of Marshallian consumer's surplus is not path independent but is determined by the path integration (Dixit and Weller, 1979 in Robledo and Wagener (2007)). This means that there are many different money measures for a unique change in utility. More importantly, the analysis does not take into account the change in utility resulting from the price change.
2. In general, the Marshallian surplus is not an exact measure of welfare change, since the utility of consumers along the ordinary demand curve is not constant.

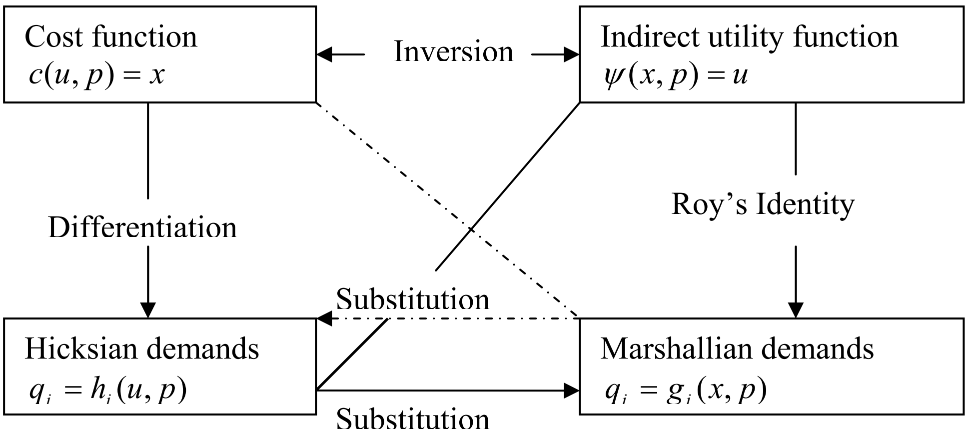
Due to these problems, they further suggest that the exact welfare change measure ought to be according to the compensated Hicksian demand curve. By considering a constant *real* income demand curve, *not* a constant money income; then the income effect of the price change should be taken out and the measure should only focus on the substitution effect.

Those problems have also been identified and justified by Willig (1976) and Hausman (1981). In fact, Hausman attempts to assess the accuracy of the Marshallian approximation. He observes that for a good which comprises just a small part of the total budget, the Marshallian area is reasonably accurate, as proven by Willig. Willig adds that the two Hicksian measures of EV and CV are equivalent and equal to the Marshallian CS only under the restrictive assumption of constant marginal utility of income (Lavergne et al, 2001).

It has also been observed that a choice for utilising those demands is only a matter of convenience. Empirical studies often make use of Marshallian (uncompensated) demands because data on prices and nominal income are more readily available (empirically observable) whereas theoretical work frequently employs Hicksian (compensated) demands.

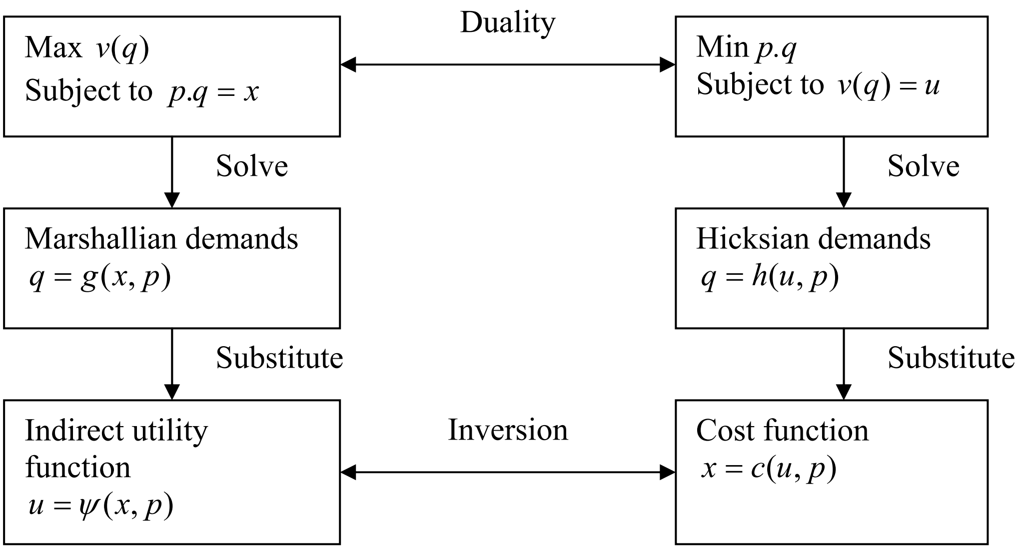
An important feature of the Hicksian demand functions which can be identified, as observed by Deaton and Muellbauer (1980) and Thomas (1987), is that the functions are the derivatives of the cost function, whereas the cost function itself can be inverted to yield the indirect utility function and subsequently, by making use of Roy's identity, to derive Marshallian demand functions. To clarify this, Deaton and Muelbauer (1980) provide a good description of the relationship between these demand functions (see Figures 2.2 and 2.3).

Figure 2-1
Demand, cost, and indirect utility functions



Source: Deaton and Muellbauer, 1980, Figure 2.10 p. 41

Figure 2-2
Utility maximisation and cost minimisation



Source: Deaton and Muellbauer, 1980 Figure 2.8 p. 38

It has been observed that in a paper entitled "Small income effects: Marshallian Theory of Consumer Surplus and Downward Sloping Demand", Vives (1987) formalises the Marshallian idea by stating that when the proportion of income spent on any commodity is small, then the income effects are small. Vives emphasises what Willig (1976) and Hausman (1981) put forward some years ago about what conditions are supposed to be met in permitting the consumer surplus of the Marshallian demand function to be equal to the compensation variations of the Compensated Hicksian demand function.

Vives (1987) rewrites the Slutsky relation in elasticity terms; noting that the own price elasticity of a good (of Marshallian demand) equals the compensated price elasticity (Hicksian demand) minus the expenditure share of the good times the income elasticity of demand. He observes that, ceteris paribus, when the proportion of income spent upon a particular commodity is small, the income effect on that commodity should be small too. Vives quotes Hicksian's Law of Demand to support his argument: "even if a good is inferior, "the demand curve will still behave in an orthodox manner so long as the proportion of income spent upon the commodity is small, so that the income effect is small" (Hick (1946, p.35), requoted from Vives (1987, p.1). Meanwhile, Vives (1987) also provides back – up for the problem occurring in the ceteris paribus assumption, namely, if the expenditure share on the good gets small, what happens to the income elasticity of demand? Vives quotes Marshallian's argument in his book of Principles of Economic Consumer Surplus and Downward Sloping Demand on the supposition that "the marginal utility of money to an individual purchaser is the same throughout" (Marshall (1920), p. 842), meaning a "constant" marginal utility of money, i.e. income effects are absent. In brief, Vives reaches the conclusion that the Marshallian notion relates to the circumstance if any good represents only a small part of the consumer's expenditure then income effects are negligible; subsequently the Marshallian demand is approximately approaching the Compensated Hicksian demand.

Vives (1987) argument here is used as a justification for making use of Model II as an alternative to the Compensated Hicksian demand function, for analysing the welfare effects of tax reforms analysis. This is discussed in more detail in Chapters 4 and 5.

2.3.3 Minimising excess burden

To minimise total excess burden, tax rates should be set so that the percentage reduction in the quantity demanded of each commodity is the same, as observed by Rosen (2005), this is called as Ramsey rule. However, in terms of government revenue generation and efficiency consideration, the Ramsey rule does not necessarily suggest all rates have to be set uniformly. The tax rate set should be dependent on the demand elasticities of the taxable goods, which are clearly expressed in Inverse elasticity rule. The Inverse elasticity rule suggests that the tax rates should be inversely proportional to elasticities as long as commodities are unrelated in consumption (Rosen, 2005). The idea is mathematically explained as follows:

$$t_x \eta_x = t_y \eta_y \qquad \frac{t_x}{t_y} = \frac{\eta_y}{\eta_x}$$

By assuming that two goods involved, x and y, the higher is η_x (demand elasticity of good x) relative to η_y (demand elasticity of good y), the lower should be t_x (tax rate on good x) relative to t_y (tax rate on good y). The intuition reasoning behind the rule is that an efficient tax distorts economic decisions in particular by consuming the taxable goods as little as possible, as the more elastic the demand for a commodity, the greater the potential for distortion. The Corlett – Hague Rule complements the work of the efficient tax when dealing with leisure. The rule suggests that when there are two goods, efficient taxation demands taxing the good that is supplementary to leisure at a relatively high rate, because high taxes on complements to leisure provide an indirect way to make leisure move closer to the perfectly efficient results that would be possible if leisure were taxable.

As Auerbach and Hines (2002) point out, and Robledo et al (2007) noted, the equivalent variation gains relevance for tax policies because the Ramsey-problem of setting the rates of distortionary taxes in a welfare-maximizing way is equivalent to minimizing the excess burden from the tax system, calculated on the basis of the equivalent variation.

In summary, the Ramsey rule, the CRE introduced by Fane (1991), and the equivalent variation suggested by Auerbach and Hines (2002) and Robledo et al (2002) reach a similar conclusion i.e. that the efficiency aspect which is clearly expressed by the denominator of equation 2.2 corresponds to the demand elasticities and the existing tax rates of the current tax regime.

2.3.4 Estimating price elasticities

Many demand and tax reform studies provide evidence that a study on consumer demand plays an important role in a policy analysis, in particular in indirect taxation policy analysis. These studies also subsequently share a great deal of consumer welfare research (see Deaton (1997), Olivia (2002), Olivia and Gibson (2002), Nicita (2004)). Meanwhile, as mentioned in subsection 2.2, the efficiency effects are determined by how demand reacts to price changes, accordingly, in this context, an empirical demand analysis is important. It is, however, crucial to ask theoretical questions that must be answered by the economist, before conducting the empirical analysis of the consumer's behaviour (Phillips, 1974, p.30):

1. *Theoretical plausibility of the demand equation utilised in the computations has to be established. Does it satisfy the general restrictions of the theory of consumer's demand, so that it could be derived by maximising a utility function? If so, how is the use of a linear function to be justified? Are the particular restrictions resulting from linearity acceptable?*

2. *How can the economist (having established the theoretical plausibility) make sure that the estimated equation is a demand equation, and not something else?*
3. *Economic theory also warns us that to write the demand of good i as a function of its own price p_i only, one has to accept a number of assumptions, put together under the label 'ceteris paribus'. Income should certainly appear in it. To leave it out is implicitly to assume that it has been constant over the period considered. Was this in fact the case? What about the other prices? What about the implicit assumption of unchanged preferences?*
4. *Statistical data in most cases refer to markets in which several individuals operate. However, demand theory describes the behaviour of one individual consumer. There is thus a problem of aggregation over individuals.*

The above questions will be used as guidance for the current study to justify demand model selection and derivation which this whole section will be devoted to.

2.3.4.1 The Engel curve

Banks et al (1997) suggest that the Engel curve analysis has been an important tool in understanding the dynamics of household welfare, in particular in modelling income distribution and the evaluation of indirect tax policy reform (see also Gibson, 2002). Accordingly, this sub-section addresses the approach as a starting point for a discussion of how the present study selects and justifies a proposed demand model specification and subsequently draws a conclusion to adopt Deaton's three stage procedure. The discussion starts with a brief discussion of the important feature of the Engel curve including the first empirical studies analysis and a discussion of Deaton's budget share approach will follow.

The Engel curve has inspired many recent demand studies utilising household budget data in their unit analysis. In fact, the function is named in honour of Ernst Engel in 1857, the first scholar to formulate empirical laws governing the relation between income and particular categories of expenditure. His work suggests the following laws:

1. Food is the most important item in household budgets;
2. The proportion of total expenditures allocated to food decreases as income increases;

3. The proportion devoted to clothing and housing is approximately constant, while the share of luxury items increases when income increases

As observed by Lewbel (2006), the Engel curve is the Marshallian demand function describing how a consumer's expenditures on some goods or services relates to the consumer's total resources holding prices fixed, so $q_i = g_i(y, z)$, where q_i is the quantity consumed of good i, y is income, wealth, or total expenditures on goods and services, and z is a vector of other characteristics of the consumer, such as age and household composition. It is also important to note that Engel curves are commonly expressed in the budget share form $w_i = h_i[\log(y), z]$ where w_i is the fraction of y that is spent purchasing good i. The goods are typically aggregate commodities.

As observed and reviewed by Phlips (1974), there have been two earlier seminal studies applying the Engel curve approach: Allen and Bowley's *Family Expenditure* and Prais Houthakker's *The Analysis of Family Budget*. Allen and Bowley's (1935) study marks the first major analysis publication of cross-section data based on a theoretical model, whereas Prais and Houthakker's study (1955) has become a classic in this area as their study adopted different non-linear functions in order to obtain a better description of observed facts. Later, Prais and Houthakker introduced quality effect in linking the unit value and price variable.

Prais and Houthakker have tried out the following four different model specifications besides the linear one:

(1) $\log q_i = a_i + b_i \log y$ (Double – logarithmic);

(2) $q_i = a_i + b_i \log y$ (Semi – logarithmic);

(3) $q_i = a_i - \frac{b_i}{y}$ (Hyperbolic);

(4) $\log q_i = a_i - \frac{b_i}{y}$ (Log – reciprocal).

After a careful comparison of the statistical results, Prais and Houthakker conclude that the semi – logarithmic function gives the best results, as far as food items are concerned. This finding infers that a commodity may be categorised as a luxury at low income levels and as a necessity (income elasticity below one) at higher income levels. Meanwhile, Prais and Houthakker suggest that for all other goods and services, the double – logarithmic form gives the best statistical results. However, Phillips contends Prais and Houthakker's findings by arguing that much has been gained in terms of descriptive power; however, much has been lost in terms of theoretical plausibility. In other words, although Prais and Houthakker introduce more realistic changes of the income elasticities, they loose contact with the theory of utility maximisation.

Lewbel (2006) provides a good summary of the empirical studies of the Engel curve approach as an addition to Phillips's review. One of his reviews is the Allen and Bowley (1935) study. He observes that Allen and Bowley (1935) firmly connected their work to utility theory and estimated linear Engel curves $q_i = a_i + b_i y$ on data sets from a range of countries and found that the resulting errors in these models were quite large, which they interpreted as indicating considerable heterogeneity in tastes across consumers. This present study attempts to develop their work by using the ideas from Deaton as discussed below.

2.3.4.2 Deaton's method

It has been observed that Deaton (1986, 1987) has largely contributed to developing a methodology for using of household survey data, not only to identify spatial price variation but also to estimate price elasticities. In his first paper he demonstrates how to estimate the own-price elasticity for a single good by comparing its demand to its price, whereas in his second paper the methodology is broadened to encompass systems of demand functions, so that cross-price elasticities could be estimated and substitution patterns investigated. However, although providing satisfactory outcomes for the Cote d'Ivoire data, Deaton admits that his studies contain a number of unresolved problems, and the most serious of these is the utilisation of double-logarithmic demand equations. Such demand functions are inconsistent with basic theory, but more importantly, they cannot be employed when modelling households that do not consume all goods. Accordingly, the logarithmic form can exclude a large part of the households for narrowly defined product groups (Nicita, 2004, Deaton, 1990). In other words, the estimated demand functions can only be applied under positive consumption circumstances. However, Deaton further argues that for most policy purposes, it is the *unconditional* demands that are of interest, i.e. the revenue effect of a tax change is dependent on how total demand is changed and not on the margin level changes' occurrences. Nevertheless, in order to circumvent those problems, Deaton and Muellbauer (1980) suggest substituting budget shares for the logarithm of quantity purchased in the model. This approach later becomes well known as Deaton's three stage procedure.

It has been recognised that Deaton's (1990) budget shares and unit value equations which replace the double log formulation look very much like the 'Almost Ideal' demand system (AIDS) of Deaton and Muellbauer (1980) (in which the budget share equation is a linear function of the logarithms of real expenditure and prices). However, Deaton argues that there are 2 reasons why the model here is different from AIDS. The equations should not be regarded as a direct representation of preferences, but simply as the regression functions of budget shares and unit values conditional on the included right-hand-side variables. Zero-expenditures are included, so that the conditional expectation is taken over purchasers and non-purchasers alike.

The equation is no longer within the framework of a standard demand model, where quantities are a function of prices and the budget, but consumers select both quantity and quality. Accordingly, the consumers' expenditure is the product not only of quantity and price, but of quantity, quality, and price. As a consequence, the analysis has to consider the price and income elasticities of quality. The existence of these effects, as observed by Deaton, leads to a complication in the relationship between the parameters and the computed elasticities.

The procedure is as follows. The **first** stage makes use of within-cluster information on households' demand, income and products' unit values to obtain estimates of total expenditure and quality elasticities, as well as estimates of error-measurement variances and co-variances. The **second** stage utilises the first stage estimates to net out the effect of the total expenditure, quality, and household characteristics and therefore calculates the "corrected" budget shares and unit values. A regression of "corrected" budget shares on "corrected" unit values, averaged by cluster, produces an estimate of the ratio of the responses to price of the budget share and the unit value. **Finally**, in the third stage, the effect of price on the budget share is extracted from the ratio by using the theory linking quality and quantity elasticities. This detailed procedure will be discussed thoroughly in Chapter 4; empirical studies utilising Deaton's approach have been reviewed in section 2.5.

2.3.4.2.1 Dealing with unobservable prices

Price is one of the important variables for building a model of demand although there are other relevant variables such as income and family size, particularly for models which replicate the Deaton procedure for computing own-price and cross-price elasticities. Gibson and Rozelle (2001) argue that as the price is so important economists require good measures of the price to conduct studies for many applications in developing countries. These studies include a study of price elasticities' estimation in the effective reform of indirect taxation and subsidy regimes to predict changes in either public expenditure or tax revenues due to demand changes following subsidy or tax rates movements (Laraki, 1989; Ahmad and Stern, 1991, as observed by Gibson and Rozelle (2001), Olivia, 2002; Olivia and Gibson, 2002).

Surprisingly, despite being important for so many analyses, few studies systematically collect price data. Gibson and Rozelle (2001) observe that state statistical bureaus in countries such as China, Indonesia and Pakistan do not collect market- price data that can be matched to their rural household income and expenditure surveys. They argue that without good price data, economists have had to turn to imperfect proxy measures, such as *unit values* (the ratio of household expenditure on a particular good to the quantity consumed).

As observed by Gibson and Rozell (2001), the ranges of applications where unit values have recently been used include the analysis of indirect tax and subsidy reforms (Deaton and Grimard, 1992; Olivia, 2002, Olivia and Gibson, 2002; Nicita, 2004). However, they have found that in some applications, such as demand studies, the use of unit values is believed to give biased results (Deaton, 1997). The problem with unit values is that, they further elaborate, in contrast to market prices, the unit values reflect household-specific quality and reporting error effects, and are subject to sample selection effects, because they are unavailable for non-purchasing households. Even procedures developed by Deaton (1990) to correct these biases have been shown to produce inaccurate and imprecise results (Gibson and Rozelle, 2001). Alternative strategies, such as using more readily available *urban* price series as proxies for the prices faced by rural households may also cause bias (Alderman, 1988).

Gibson and Rozelle (2001) claim that their paper is one of the only papers which empirically shows the magnitude of the bias from using unit values as proxies for market prices. Surprisingly, they admit that d*espite the widespread reliance on unit values and despite the plea by Deaton (1990), there has never been a 'crucial experiment' in which results calculated from market price data are compared with the results from either naïve or corrected unit value procedures* (p. 28). They conclude that unit values, whether used in naïve or improved estimation procedures, lead to biased estimates of price elasticities. Thus, based on these findings, it may be worthwhile to pursue the approach of directly asking households about prices, rather than indirectly obtaining price information from unit values.

A two equation system that includes both a demand relation and the explanation of the unit value is necessary if information on non-consuming households is to be used (Wales and Woodland, 1983 in Jensen and Manrique 1998). Wales and Woodland note that in the two equation models both sample selectivity and simultaneity problems are produced. Sample selectivity arises from the fact that some households may not purchase the commodity. Thus, neither expenditures nor unit values are observed for them. If the unit value is correlated with the disturbance term in the expenditure equation, then simultaneity must be accounted for. Simultaneity is an empirical issue that depends on whether or not the correlation coefficient of the two equations is zero. Its absence still does not ameliorate the selectivity problem.

As pointed out by Crawford et al (2002), one of the other difficulties in the estimation of demand systems using household data concerns the precise estimation of price reactions. The reason is that, whereas data on households normally exhibit considerable variation in expenditures, this is not typically the case for prices. Very often information about geographical variation in prices or variation over time within the period covered by one cross-section is lacking, so that prices are assumed uniform over all households of the same cross-section or at least they are assumed as having the uniform price at a cluster level, e.g. at village level (see Deaton (1990), Nicita (2004), Olivia (2002), Olivia and Gibson (2005)).

2.3.4.2.2 Dealing with missing observations

As recognised in the previous subsection, the unobservable price makes precise estimating of price reaction difficult, so Crawford et al (2002) developed a method for this by utilising unit value data exploiting the implicit links between quantity and unit value choices, and building on methods previously proposed in the demand literature. They argue that this method permits us to combine appealing Engel curve specifications with a model of unit value determination in a way which is consistent with demand theory. They believe that their new approach to the estimation of demand systems on the basis of unit values has an advantage over Deaton's approach because their approach treats unit values as consumer choice variables; this leads to an improvement, both in demand theory in terms of consistency, and in the naive treatment of unit values as error-ridden measurements of prices in terms of statistical consistency. Case (1991 in Olivia and Gibson, 2005) supports Crawford et al's (2002) argument about statistical consistency by stating that combining, on the one hand, a proper treatment of the fact that unit values are outcomes of choice and, on the other, the spatial patterns of demand, would seem a rewarding endeavour.

Dealing with aggregate data adds the complication of the unit value computation. Fortunately, Olivia and Gibson (2005) offer a formula to deal with this problem. They suggest that it is important to compute a unit value index for aggregate data analysis.

$$\ln V_{jk} = \sum_{i=1}^{I} \overline{w}_i \ln v_{ij}.$$

The unit values for each of the number of single commodities were aggregated, using a weighted geometric index, to provide a unit value index for each of the number of food categories. The weights utilised here are the average budget shares for each component food commodity in the group, computed over all households in the survey. For example, for household j the unit value index for cereals k, ln V_{jk} depends on the unit values, $v_{ij,}$ and weights for the i individual cereals types making up group cereals k

Many studies, including the present study have recognised that zero expenditure can occur for many reasons, i.e. the household cannot afford to buy an expensive good, religious considerations prevent the household from buying the goods, the household could not recall his/her expenses as the goods were bought in infrequently, or the household consumed from his/her own production. In fact, this zero-expenditure problem leads to missing value in unit values. Accordingly, much data should be excluded from the analysis. If this is the case, then the non-zero demand model specification is only valid for those households which consume the analysed commodity not for no-consuming households. For this reason, the zero expenditure should be part of the analysis and should be treated appropriately. The inclusion of zero expenditure raises a missing value of unit values problem. Fortunately, Olivia and Gibson (2005) offer and examine various ways of replacing the missing unit values proposed in many former studies such as Minot (1998), Sahn (1988), Jensen and Manrique (1998), Heien and Pompelli (1989), Case (1991) and Rae (1999). Olivia and Gibson's main objectives are to look at the Deaton's share in developing a method for correcting the demand elasticity estimate biases as a result of unit value data utilisation, and to compare and contrast with other procedures in handling the missing unit value data. In brief, Olivia and Gibson's (2005) study demonstrates a selection of methodology dealing with the missing unit values. These are,

1. Replacing *missing* unit values with the mean unit value calculated across other households in the same *province*;
2. Replacing *missing* unit values with the mean unit value calculated across other households in the same *district*. This procedure, and the replacement with provincial means are similar to Minot's (1998 in Olivia and Gibson, 2005) study, noting that there is no seasonal variation in SUSENAS because all households are observed in the same month;
3. Replacing *missing* unit values with the *cluster mean* of the unit value (Sahn, 1988 in Olivia and Gibson, 2005);
4. Replacing *missing* unit values with the *predictions* from a regression of observed unit values on regional dummies and household total expenditures (Jensen and Manrique, 1998; Heien and Pompelli, 1989 in Olivia and Gibson, 2005);
5. Using *cluster mean unit values*, in place of both household-specific and missing unit values (Case, 1991; Rae, 1999 in Olivia and Gibson, 2005).

Olivia and Gibson (2005) demonstrate that results obtained from the approach replacing *missing* unit values with the *cluster mean* of the unit value (Sahn's approach, 1988) is the closest result to Deaton's approach findings.

2.3.4.2.3 The 'quality' effect

In the early literature on demand estimation with cross-sectional data, attention focused on the sources and meaning of price variability. Prais and Houthakker (p.110) argue that the causes of cross-sectional price variation must be identified, in order to interpret correctly the effects of prices in the analysis of household budget data. They identify price variation due to region, price discrimination, services purchased with the commodity, seasonal effects and quality differences caused by heterogeneous commodity aggregates. Of these factors, price variation induced by region and season is more dominant from the standpoint of estimating commodity demand curves (Cox and Wohlgenant, 1986).

As observed by Diansheng et al (1998), Prais and Houthakker proposed that prices in cross-sectional data usually reflect "quality" effects that should be accounted for prior to estimation. As also recognised by Diansheng et al (1998), Theil and Houthakker developed a model to treat the effects of price and quality and used the traditional utility maximisation approach to derive the demand functions. In their framework, they note that heterogeneous commodity quantities are defined as the sum of the physical quantities of elementary goods in the group, and 'quality' choice is reflected by a separate set of elements in the household utility function. This model was used and adapted by Deaton (1987, 1988) and Cox and Wohlgenant (1986). However, Nelson (1991) pointed out that this model has an inherent ambiguity about how the quantities of composite commodities related to the 'quantity demanded' of consumer demand theory.

In brief, by utilising the methodology of Prais and Houthakker (1955) the size of the quality effect can be easily estimated. As noted by Nicita (2004), the underlining assumption of the method is that, ceteris paribus, the richer the household, the higher the quality of the products that the household consumes. Because unit values not only vary with the choice of quality, but also with actual market prices, prices theoretically should be included in the estimation. The fact that prices are not observed in household surveys makes it impossible to obtain directly parameter estimates for the price variable. Accordingly, by utilising unit value equation, one of the two equations of the three stage - budget share - procedure proposed by Deaton, the size of quality effect can be computed and captured (a detailed discussion of this matter will be found in Chapter 4).

2.3.4.3 Aggregation

Brown and Deaton (1972) observe that the theory of consumer behaviour usually deals with a single individual. Accordingly, there are two difficulties faced by this theory in order to meet practical application:

1. It is impossible to deal with hundreds or thousands of distinguishable commodities which would correspond to single homogeneous goods
2. Data almost inevitably relate to groups of consumers, or all consumers, and not to the single individuals of the theory

Therefore, Brown and Deaton (1972) suggest that the theory must be extended so as to relate to aggregate demand for aggregated commodities as well as aggregate individuals. This is s general problem faced in many fields of economics.

2.3.4.3.1 Aggregation of commodities

Brown and Deaton (1972) observed that a formal justification for dealing with groups of commodities lay in the Leontief – Hicks composite commodity theorem, stating that commodities whose relative prices do not change may be treated as a single commodity for the purpose of the theory. Though formally correct, Brown and Deaton (1972) argue that this is of limited usefulness.

They further argue that the work of Gorman and Strotz on utility trees provides alternative conditions to the justification. The most important case for this is that the utility function should be strongly or additively separable into "branches," each of which is homogeneous, known as additive homogeneous separability.

Brown and Deaton (1972) come to a conclusion that provided that commodities can be grouped according to the differing needs they satisfy, and that no commodity is included in more than one group, then it is possible without great error to work with a rougher rather than with finer classification. However, they admit that *the discussion has provided little more than a justification for what has always been done in* *practice – some aggregation is always necessary – but is nevertheless important for that (p. 1171).*

As observed by Brown and Deaton (1972), the concept of separability arises from the independent work of Leontief and Sono suggests that commodities, in general, may be grouped such that goods which interact closely in the producing of utility are clustered together, while goods which are in different groups interact, if at all, only in a general way. The intuitive appeal of this supposition lies in the fact that it is easy to imagine such groupings: for example, different types of food go into one group, different non – food into another. It might then be expected that if a relationship between one type of food and one type of non- food exists, then that relationship will be much the same for all pairs of commodities chosen from the two clusters.

From an empirical point of view, as Brown and Deaton (1972) suggested, if goods belong to different branches of the utility function, then the scope for substitution between them must also be limited. There is then a possible way of further reducing the number of responses which must be estimated. How this can be done is dependent on which assumption is used, as indicated and stated by Brown and Deaton (1972) as the main types of separability: weak and strong separabilities and their empirical consequences. They elaborate the separability types as follows.

The least restrictive form is weak separability. This states that, if two goods belong to a group, the ratio of their marginal utilities is independent of the quantity consumed of any good outside that group. In this case the utility function may be written

$$v(q) = f\{v_1(q_1), v_2(q_2), \ldots, v_N(q_N)\}$$

A more intense assumption is that of strong separability. Here it is assumed that, if two goods belong to different groups, each of their utilities is independent of the quantities consumed of the other. In this case the utility function may be written

$$v(q) = f\{v_1(q_1) + v_2(q_2) + \ldots + v_N(q_N)\}$$

which accounts for the alternative name of this assumption, additive separability

Additivity or want-independence take place when the marginal utility of every good is independent of the quantity consumed of all other goods; this may be considered as additive separability, with one good in each group. In this case the utility function is a transformation of a sum of functions, each of which has only one good for argument, i.e.

$$v(q) = f\{v_1(q_1) + v_2(q_2) + \ldots + v_n(q_n)\}$$

Brown and Deaton (1972) observe that although the most restrictive, this form of separability has been the most frequently utilised.

In brief, as Varian (1985) suggested, consumers' preferences are assumed to be 'weakly separable' when the goods they purchase can be separated into groups such that they are able to rank all possible bundles of goods within one group into a well-defined ordering, which is independent of the quantities consumed of all goods outside the group. This means that within-group preferences are not dependent on purchases outside the group.

In fact, traditional consumer theory assumes homogeneous goods with a single price. This means that when separate goods are aggregated into a single composite commodity; these result in a variation in the average price paid for the aggregate commodity, which changes with the quantities of the component goods consumed (Phillips, 1974).

2.3.4.3.2 Aggregation over individuals

An interesting point was made by Brown and Deaton (1972) dealing with aggregation over individuals. They point out that the oldest, and still most common approach, is to ignore the problem of aggregation over individuals by formulating aggregate relationships directly from the micro-theory. They illustrate this as follows:

> *In order that all consumers together should behave as the single consumer of the theory, it is necessary for all consumers' Engel curves to be parallel straight lines. This not only imposes constraints upon the demand functions for each individual but also requires an unreasonable degree of uniformity between individuals (p. 1168).*

However, they further argue that the case may not be interested in individuals but in groups of individuals differing in social class or income distribution. Accordingly, the question then arises as to what errors should be expected, if aggregate models are used, when the true conditions for aggregation are not met. In answer they then suggest that as the empirical use of an aggregate utility function probably cannot be justified as a short cut to the aggregation of micro-relations, accordingly, the demand equations including explicitly terms arising via aggregation should be modified. The, present study deals with the problem by using many small villages / clusters, although by no means ideal it is better than nothing.

2.4 Equity aspects of tax reform

The excess burden analysis only answers the efficiency aspect of tax imposition with conditions of either constant marginal utility of income, utilitarian (additive social welfare) or no income redistribution. What happens when the marginal utility of income is not constant? This interesting question will be answered in the following sub-section by introducing equity consideration.

Many studies observe that it is important to look at equality since people do value and care about equality or clearly care about the poor members of society. However, the idea of equality itself is subjective. This means that there is no agreement about a unique equality indicator. Instead, people tend to look at the problem the other way round, namely about inequality. The degree of inequality aversion reflects how individuals within a society care about the welfare of other members of society (in particular the poor). A larger degree of inequality aversion reflects a larger degree of care about the poor. Accordingly, this section will be devoted to attempting to understand the notion of inequality aversion and how important this notion is in relation to welfare improvement. This section will also justify the importance of social welfare function in interpreting inequality measures. It will end with a discussion on the importance of an inequality aversion index to be included in the review and how this parameter is to be measured and computed.

2.4.1 Differences in the marginal utility of income

As discussed in the previous section, the excess burden or deadweight loss (DWL) becomes one of the key ideas in the field of public economics. As noted by Trandel (2003), theoretical and empirical studies of the size of the DWL affect judgements about both the proper size of government and how its activities should be financed.

DWL is a component of social welfare, so it partly measures the change in social welfare resulting from change in tax, but this is not the whole story of welfare analysis of tax imposition. The DWL analysis so far only answers the efficiency of a tax imposition in terms of economic behaviour distortion; it only measures changes in social welfare if the marginal utility of income is constant. In other words, the change in an individual's utility (economic welfare) that occurs after the imposition of a tax is equal to (i.e. can be measured by) the DWL associated with the tax, providing that the marginal utility of income is constant. Further, if the marginal utility of income is constant (and equal) across all individuals, then the DWL associated with a tax change will measure the change in social utility that results; redistribution is not relevant, since a fall in utility in one individual will be 'cancelled out' by increases in the utility of another. This is, in essence, social welfare.

However, if the marginal utility of income is not constant, or equal, across all individuals, then DWL will not adequately capture all changes in utility that occur when a tax change redistributes income amongst individuals. Likewise, social welfare may not simply equal the sum of every individual's utility. Accordingly, it is important to look at social welfare functions (not just DWL's) when evaluating the change in social utility that occurs when taxes are changed.

Joan Robinson (1933), as quoted by Haveman (1970), suggests that it is not reasonable to discuss maximum satisfaction to a whole population, unless all individuals are exactly alike, e.g. they have the same real income. Only then can the same satisfaction be derived from it; only then is it allowable to add up the satisfactions and aggregate them.

However, Robinson (1933) further argues that if one individual has larger real income than another, then the marginal utility of income to him /her is less (Joan Robinson, 1933, as quoted from Haveman, 1970, p. 78, footnote 8). This argument is expressed as diminishing marginal utility of income. The principle shows a relationship between an individual's economic wellbeing (utility) and his/her income, suggesting that total utility increases when income grows, but that it increases at a decreasing rate (Haveman, 1970). This implies that if a person is poor, one additional rupiah signifies an enormous amount to him/her; whereas when a person becomes rich, one more rupiah bestows less additional utility than when he/she was poor. To follow the principle, it is widely accepted that the system of taxation should be progressive in order to keep the "pain" of taxes small. This happens because one rupiah of income taken from a rich person implies a smaller loss of satisfaction than one rupiah taken from a poor person. Even if it is required that all income earners in society share the tax revenue, these assumptions require progressivity in the tax structure-if the government is trying to minimize the loss of economic welfare due to its tax system. In other words, taxes are to be raised with the lowest feasible loss of economic welfare (Haveman provides a detailed discussion oft the income transfer between the rich and the poor, and this can be seen from Figure 2.1 and its explanation. See Appendix B).

There is some controversy about the idea of diminishing marginal utility of income. The success of an implementation of the Ramsey rule is determined by consumption patterns, in which they are not homogeneous, meaning that not all are poor and not all are rich. This heterogeneity gives an indication of how society values equality. If society is greatly concerned about the equality (or the welfare) of the poor then the Ramsey rule cannot be applied deliberately. For these reasons Rosen (2005) recommends two considerations to optimally apply the Ramsey rule and the elaboration:

1. How much society values equality; if it cares only about efficiency, - meaning that 1 rupiah to one person is the same as 1 rupiah to another, regardless of whether they are rich or poor, - then it may be better to stick to the Ramsey rule
2. The degree to which the difference in consumption patterns between the rich and poor; if the rich and the poor consume both goods in the same proportion, imposing tax on the goods at different rates, the distribution of income is not affected. Even if society takes into account an equity objective, differential commodity taxation cannot accommodate this

In summary, welfare analysis of tax imposition cannot be focused only on the efficiency principle of tax embodied in the DWL analysis, and on equity consideration, but also on the form of the social welfare function.

2.4.2 The social welfare function and income distribution

A concept of a social welfare function first introduced by Bergson and Samuelson is one attempt to resolve *the unsatisfactory status of welfare economics*, as observed by Suzumura (1987). Bergson and Samuelson define that *social welfare is a function of the levels of utility of members in society*. Therefore, there is a need for an aggregation rule for the utility functions of all individuals expressed by SWF. There are many varieties of SWFs available in the literature, for example, Standard Utilitarian (Bergson-Samuelson), Additive (Benthamian), Maximin (Rawlsian), Multiplicative (Nash) and the Abbreviated SWF. Table 2-1 summarises the Social Welfare Functions available in the literature in terms of their views, objectives, implications and their empirical studies.

Table 2-1
Summary of the SWF approaches: Views, objectives, implications and empirical studies

Views of SWF	Objectives or Function	Implication of Assessing change in welfare	Empirical studies
Utilitarian or Benthamian (Jeremy Bentham, 1748 – 1823) Additive Utilitarian (Bergson (1938) and Samuelson (1947))	Sum of individual utility in a society Maximising total income of the people in society disregarding how incomes are distributed Interpersonally unit comparable cardinal welfare functions	Welfare is increased if anyone's utility is increased (Pareto Principle)	India, Pakistan, Indonesia, Ireland, Norway
Rawlsian (Maximin) (John Rawls, 1971)	Maximizing the income of the poorest without regard for the others' incomes Extended orderings, or Interpersonally comparable ordinal welfare functions	Welfare is increased if utility of the poorest is increased	Norway

Views of SWF	Objectives or Function	Implication of Assessing change in welfare	Empirical studies
Multiplicative (John Nash, 1950)	Multiplication of individual utility in a society Individual cardinal welfare functions w/o interpersonal comparability	More distributive than Additive Utilitarian	Theoretical Study of Kaneko and Kenjiro (1979) Theoretical Study of Ng (1982)
The Abbreviated Sen type (Paretian) Sen, 1974	Function of efficiency and equity aspect	Welfare is increased if the total income increased and inequalities is decreased (Put more emphasis on efficiency over equity)	
The Non Paretian Abbreviated Sen type modification (Mukhopadhaya, 2002)	Function of efficiency and equity aspects and β (the rate of efficiency-equity trade-off) by introducing value of β	Similar outcomes with the Sen type, but allowing the policymakers be flexible to organise their society	Australia

Sources: relevant journals (see references)

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Among the SWFs available in the literature, it seems that the Additive Utilitarian SWF, Maximin (Rawlsian), the Abbreviated SWF and Sen are the most relevant to the present study. Accordingly, only these welfare functions will be examined thoroughly.

Firstly, Additive (Utilitarian or Benthamian) SWF is associated with the founder of utilitarianism: Jeremy Bentham (1748 – 1823). He points out that the objective of economic policy is to achieve *'maximum happiness for maximum number of people'*. Accordingly, the aggregation rule of the approach is to sum up individual utilities with equal weights of unity for each individual. This approach does correspond to perfect substitutability between the utilities of different individuals. If utility is a concave function of income, then the utilitarian SWF does weigh the low-income individuals more heavily. However, if marginal utility of income is constant then high / low income does not matter.

Secondly, Maximin (Rawlsian) SWF corresponding to John Rawls (A Theory of Justice, 1971) suggests that individuals under the "veil of ignorance" maximize the welfare of the least well-off individual. The function relates to a Leontief – type social indifference curve and assumes no substitutability between utilities of different individuals.

These two approaches imply that in the Utilitarian approach, maximizing the SWF means maximizing the total income of the people in the society, regardless of how incomes are distributed in this society (unless diminishing marginal utility of income and additive). Only total happiness matters to a Utilitarian, not its distribution, i.e. not who is happy and who is not happy. On the other hand, the Maximin Utility Function suggests that the social welfare of the society chosen is related to the income of the poorest person, disregarding the others' incomes. In other words, the Utilitarian emphasizes total incomes whereas the Rawlsian emphasis on the needs of the poorest.

Thirdly, the Abbreviated SWF is another type of SWF introduced by Sen (1974) and developed later by Mukhopadhaya (2002). The original Bergsonian SWF, which was constructed to rank the combinations of all those variables on which individual welfare depends, including the consumption goods and services, but not the combination of individual welfare (Mukhopadhaya, 2002), inspires this SWF. However, this SWF arises because the distributional implications of alternative social states are considered. The SWF is determined by the total income of the society (efficiency aspect) and inequality of income in the society (equity aspect). The basic properties of the SWF are: it is positively related to total income and negatively related to inequality of income in the society. Additionally, the other property of the SWF suggests that factors other than income differences are irrelevant for comparison of welfare. The Pareto principle is also considered in this SWF, namely that: given an increase in income of one person, ceteris paribus, social welfare will increase; but if there is an increase in inequality, then its effect on total welfare has to be less than the effect of efficiency on total welfare.

Fourthly, Sen (1974) proposes that the SWF (a function of mean income) represents efficiency and that the GINI coefficient (a functional income distribution) represents equity By doing this, as noted by Mukhopadhaya (2002), Sen (1974) attempts to show the importance of twin objectives: efficiency and equity in national development. Unfortunately, as identified by Mukhopadhaya, his proposed SWF, as with other typical types of Paretian SWF, is mainly sensitive to mean income, but less sensitive to inequality. In other words, the Sen SWF gives greater emphasis to efficiency than to equality, so that it is not surprising if, in extreme cases society's social welfare would be categorised as increasing, by Pareto principle, although the fruits of growth only go to the richest segment of society. For this reason, Mukhopadhaya proposes a Non-Paretian SWF which is a modification of the Sen Type SWF – one that introduces the value of β as the rate of trade-off between efficiency and equity. As a consequence, this value makes the policymakers more flexible in considering society's social welfare.

It seems that the idea of β (Mukhopadhaya, 2002) has inspired the idea of inequality aversion parameter, ε – one of important variables for conducting tax reform analysis. By looking at various values of the parameter, one can examine how society, including the government, values and has concerns for the poor as discussed in the following sub-section.

2.4.3 Inequality aversion

Amiel, Creedy and Hurn (1996) suggest that having groups of income distributions which lie on the same social indifference curve for each respondent, a family of social welfare functions derived from the Gini index is a better fit for most of the respondents than social welfare functions based on constant relative or absolute inequality aversion. This implies that an income inequality index such as the GINI index can be utilised as a proxy for the inequality aversion. More specifically, the inequality in terms of income is one of the important aspects to be considered in evaluating the welfare of tax reform.

It has also been argued in the previous subsection that it is important to include the inequality aversion in evaluating tax reform in terms of welfare improvement, as this parameter acts as an expression of how society values the equality. In addition, Van de Gaer et al (1997) demonstrate that a choice of model adds to a complication of welfare cost evaluation, even in a marginal perspective, and conclude that the welfare costs in the different models vary with the degree of inequality aversion.

Kroll and Davidovitz (1999) define the concept of inequality aversion as the extent to which an individual prefers a society with a more equal distribution of income. They argue that the degree of inequality aversion is measured by the amount society is willing to give up in order to achieve a more egalitarian distribution of income; that is, the more convex the overall *social* indifference curve, the more averse the society is to inequality (see also Amiel *et al*., 1996). What is interesting about their study is that they define inequality aversion as a response to an increase in perceived inequality among participants in the economy that does not affect any other features of personal income distribution, not as a preference for more equal distribution.

Olivia (2002) observes that there seems to be a lack of certainty in selecting the proper value for the inequality aversion parameter when evaluating tax reform. Indeed, there have been a number of discussions of the 'appropriate' level of the inequality aversion parameter ε in the literature. As observed by Olivia, many studies of indirect taxes on food, such as Christiansen and Jansen (1978), Stern (1977) and Dalton (1939) suggest that the aversion to inequality parameter was between 1 and 2.Olivia adopts an influential study by Ravallion and Dearden (1988), who propose a methodology to model both transfer receipts and outlays in a choice-theoretic framework, with an empirical application to Indonesian data, in enabling the estimation of the inequality aversion parameter from household survey data.

Olivia (2002) argues that different values of ε reflect different judgements about the desirability of making transfers to reduce income inequality. As this element of value judgement, a range of values for ε are generally utilised to examine whether tax reform recommendations are robust to specific ethical judgements. Accordingly, it is important to consider income inequality measurement as one of the best proxies of the inequality aversion parameter for demonstrating how the society values the equality.

Several studies have observed that the choice of model and the degree of inequality aversion are of importance for the evaluation of the marginal costs of taxation (Olivia, 2002, Van de Gaer et al, 1997 and Kroll and Davidovitz, 1999). In addition, as shown by Kroll and Davidovitz, the welfare evaluation of tax reform needs a combination of empirical facts and normative judgments. By utilising an approach which has been initiated by Ahmad and Stern (1984, 1987), marginal welfare costs are computed using Belgian data in order to answer the following questions:

1. Does a change in the concern for income inequality have a similar effect on the ranking of the marginal welfare costs in all specifications of the economy?
2. Are there any reforms of the system of indirect taxation possible which are welfare improving, irrespective of both the model of the economy and the extent to which one is concerned about income inequality?

Kroll and Davidovitz (1999)'s study indicates how differences in inequality aversion lead to differences in the importance attached to the different macroeconomic objectives. People with a low aversion to inequality tend to stress the evolution of profits and net wages, while those highly averse to inequality will emphasize inflation and unemployment. To analyse the effects of changes in the tax instruments, one has to specify the structure of the economy. Kroll and Davidovitz's findings suggest that as the degree of inequality aversion increases, the relative marginal welfare cost of heating, food and rent increases, while the relative cost for leisure, durables, and both the purchase and use of private transportation decreases.

2.5 Empirical Studies

Previous empirical studies are summarised here in order to seek for the gaps in their studies in asserting the importance of the present study. The summary is dictated by various demand equations as used by them.

2.5.1 Applied Demand Studies (excluding Indonesia)

This sub – section is devoted to the review of a number of empirical demand studies, which are relevant to the current study. The purpose of the section is to gain an understanding of how to bridge the gap between theoretical reasoning and empirical practicalities.

Several studies have been carried out in the area of applied demand analysis, analysing own-price and cross-price elasticities for the preliminary stage in conducting tax reform simulation. Most of these studies were based on Deaton's influential contribution of the introduction of three stage procedures and Almost Ideal Demand System (AIDS) to computation of demand elasticities. They apply the methods in different countries including Indonesia, both with cross-sectional and time series data or pool / panel data which result in an enormous variation among the estimates of the demand elasticities. Accordingly, it is not surprising that the differing outputs reflect the differences in model specification; data types and estimation procedures (see Table 2-2). Nevertheless, they provide important guidance for the model specification proposed by the current empirical study. These include Nicita (2004), Chang, Griffith, Bettington (2002), Crawford, Laisney and Preston (2002), Chang and Bettington (2001), Banks, Blundell, and Lewbel (1997), Deaton and Grimard (1992), Decoster and Schokkaert (1990), Deaton (1987). Meanwhile, in Indonesian case they cover Olivia and Gibson (2005), Olivia (2002), Olivia and Gibson (2002), Hutasoit, Chang, Griffith, O'Donnell and Doran (2001 in Olivia and Gibson, 2005), Jensen and Manrique (1998), Deaton (1990), Teklu and Johnson (1987).

Table 2-2
Previous demand studies making use of Deaton's approach other than three-stage procedure in various countries (excluding Indonesia)

Author	Model	Data	Country
Chang, Griffith and Bettington, 2002	AIDS	1975/76 – 1989/99	Australia
Crawford, Laisney and Preston, 2002	Approximate AIDS	1991 – 1992	Czech
Chang and Bettington, 2001	AIDS versus single equations	1975/76 – 1989/99	Australia
Jensen and Manrique, 1998	LA / AIDS	1981(sub-round 1), 1984 and 1987)	Indonesia
Banks et al, 1997	QUAIDS	Pooled of 1970 – 1986	UK
Decoster and Schokkaert, 1990	AIDS, Rotterdam, CBS		Belgium
Deaton, 1987	Standard Double Log	1979	Cote d'Ivoire

Source: relevant journals

Indeed, the present study acknowledges that Deaton's study is the seminal study, which not only proposes using the budget share equation replacing double log model in solving zero consumption problem, but also in managing unobservable price variable which is an important variable in demand analysis.

Table 2-3 lists several previous studies which have utilised Deaton's three stage procedure to estimate systems of demand.

Table 2-3
List of previous studies utilising Deaton's three-stage procedure in various countries (excluding Indonesia)

Author(s)	Commodities observed	Data	Country
Laraki (1989)	Soft wheat, hard wheat, barley, vegetable oil, olive oil, sugar loaf and sugar powder.	1984/1985	Morocco
Deaton and Grimard (1992)	Wheat, rice, dairy products, meat, oils and fats, and sugar.	1984/1985	Pakistan
Deaton, Parikh and Subramanian (1994)	Rice, wheat, jowar, other cereals, pulses, dairy products, edible oils, meat, fruit and sugar.	1983	Maharashtra, India
Nelson (1994)	Cereals, bakery products, beef, pork, other meat, poultry, fish, eggs, milk, processed vegetables and sweets.	Second quarter Of 1985	USA
Gracia and Albisu (1998)	Beef and veal, pork, lamb and goat, poultry, processed pork and fish.	April 1990 – March 1991	Spain
Nicita (2004)	wheat, maize,	1989 -	Mexico

Author(s)	Commodities observed	Data	Country
	alcohol and tobacco, meat, legume, dairy, Oil and fats, vegetables, fruits, sugar, others	2000	

Source: Olivia (2002) and relevant journals

The study by Nicita (2004) is one of the important references of the present study. It uses 1989 – 2000 Mexican panel data, and covers 5 different income groups, urban and rural areas and average households. He considers 10 commodities including wheat, maize, alcohol and tobacco, meat, legumes, dairy, oil and fats, vegetables, fruits, sugar and other goods. His findings suggest that 40% of Mexican income is spent on food products of maize, meat, dairy products and vegetables. These commodities were the most important product groups, as they used up 20% of their total expenses. However, he finds that the rich group spent only 25 % of their income on food products, whereas the poor spent 50% of their income. He also observes that differences between urban and rural communities are relatively small and are more driven by income. He identifies legumes and vegetables as inferior goods, which the consumption basket of the poor tends to be biased towards, whereas meat, dairy products and fruits are categorised as luxurious commodities which the rich tend to be biased towards.

The empirical demand analysis of Deaton and Grimard (1992) delineates consumption patterns and estimates the responsiveness of demand to price. They extend the methodology of Deaton (1988, 1991) and apply it to the 1984 – 85 household Income and Expenditure Survey of Pakistan data. A theory of quality variation based on separable preferences is developed, and the implications for welfare and empirical analysis are laid down.

2.5.2 Applied Demand Studies - Indonesian

It has been recognised that various studies have been carried out in relation to Indonesian demand studies, in particular the consumption patterns of households for different commodities. Most recent studies utilise Deaton's procedure including its variance of AIDS. They are Teklu and Johnson (1987), Deaton (1990), Jensen and J.

Manrique (1998), Hutasoit, Chang, Griffith, O'Donnell and Doran (2001), Olivia (2002), Olivia and Gibson (2002), Olivia and Gibson (2005). Table 2-4 below provides a summary of the studies.

Meanwhile, studies such as those by Timmer and Alderman (1979), Dixon (1982), Chernichovsky and Meesook (1984), Tabor et al (1989), and Molyneaux and Rosner (2004) also look at demand and consumption patterns of Indonesian households, although they employ different analysis tools.

Table 2-4
Previous Indonesian demand studies making use of Deaton's approach

Author	Model	Data	Coverage	Commodities
Olivia and Gibson, 2005	Three stage	1999	Java: urban and rural	Meat
Olivia, 2002	Three stage	1999	Java: urban and rural	16 commodities
Olivia and Gibson, 2002	Three stage	1999	Indonesia	16 commodities
Olivia and Gibson, 2002	Three stage	1999	Java	Fuel
Hutasoit et al, 2001	LA/AIDS	1990, 1993, 1996	Indonesia	Beef
Jensen and Manrique, 1998	LA/AIDS	1981(sub-round 1), 1984 and 1987)	Indonesia, income groups	8 commodities
Deaton, 1990	Three stage	1980	Java: rural	11 commodities
Teklu and Johnson, 1987	AIDS (and MMLM)	1980	Indonesia: urban	6 commodities

Sources: Olivia and Gibson (2005), and various relevant journals

A study by Timmer and Alderman (1979) is recognised as the first study that provides reliable estimates of actual price elasticities of demand for rice and other important foods for Indonesia (as observed by Afiff et al (1980) and noted by Olivia (2002)). Timmer and Alderman (1979) and also Timmer (1987) report price elasticities for rice and cassava from the Indonesian 1976 survey. They employ a double logarithmic formulation, but apply the model, not to the micro data, but to cell-means of income classes by province, sector, and time period. They estimate different elasticities for different income groups and find figures that are numerically very much larger than those reported by Deaton (1990).

Dixon (1982) confirmed the Timmer and Alderman's (1979) results with slightly different specifications. Dixon included the additional commodities, dried cassava (gaplek), sweet potatoes, white sugar, brown sugar, cooking oil and kerosene. Dixon only reported elasticities for Java and then only for rice, fresh cassava and gaplek. By comparing their results, the own price elasticities of Timmer – Alderman for rice and fresh cassava show more price responsiveness, i.e. the elasticity estimates for Timmer-Alderman's poorest class are –1.92 and –1.28 for rice and fresh cassava respectively, whereas those for Dixon's poorest rural class are –1.28 and –1.09.

Chernichovsky and Meesok (1984) carried out further estimation of income and price elasticities of demand for food and nutrients in Indonesia, by making use of 1978 SUSENAS data. They found that rice, the major staple, has the highest income elasticity of demand on average among low income groups in Java and the Outer Islands. On the other hand, they found higher expenditure elasticities for corn, wheat and potatoes. These findings demonstrate that (1) as total expenditure increases, people with low incomes increase rice consumption and eventually switch to corn, wheat and potatoes; (2) over two-thirds of the household's total expenditures are spent on food, where rural populations spend relatively more on food than the urban population; (3) food share falls with rising incomes, while the poorest 40 percent of households allocate 73 percent of their total expenditure to food, the richest 30 percent allocate 59 percent.

Teklu and Johnson (1988) make use of 2 models: Multinomial Linear Logit Model (MMLM) and Almost Ideal Demand System (AIDS) by utilising the 1980 SURGASAR Indonesian data. Their findings suggest that (1) food expenditure elasticities for fish, meat and dairy products, fruits and vegetables are greater than unity, whereas rice is less than unity; (2) Fruits and vegetables are income inelastic, whereas non – fish meat is income elastic; (3) all the uncompensated own price elasticities are negative; (4) rice is least responsive to change in own price, however, all food groups were responsive to the price of rice (key government policy variable);

(5) cross – price elasticities generally had lower values than the own price elasticities but cross – price effects for rice were substantial; (6) rice and palawija (tuber) crops are complements whereas rice, fruits and vegetables, and non – fish meats are net substitutes as well as bean, fish and meat. Meanwhile, fruits and vegetables were net complements to beans but net substitutes for fish.

Meanwhile, Tabor et al (1989) estimate a set of seven equations with restrictions by employing Full Information Maximum Likelihood (FIML) techniques into seventeen years of time-series Indonesian data, from 1969 to 1985 for rice, corn, soybeans, mungbeans, peanuts and cassava. The first equation is a semi-log relationship between food and total expenditures, whereas the other six equations are the compensated demand equations for the staple foodstuffs. Accordingly, a total of 35 parameters are estimated. Their findings suggest that demand for basic staples has become more inelastic In addition, the utilisation of theoretically consistent techniques for their analysis of consumer demand patterns results in significant cross – price relationships between food crops. Their study also identifies not only the shift in government policy from a single-market to a multi-commodity focus, but also that the rapid growth in feed and starch demand transformed them from inferior foodstuffs to normal commodities.

Deaton's (1990) study makes use of budget shares to the logarithms of prices and incomes replacing double logarithmic demand functions, and his approach treats zero expenditure appropriately. He proposes a method for using large – scale household surveys for the estimation of a system of demand equations, utilising spatial variation in price to identify and estimate a matrix of own – and cross – price elasticities for estimating 11 commodity systems of food demands, by employing the 1981 Indonesia data. He acknowledges that even though the model seems to work well in the application, there are a number of unresolved issues that should be noted: (1) the model is very close to being exactly identified, and so it is difficult to construct the sort of cross - checks that would lend it greater conviction; (2) plausibility of demand elasticities is not in itself a very powerful test. It would be extremely desirable to have data with direct measures of market prices against which this method could be compared; (3) the model would also be improved by permitting a more general functional form for the Engel curve.

Jensen and Manrique's study (1998) classifies households into income groups before analysing expenditure patterns. They use eight commodity groups, namely rice, meat, dairy, fish, *palawija* products (e.g., soybeans, corn and cassava), wheat, fruits, and other foods and non-foods.

It is interesting to note that their means of classifying the observed households into income groups is based on the behaviour of households with respect to their acquisition of goods. To do this, an analysis of the homoscedasticity of variances of residuals from the regressions of Engel relations is employed. They separately estimate demand system parameters for each of four income groups. Unfortunately, Jensen and Manrique (1998) treat unit values (expenditures divided by quantities) as if they were `prices'. They attempt to handle the missing or unreported prices, required for estimating the demand system, by regressing observed prices on regional dummies and household total expenditures. The estimated prices replace the missing prices in the estimation of the demand system. Their findings suggest that there are differences in consumption behaviour and demand for food among income groups.

Jensen and Manrique argue that these results have important consequences for food policy formulation and welfare analysis, particularly when income differences lead to markedly different food consumption patterns. They further argue that income group specific demand parameters can be used not only to evaluate more accurately the effects of alternative price policies on the well – being of the different income groups, but also to design any specific target group compensation schemes based on specific food items (such as food price subsidies and food stamps).

Olivia's thesis (2002) is one of the most important references for the present study. It has three main objectives: (1) to calculate estimates of demand parameters for Indonesian households for use in analysis by researchers and policy makers; (2) to estimate the aversion to inequality parameter of Indonesian households; and (3) to examine the direction of reform for indirect taxes and subsidies by using the estimated demand elasticities and inequality aversion parameters, combined with information on tax rates (under the framework of Ahmad and Stern (1984)). Her methodology sticks to two seminal contributions of both Ravallion and Dearden (1988) on gauging the inequality aversion parameter and Deaton (1990) on computing own – and – cross price elasticities without biases, by utilising consumption data from the 1999

SUSENAS which covered both urban and rural areas in Java only. Her findings suggest that urban and rural households have different consumption patterns, evidenced by both the type of food consumed and by estimated demand parameters and elasticities.

Olivia and Gibson (2002) use Deaton's three-stage procedure to estimate demand elasticities and to conduct tax reform simulations. Their study analyses 16 food commodity groups (containing 214 food items) consumed by 28,998 households in Java, collected from the 1999 Indonesian National Socio Economic Survey (SUSENAS). As no market prices were available, their study uses unit values as proxies across all goods in the group.

In implementing the Deaton procedure, the variables used are budget shares, unit values, total expenditure, household size, and dummy variables for: having school age children, the tenure status of the dwelling and the sources of household income. Their analysis computes expenditure elasticities to be used for goods categorisation. Their findings suggest that positive coefficients of expenditure elasticities (the elasticities > 1) mean that some goods, e.g. fresh fish and meat, are categorised as luxury goods because, as household expenditures increase, the budget shares for the goods also rise; whereas maize and cassava are categorised as inferior goods (expenditure elasticities < 1) – which is similar to Deaton's findings.

In relation to tax reform recommendation, Olivia and Gibson's study find that, *inter alia*, meat is identified as the food with the least own-price elastic demand and the highest expenditure elasticity, therefore, it would be both equitable and efficient to tax meat. Regarding the estimated cross-price elasticities, their study also finds that meat is a substitute for fresh and dried fish.

Olivia and Gibson (2005) is the most recent Indonesian study utilising Deaton's three -stage procedure. In this study price elasticities of demand are estimated from unit values and they focus on the way in which various quality and measurement error biases can arise. They observe that although ways for correcting the errors have been developed, most notably by Deaton (1987, 1988, and 1990); many studies fail to make use of them. Accordingly, to observe if such corrections have any practical impact on the demand estimation, Olivia and Gibson (2005) make an effort to estimate demand systems for beef, chicken and other meat groups, using data from 28,964 households on the island of Java in Indonesia (gathered from the 1999 SUSENAS). Subsequently they compare the computed demand elasticities with those resulting from simpler procedures without corrections (Deaton's).

They find that when estimation procedures attempt to correct the biases caused by unit values, the own-price elasticities of both beef and chicken are smaller than in previous studies (Hutasoit, 2001 in Olivia and Gibson, 2005). Olivia and Gibson (2005) argue that the difference is consistent with the theoretical literature suggesting that using unit values (instead of prices) will result in own-price elasticities were too large in absolute terms.

2.5.3 Empirical evaluations of tax reform – excluding Indonesia

As mentioned in the previous sub-section, Ahmad and Stern's study (1984, AS hereafter) seems to have become an important reference for later scholars who carried out tax reform analysis, although a similar study of Christiansen and Jansen (1978) for Norway had been conducted earlier. Later, many studies similar to Ahmad and Stern's have been carried out in several countries, with different emphasis. Some examples, as recorded by Madden (1995), are: Brugiavini and Weber (1988) for Italy, by Kaiser and Spahn (1989) for Germany, by Decoster and Schokkaert (1990) for Belgium, by Cragg (1991) for Canada, by Ahmad and Stern (1991) for Pakistan, by Deaton and Grimard (1992) for Pakistan, by Madden (1995) for Ireland, and by Schroyen and Aasness (2003) for Norway.

In the present study, however, only relevant previous studies to the objectives of the present study will be reviewed, notably, Ahmad and Stern (1984, 1990), Grimard and Deaton (1992), Madden (1995) and Schroyen and Aasness (2003).

The Ahmad and Stern study (1984) started with the question as to whether some feasible tax changes would increase welfare by giving a set of value judgments, an initial state, and a model of the economy.

They offer three ways to evaluate a tax system (1984, p.259):

i *To specify an economic model and its initial equilibrium with value judgments, embodied in function of social welfare then to question whether it is possible to reform tax in order to increase social welfare* ii *To question whether there is a set of value judgements under which, provided the economic model, the initial affairs condition would be considered as optimum (dealt with the inverse optimum problem)*

iii *To find out Pareto improvements in order to avoid using social welfare function*

Their paper outlines a theory of how these three ways may be applied. They show the interrelations between the parameters and demonstrate the methods, with a discussion of the empirical possibilities for Indian Tax reform. Specifically, the AS study emphasised the advantages of marginal reforms analysis, as the study allowed them to deal with actual demand data rather than fitted values, as well as only needing aggregate demand elasticities, not those for individual households.

The main concern of the AS study is Marginal Cost, λ_i, i.e., marginal social welfare by raising an extra amount of government revenue from taxing a given good. In Madden (1995) terminology, λ_i is Marginal Social Cost (MSC) of raising revenue via an increase in the tax on a specific good. MSC or λ_i for all goods should be equal, in order to meet the optimality. Otherwise, the tax reform directions could be identified at the margin, i.e. the tax on the good with a lower MSC should be raised, whereas the tax on the good with a higher MSC should be lowered. In other words, if $\lambda_i < \lambda_j$ then it is recommended to increase tax on good i and reduce tax on good j in order to raise welfare without changing the revenue. In fact, the MSC expresses the ratio of a welfare effect and a revenue effect.

However, Ahmad and Stern (1984) admit that their study is sensitive to an inequality aversion parameter known as ε because λ_i calculation requires particular distributional value judgments. Accordingly, it is not surprising if greater concerns to the poor's welfare result in no policy attracted to raise taxation. In brief, Ahmad and Stern conclude that the directions of the welfare improving tax reform are sensitive to the specification of the judgements concerning inequality. The important role of the ε value and the computation will be thoroughly discussed in sub-section 2.4.3 and chapter 4).

Their study observes that the utilisation of explicit social welfare functions is a valuable method in solving that problem. The method offers two solutions. **First**, they introduce the inverse optimum problem that is the non-negative welfare weight calculation on households, implying that the initial state is optimum. However, they argue, if no such welfare weight exists, and then a Pareto improvement is possible.

Second, the method provides a way of seeking for a social welfare function in which the affair's current state is optimum. They illustrate the concepts and results utilising data from the Indian economy for 1979-80 and present directions of tax reform for a number of specific social welfare functions, and for Pareto improvements. They also argue that their method could be directly implemented in countries having surveys of consumer expenditure as well as aggregate demand system estimates. In addition, they point out that judgments of distribution and demand response estimates are important elements in establishing the outputs.

Unfortunately, their analysis only deals with directions of reform and therefore no specific recommendations can be suggested. Further, their analysis is sensitive to the distributional value judgment as well as to the revenue responsiveness of the changes in taxes. Accordingly, their study suggests that marginal and non-marginal analyses are complementary and they should be utilized in the reform analysis. Thus, the study shows how to fit those factors into the policy analysis and how sensitive the study conclusions are both to specification of model and estimates of parameter.

An interesting feature in their later study (1990) on the 1970 Pakistani data for 13 commodities (wheat, rice, pulses, meat/egg, milk, vegetable, edible oils, sugar, tea, housing, clothing, other food and non-food), is that they compute the Spearman Rank Correlation Coefficients to assess the ranks changing patterns of λ_i. Their findings emphasises their previous study (1984) on Indian data indicating that the distributional characteristics seem to be of particular importance in the calculations of λ_i, provided there is some reasonable concern about inequality.

The second study is also an important reference to the present study and was conducted by Madden (1995). This study is aimed at extending the AS methodology and applying it to a study of the Irish indirect tax system. His study is based on his former work (Madden, 1989) but is different in a number of respects: (1) based on the methodological point of view, the paper addresses a problem that can happen with the AS's MSC measure, in which that measure is not a continuous measure; (2) His study further observes the effects of both 1980 and 1987 indirect tax reforms. More importantly, the Madden study not only factors in family size and equivalence scales into the expenditure distribution, but takes account of the inequality aversion issue. He utilises a more reliable set of demand responses than those used by the Ahmad and Stern.

Madden's study identifies that the optimal tax rates calculation requires comprehensive information: utility function specification, distribution of income, evaluation of individual demand responses, and estimates of the household behaviour response to the tax changes, whereas the analysis of Ahmad and Stern (1984) does not require the information about both explicit utility functions and distribution of expenditure. The required information is the actual position of the economy about actual consumptions, actual distributions of expenditure and aggregate demand responses. In other words, the calculation requires information on household demands for goods, tax rates, welfare weights and price responses. Accordingly, AS's study has substantial advantage over the Madden study in terms of information required.

Importantly, Madden has applied the marginal indirect tax reform model introduced by Ahmad and Stern (1984) to the 1980 and 1987 Irish indirect tax system. However, his study introduces the MRC instead of the MSC of taxation (AS's approach) in order to rank commodities. He found that (1) there is substantial range for the marginal indirect tax reforms for both 1980 and 1987; (2) the estimated degree of inequality aversion, consistent with the existing tax system being optimal, is low but positive in 1980 and negative in 1987.

Madden's study suggests at least two possible extensions to the AS model. **First**, the recent study assumes separability between goods and leisure, then the study treats indirect taxes analysis independently of decisions relating to labour supply and direct taxes. Meanwhile, optimal indirect tax recommendations are extremely sensitive to the assumption of the leisure and goods separability. Therefore, analysis of tax reform effects could be quite complex by disregarding the separability of leisure and goods (Madden (1994 and 1995)). **Second**, the analysis of the study has only focused on marginal reforms, so that it is not possible to tackle global comparison issues, either across time or between situations, involving major changes in the tax regime.

The third study that is of interest is that by Schroyen and Aaness (2003). This study attempts to present a framework for identifying and evaluating marginal tax reform implemented by the 2000 indirect tax system in Norway. Their study includes environmental considerations and demerit goods for their concern, as the notion seems to them to be new in tax reform studies. Their analysis demonstrates that the Norwegian tax reform reflects re-distributive contour: VAT rate on food is lowered whereas VAT on services is introduced, so that the lowest five deciles benefit and the upper five deciles are worse off. The 2000 reform had been supplemented by tax rate changes in other products that made every group better off. Their study also finds that by increasing the inequality aversion degree, the marginal welfare cost of an increase in tax for food, beverages, tobacco, and electricity get higher rankings, meaning that these items are better candidates for tax cutting. Meanwhile, those for clothing and footwear, post and telecommunication services and other services get lower rankings; meaning that the items are subject to tax rates increase. The study acknowledges the limitations of their analysis, i.e. the study uses local information of behaviour responses of economic agents (price elasticities) in assessing finite changes in the structure of tax. Accordingly, an explicit system of demand equations is required in tracing out the responses. The study is also limited by the quality of data, as the data is heterogeneously composed. This leads to different conclusions in terms of subgroups and aggregate groups, which further means that the worse-off subgroup does not necessarily mean worse-off for the aggregate group. The effective tax rates on different categories of commodities are not available in the statistical accounts and the rates in the study make use of other data sources.

In their study, Deaton and Grimard (1992) extend the methodology of Deaton (1988, 1990) and apply the method to the 1984-85 Pakistani household Income and Expenditure Survey. They also develop a theory of quality variation based on separable preferences, and find that the prices of oils, fats and sugar do not vary very much in the survey data. In addition, they discover that the symmetry and homogeneity restrictions from the theory significantly contribute to obtaining sharp estimates of own and cross-price elasticities. Their parameter estimates suggest that there are significant cross-price elasticities between the high-calorie foods, wheat, rice, sugar, and oils, and the presence of these substitution patterns means that the effects of potential price reforms are quite different from those that would be estimated using the traditional and more restrictive assumptions. According to demand patterns alone, it would be favourable to increase government revenue by raising the consumer price of rice. However, as it is not generally possible to decouple the producer and consumer prices of rice in Pakistan, a full analysis of policy change would also depend on the supply responses, which are not considered in this study.

2.5.4 Empirical analyses of Indonesian Tax Reforms

Studies of tax reforms have been carried out in Indonesia by Gillis (1985, 1989, 1990), Miyasto (1991), Bird (2003), Yitzhaki and Lewis (1996), Asher (1997) and Heij (2001), Olivia (2002), and Olivia and Gibson (2002). Their studies have different emphasis in terms of types of taxes, application of different approaches, as well as different elaboration packages. For example, Gillis and Asher focused on the descriptive elaboration of the tax reform instituted by the Indonesian government, whereas Yitzhaki and Lewis evaluated Indonesian tax reform by utilizing Computable General Equilibrium and only concentrated on taxes in the energy sector. Interestingly, Heij was more concerned with discussing the process of introducing tax reforms. Meanwhile, Olivia and Gibson have carried out an Indonesian tax reform study by making use of a similar approach to Ahmad and Stern, but including another aspect of tax, i.e. subsidy transfer representing equity aspect.

Gillis (1985, 1989) describes his experience as one of the 1983-1984 Indonesian tax reform consultants by elaborating reasons why tax reform took so long in Indonesia; what were the tax reform goals, and the extent to which such goals were accomplished. The main objectives of Gillis's study were: (1) to describe the principal objectives of the 1983 – 84 Indonesian Tax Reform; (2) to discuss the element of tax reforms mainly comparing between the old system and reformed system, including specific taxes, (3) to discuss the outcomes of the tax reform covering revenues obtained economic stability and tax administration.

Gillis (1985, 1989, and 1990) draws the following important lessons from the Indonesian tax reform experience*, inter alia*: (1**)** having clear revenue objectives when designing tax reform programs for a developing country, focus on the impact of indirect rather than direct taxes, the suitability of VAT. (2) Successful reform can be critically dependent upon the follow-up reform as the Indonesian tax reform has less support from the tax administration. (3) Adoption of a VAT by a country has little impact upon that country's price level, having an insignificant effect on inflation. (4) The importance of identifying at the outset those fiscal problems lying at the intersection of the sets of 'complex', 'difficult' and 'politically sensitive' issues.

Likewise, Bird (2003) draws similar conclusions to Gillis in the sense of unusual experiences for typical developing countries. Bird (2003) observed that the Indonesian tax reform was unique. He expressed this in the following citation (p. 10).

> *First, it was—as is often recommended but seldom done—planned well in advance. Second, unlike most tax reforms in developing countries, it was not done in response to an immediate and urgent revenue crisis but rather in anticipation of a likely future revenue need arising from diminishing petroleum revenues. Third, it was considerably more comprehensive in both intention and to some extent reality than most tax reforms in developing countries. Finally, and again rather unusually, it was to a very large extent carried out as originally planned.*

Asher's study (1997) analysed the Indonesian tax reform experience in the areas of both tax policy and administration during the 1980s. He discussed the reasons why the Indonesian reform was undertaken, attempted to evaluate its success in fulfilling its objectives, and offered some general lessons in relation to the possibility of improving a tax system in a short period of time: consistency between tax reform objectives and the country's developments plan; inclusion of both mechanisms in bringing under control government expenditure and ways to generate non- tax revenue. He observed that the Indonesian tax reforms were economically desirable, most of the changes were good, and most have lasted. He argued that the Indonesian tax reform clearly demonstrates that, even in a low–income country, it is possible to develop and introduce a major tax reform in a relatively short time, to substantially improve the tax system as a result, and to sustain these good results for many years. Nevertheless, Asher identified the key problems that remain to be solved as improving the technical difficulties of the tax administration, improving equity, and putting into practice new techniques to improve enforcement and compliance.

The main lesson to be learned from the experience of the Indonesian tax reform is that the tax reform obviously did mark very well on "careful design and attention to detail" (Bird, 2003, p.12). This expression can be inferred from the following statement of Arnold Harberger (1989, p.27, quoted by Bird (2003, p. 12):

> *"(a) clarity of conception in designing a reform, (b) professional-level intention to detail in converting that conception into laws, regulations, and procedures, and (c) administrative machinery for implementing the reform efficiently, fairly, and above all in the long run."* .

Three of these scholars (Bird, Gillis, and Asher) came to a similar conclusion: that one of the major problems encountered with Indonesia's tax reform was the attempt at general lack of support and enthusiasm for reform from the tax administration. Bird (2003) argued that it is indeed difficult to implement a new system if those who have to make it work do not have any interest or real incentive to do so. Accordingly, Indonesia thus offers another example of the importance of the administrative dimension in tax reform.

The Heij (2001) study aimed to analyse the drafting and adoption of the 1983 Indonesian Income Tax Law and the ways in which this process was formed by the political circumstances of the time. His study was useful for providing an insight into the constraints faced by the makers of the law, and into the influences various agents brought to bear on the final outcome.

Miyasto's (1991) study thoroughly analysed the replacement of sales tax into VAT and luxurious goods tax in terms of double taxation, pyramiding tax and customer losses for small scale firms In the dissertation entitled "The Sales and the Value Added Taxes: Study on the impact on Price, Revenues and Structures"., the author noted that the following actions were taken by the Indonesian government in order to meet development fund needs resulting from the decline in oil revenues in the mid 1980s: (1) changing the tax structure: replacement of sales tax by VAT and tax on luxury goods (Act no. 8/1983), (2) expanding the tax base for VAT, and (3) increasing the tax rates for sales tax on luxury goods (Government Regulation No. 28 and 29/1988). He also noted that the sales tax resulted in double taxation and tax pyramiding resulting in an increase in consumers' burden in paying taxes. Consequently, these conditions encouraged tax avoidance. By making use of the 1985 Indonesian Input-Output Table, his study suggests that, *inter alia,* (1) the change of the sales tax to VAT resulted in a rise in general prices. He observed that this rise, due to the rise of tax rate, was greater than the impact of losing double taxation and tax pyramiding; (2) the change of the sales tax to the VAT increased the potential of tax revenues. However, both taxes have regressive tax structures. This means that low income groups pay a higher proportion of the taxes than high income groups. His study also found that the application of exempting some kinds of commodities, expanding the tax base of VAT and imposing tax on luxury goods reduced the regressivity of the VAT structure. Unfortunately, he also found that the structure of VAT was even more regressive than the sales taxes.

Yitzhaki and Lewis's paper (1996) recorded the investigation of a Dalton-improving tax and expenditure reform using a methodology developed by Yitzhaki and Slemrod (1991) and Mayshar and Yitzhaki (1995). This methodology surmounted the need for defining a specific social welfare function by looking, instead, for reforms that improve each social welfare function belonging to a wide class of functions. They applied the method to the energy sector of Indonesia, disregarding distributional constraints, and discovered that both the subsidy on kerosene and the tax on gasoline should be reduced. However, by considering distributional concerns, their study suggested that the existing composition of energy taxes was reasonable and the country may gain by increasing the subsidy on kerosene, taxing electricity, and reducing the gasoline tax.

Most Indonesian studies (Gillis, 1985, 1989, 1990, Asher, 1997) cover only tax reforms implemented during the period of 1981-1988 and were aimed at pinpointing out the reasons for the reforms, attempting to assess the achievement in completing the reform aims and proposing some broad lessons in terms of amending the tax system as well as the coherency between tax reform objectives and the country's plan of development.

The most significant contributions of Olivia (2002) and Olivia and Gibson (2002) on demand and tax reform analysis were their attempt to replicate works of Ravallion and Dearden (1988) on measuring the inequality aversion parameter, ε, and of Deaton (1990) on finding own and cross price elasticities without biases simultaneously. These studies were discussed in the previous section.

2.6 Policy debates on tax reform in Indonesia and Research gap

As reviewed above, there is a vast literature associated with tax reform, but there is still much to learn about Indonesian Tax reform. Olivia (2002) and Olivia and

Gibson (2002) investigated tax reform in Indonesia, but the most detailed part of their analyses applied to Java only and their data was from 1999 – just two years after the "ASIAN CRISIS" and the 1997 reforms which were implemented to deal with the crisis. Consequently, at least some of their conclusions may not apply throughout Indonesia, and may be distorted by the significant macroeconomic problems created by the crisis. Current day policy makers could therefore benefit by accessing more up-to-date information re tax reform.

In addition, as observed by Ikhsan et.al (2005b), a tax system, with a more integrated world economy, takes on an important role among a number of other key indicators of the overall investment climate. Consequently, countries, in particular developing countries, often compete with one another to offer tax incentives in order to attract both domestic and foreign investors to their shores. Accordingly, it is important to reform the Indonesian tax system to meet this business competitiveness objective.

In order to achieve the objective, the Indonesian government, through the Directorate of General of Taxation (DGT), has initiated the introduction of a new provisional proposal for Indonesian tax reform (Ikhsan et.al, 2005b). Yet the DGT's proposal has been challenged by a similar proposal advised by the Komite Pemulihan Ekonomi Nasional, KADIN (National Economic Recovery Committee, Chamber of Commerce, KPEN, hereafter)

Those two tax proposals have focused on (a) the income tax bill which consists of number of tax brackets and top marginal tax rates, taxable objects and gross income deduction, and tax administration; and (b) the value added tax bill which comprises taxation on service exports, the VAT on general mining goods, and the VAT rate on specific goods.

Ikhsan et.al (2005b) argue that although both proposals seem to focus on similar issues – namely expanding the fiscal base and improving the administration – their ideas are somewhat different with respect to implementation. Accordingly, Ikhsan et.al (2005b) carried out a study which attempts to review and evaluate the major differences between these proposals. Their evaluation is based on how the proposals are able to meet the main principles of and goals of taxation as the pesent study also refers to. Namely, economic efficiency, tax equity and, simple and feasible tax administration.

Ikhsan et.al (2005b) observe that in many cases both proposals have similar objectives but at the same time those tend to be biased towards their own interests. The DGT's proposal is aimed at improving country's competitiveness, but it tends to put more weight on the revenue objective whereas KPEN's proposal places more weight on tax competitiveness considerations than on revenue considerations. Accordingly, some recommendations have been made by Ikhsan et.al (2005b) to fill this gap. The present study only concerns the recommendations which are relevant to the focus of this study, i.e. indirect 'commodity' taxation. Accordngly, the following recommendations that focus on VAT taxes bill made by the Ikhsan et.al study are to be considered. They suggest that there should be[2]:

(a) a General VAT tariff of 10% and a special tariff of 3% (2.5% - 5%);

(b) a 0% VAT tariff for taxable export goods; and

(c) taxes on items such as general mining output and insurance services which are not currently taxed.

The present study attempts to shed some light on the current debate, addressing the 'desirability' of the first of Iksan's recommendations[3]. It updates, extends and improves upon former Indonesian studies of tax reform analysis – drawing mainly upon the previous works of Deaton (1990), Manrique and Jensen (1998), Olivia (2002), and Olivia and Gibson (2002). Although it made use of Mexican data, Nicita's (2004) study also makes a significant contribution to the present study in providing a justification for separate analysis of income groups in line with Jensen and Manrique's study.

[2] It is important to note that some elements of the new proposals were implemented in 2005, i.e. the non taxable income scheme has been changed to a new proposal. The change was made to provide an incentive for Indonesian families by introducing a fuel price adjustment compensation scheme. Recently, another independent team was led by the former Minister of Finance: Bambang Subiyanto to mediate and to fill the differences between these two proposals, as well as to finalise the final draft of the new tax package. This new tax package will be submitted for approval to the Parliament.

[3] The second and third are beyond the scope of this investigation.

In brief, the current study will fill the gap identified from the previous studies in terms of the following:

1. To make use of more recent data sources i.e. cross sectional data of 1999 (Olivia and Gibson) versus the 2002 cross section data for the present study.
2. To extend data coverage of Olivia's study (2002) which focused only on Java; analysing all of Indonesia instead.
3. To carry out separate analysis for not only urban and rural areas but also for income categories. This is to test if Nicita's findings (that income categories are driven by the difference in the computed demand elasticities) also appear to hold in Indonesia.
4. To employ unit value index as proposed by Olivia and Gibson (2005) to compute a variable log of unit value
5. To remedy the heteroschedasticity problem which mostly occurs in cross-sectional data analysis
6. To replace the missing value of the unit value by cluster average as suggested by Olivia and Gibson (2005)
7. To include income variable as an alternative model to Deaton's procedure, adopted by the former studies so as to estimate Marshallian demand.
8. To propose a new method of obtaining an appropriate value for inequality aversion by utilising the Atkinson Index approach

2.7 Concluding remarks

Van de Gaer et al (1997) observe that the welfare evaluation of tax reform requires a combination of empirical facts and normative judgments. The first step in the analysis is the computation of the effects of changes in the instruments on the relevant economic variables. Marginal welfare costs will be computed by utilising an approach which has been initiated by Ahmad and Stern (1984, 1991). One of the main motivations for estimating demand systems is to facilitate welfare analysis resulting from policy changes in particular tax reform policy.

As suggested by the previous sub-section, Lambda criteria are an important instrument to provide a tax reform recommendation for future tax policy. In order to obtain rational figures of the Lambda, computed price elasticities and income distribution effects represented by inequality aversion and SWF choices are carefully facilitated. Elasticities of commodity prices and a range of inequality aversion parameters determine commodities as candidates for increasing tax or decreasing tax to keep government revenue neutral.

Considering thoroughly the above discussions in relation to key variables involved in Lambda criteria and assessing how the previous studies carried out their empirical works and the gaps that could be extended, the present study proposes to use two general economic models:

Model I: Multi good case with total expenditure (x)

$$w_{hic} = f(lx_{hc}, z_{hc})$$

$$lv_{hic} = f(lx_{hc}, z_{hc})$$

Model II: Modification of Model I with both a replacement of total expense (x) with expenditure for food (TEF) and inclusion of income variable

$$wf_{hic} = f(lTEF_{hc}, z_{hc}, lIC_{hc})$$

$$lv_{hic} = f(lTEF_{hc}, z_{hc}, lIC_{hc})$$

Where

w_{hic} = budget share of household h for aggregate commodity i in c cluster (as a ratio of total expenses)

wf_{hic} = budget share of household h for aggregate commodity i in c cluster (as a ratio of total food expenses)

lx_{hc} = log of total expenses for each household h in c cluster

lv_{hic} = log of unit value of aggregate commodity i in c cluster

z_{hc} = family size for each household h in c cluster

$ln\ IC_{hc}$ = log of Income for each household h in c cluster

$ln\ TEF_{hc}$ = log of expense for food for each household h in c cluster

c = cluster

The above models determine magnitudes of the price elasticities in which this is the early step to conduct tax reform simulation of lambda. Meanwhile, the lambda itself is determined by distributional characteristics which are accentuated by a number of varied values of inequality aversion parameters. In this case, the present study will compute the parameter by making use of the Atkinson Index which considers existing income distribution. A more detailed discussion of this methodology can be found in Chapter 4.

Meanwhile, data availability is also important to obtain reasonable outcomes from the proposed models. Accordingly, Chapter 3 presents the detailed data including the relevant problems and solutions.

Chapter 3
Data

3.1 Introduction

As discussed in Chapter 2, this study attempts to extend the previous studies of Olivia (2002) and of Olivia and Gibson (2002) on measuring own – and cross-price elasticities from spatial variation in prices, using household survey data. The study makes use of more updated data from of the 2002 SUSENAS:

1. to extend the scope of the former study, by covering more regions, areas and income groups.
2. to replicate Deaton's procedure and also tests a modified model that includes an income variable, and hence generates estimates of Marshallian demand.

Accordingly, the present study proposes the following two economic models:

The first model is for use in SWF analysis (as per previous studies):

$$w_{ihc} = f(\ln X_{hc}, z_{hc})$$
$$\ln v_{ihc} = f(\ln X_{hc}, z_{hc})$$

The second model will generate estimates of Marshallian price and income elasticities as an alternative to the previous model:

$$wf_{ihc} = f(\ln TEF_{hc}, z_{hc}, \ln IC_{hc})$$
$$\ln v_{ihc} = f(\ln TEF_{hc}, z_{hc}, \ln IC_{hc})$$

Where,

w_{ihc} is budget share of good i for household h, where $i=1, ...,13$ *and* $h=1,...,H$

wf_{hic} is budget share of household h for aggregate commodity i within c cluster (as a ratio of total food expenses)

H is number of households

$\ln v_{ihc}$ is log of unit value of good i for household h within c cluster

$\ln X_{hc}$ is log of total expenditure for household h within c cluster

z_{hc} is family size (number of family members in household h) within c cluster

$\ln IC_{hc}$ is log of income for household h within c cluster

$\ln TEF_{hc}$ is log of total expenses for food of household h within c cluster

In order to conduct an empirical analysis of the proposed models, it is important to obtain data for household behaviour such as expenditure, income, budget share and unit values as well as household characteristics. Accordingly, this chapter aims to:

1. provide an overview of the 2002 Household Budget Survey of National Socio and Economic Survey (SUSENAS, hereafter);
2. describe characteristics of data (commodities, income, number of households surveyed and tax rate) available to the present study including justification for appropriateness of the data utilisation in the analysis;
3. discuss income, expenditure and consumption patterns of Indonesian households, to help justify the selection of commodities used in the model, as well as to interpret the results.
4. describe how the models will be populated with the SUSENAS data

Chapter 3 is structured as follows. The Introduction will be followed by Section 3.2 which gives a brief overview of the 2002 SUSENAS and the sample. Section 3.3 discusses the structure of the data set, noting which types of goods will be included in the analysis, and explaining why they were chosen. This section also explains the strategies that will be used to solve data problems in relation to zero expenditure and unavailability of unit values data. Section 3.4 discusses the income data. In particular, it looks at the expenditure patterns of Indonesian households by type of regions, areas and income groups. Section 3.5 looks at the consumption patterns of necessities, luxuries and inferior goods. These preliminary findings also provide a better justification of choices made regarding commodities and regions used in the empirical investigation of chapter 4. Section 3.6 discusses tax rate data with respect to the supported tax regulations, including a brief discussion of tax reforms, as well as taxable commodities observed. Section 3.7 offers some concluding remarks.

3.2 Overview of the 2002 SUSENAS data and the sample

This study utilises Indonesian data from the 2002 SUSENAS. The Indonesian government periodically carries out the survey to gather data related to expenditure and the socioeconomic characteristics of Indonesian households.

The SUSENAS sample is selected so as to fairly represent all segments of the Indonesian population as a whole. This can be seen from Table 3-1 below where, by making use of 2000 census data as a basis of comparison, the proportion of the sample drawn from the total sample for every single region (province) in general properly reflects the proportion of the region's population to the Indonesian population. For example, the proportion of sampled rural households to total sample in North Sumatra (58.7%) closely follows that of the province's rural population to total population (57.6%).

In addition, considering that the majority of the Indonesian population are villagers, it is not surprising that the obtained data sample of rural people was proportionally larger than that of urban people. Table 3.1 below further suggests that 54.55% of the Indonesian population in the survey are villagers (19 regions out of 26 regions) and 45.45% are city dwellers. Recognising the characteristics of the sample is important for justifying the further analysis that is presented in this study.

Table 3-1
Distribution of population according to 2000 Census and the 2002 SUSENAS data sample

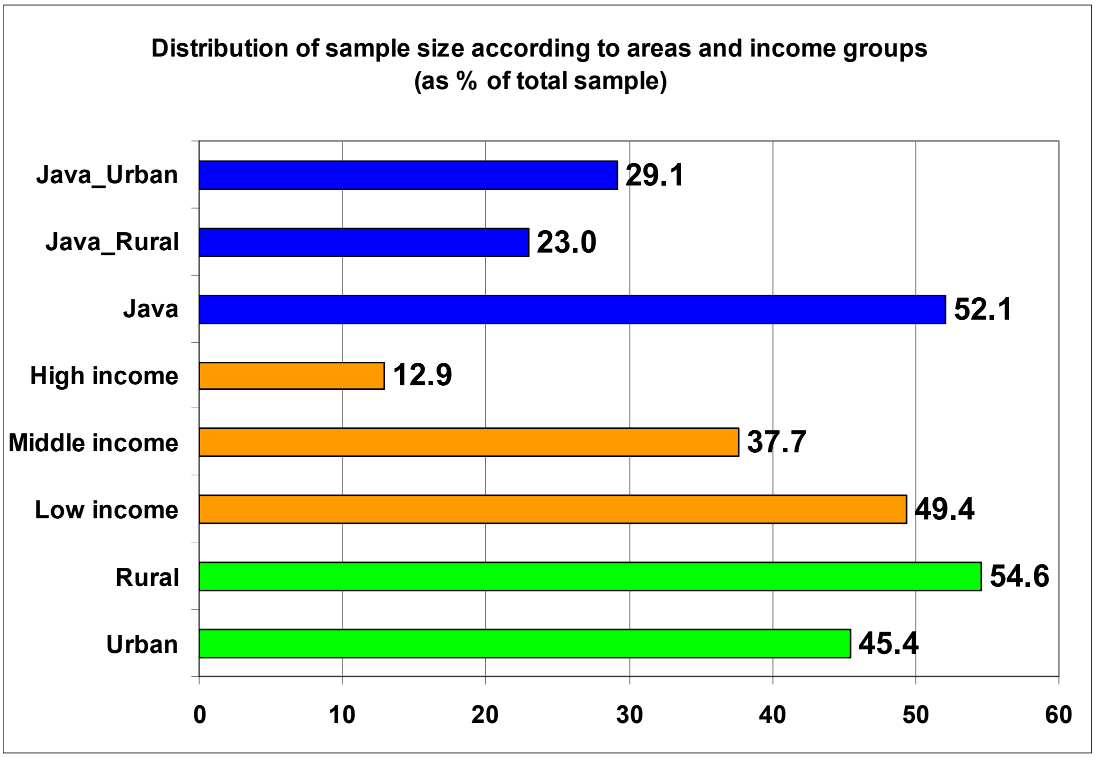
		Census 2000		% of Population			% of Sample	
No	Province	POP	% of IND POP	U/POP (%)	R/POP (%)	S/POP (%)	U/S (%)	R/S (%)
1	11 Nanggroe Aceh Darussalam	3,930,905	1.91	23.6	76.4			
2	12 North Sumatera	11,649,655	5.65	42.4	57.6	0.029	41.30	58.70
3	13 West Sumatera	4,248,931	2.06	29.0	71.0	0.041	28.98	71.02
4	14 Riau	4,957,627	2.40	43.7	56.3	0.023	52.30	47.70
5	15 Jambi	2,413,846	1.17	28.3	71.7	0.047	30.52	69.48
6	16 South Sumatera	6,899,675	3.35	34.4	65.6	0.026	32.92	67.08
7	17 Bengkulu	1,567,432	0.76	29.4	70.6	0.064	30.82	69.18
8	18 Lampung	6,741,439	3.27	21.0	79.0	0.031	21.95	78.05
9	19 Bangka Belitung	900,197	0.44			0.086	45.09	54.91
10	31 DKI Jakarta	8,389,443	4.07	100.0	-	0.070	100	0
11	32 West Java	35,729,537	17.32	50.3	49.7	0.019	51.53	48.47
12	33 Central Java	31,228,940	15.14	40.4	59.6	0.024	41.44	58.56
13	34 D.I. Yogyakarta	3,122,268	1.51	57.7	42.3	0.093	51.36	48.64
14	35 East Java	34,783,640	16.86	40.9	59.1	0.025	42.79	57.21
15	36 Banten	8,098,780	3.93	na	na	0.023	57.95	42.05
16	51 Bali	3,151,162	1.53	49.8	50.2	0.060	53.20	46.80
17	52 West Nusa Tenggara	4,009,261	1.94	34.8	65.2	0.053	37.92	62.08
18	53 East Nusa Tenggara	3,952,279	1.92	15.9	84.1	0.042	16.35	83.65
19	61 West Kalimantan	4,034,198	1.96	25.1	74.9	0.046	25.73	74.27
20	62 Central Kalimantan	1,857,000	0.90	27.5	72.5	0.060	30.82	69.18
21	63 South Kalimantan	2,985,240	1.45	36.3	63.7	0.058	37.49	62.51
22	64 East Kalimantan	2,455,120	1.19	57.6	42.4	0.045	58.45	41.55
23	71 North Sulawesi	2,012,098	0.98	37.0	63.0	0.055	38.62	61.38
24	72 Central Sulawesi	2,218,435	1.08	19.7	80.3	0.050	18.47	81.53
25	73 South Sulawesi	8,059,627	3.91	29.4	70.6	0.028	30.54	69.46
26	74 Southeast Sulawesi	1,821,284	0.88	25.5	74.5	0.061	21.60	78.40
27	75 Gorontalo	835,044	0.40	na	na	0.093	28.42	71.58
	Total Pop (Without Aceh)	202,053,063	97.96			0.032	45.45	54.55
28	81 Maluku	1,205,539	0.58	25.9	74.1		**Dominant Sample**	
29	82 North Maluku	785,059	0.38	22.2	77.8		7 regions	19 regions
30	94 Papua	2,220,934	1.08					
				Average % of no. sample		0.048	Urban	Rural
	INDONESIA	**206,264,595**						

Note:

- POP: number of population
- % of POP: proportion of every region to total population
- U/POP: proportion of urban population to total population, taken from Table 2 % of Urban Population in Indonesia: 1980, 1990, 1995 and 2000
- R/POP: proportion of rural population to total population
- S/POP: proportion of total Sample to total population
- US/S: proportion of Urban Sample to total Sample
- RS/S: proportion of Rural Sample to total Sample
- Province Maluku, North Maluku and Papua were excluded from the data sample
- 7 provinces were dominated by urban people whereas 19 provinces included, predominantly villagers

In fact, the present study makes use of 64,422 households across 26 provinces out of 29 available provinces.[4] The regional coverage included 5 different islands: Sumatra, Java, Sulawesi, Bali and Nusa Tenggara and Kalimantan, in which urban and rural areas were considered (see Figure 3.1).

Figure 3-1
Distribution of sample size according to areas and income groups, 2002



It should be noted that the 2002 SUSENAS data gathered in every selected household was conducted by direct interview between enumerator and respondent. The data collected made use of a consumption module questionnaire covering characteristics of consumption and expenditure of the selected household. It collected detailed data about household expenditure on food and non- food items, as well as household demographic characteristics. The demographic information was obtained from the head of household, the spouse of the head of household or a household member who knew the required characteristics.

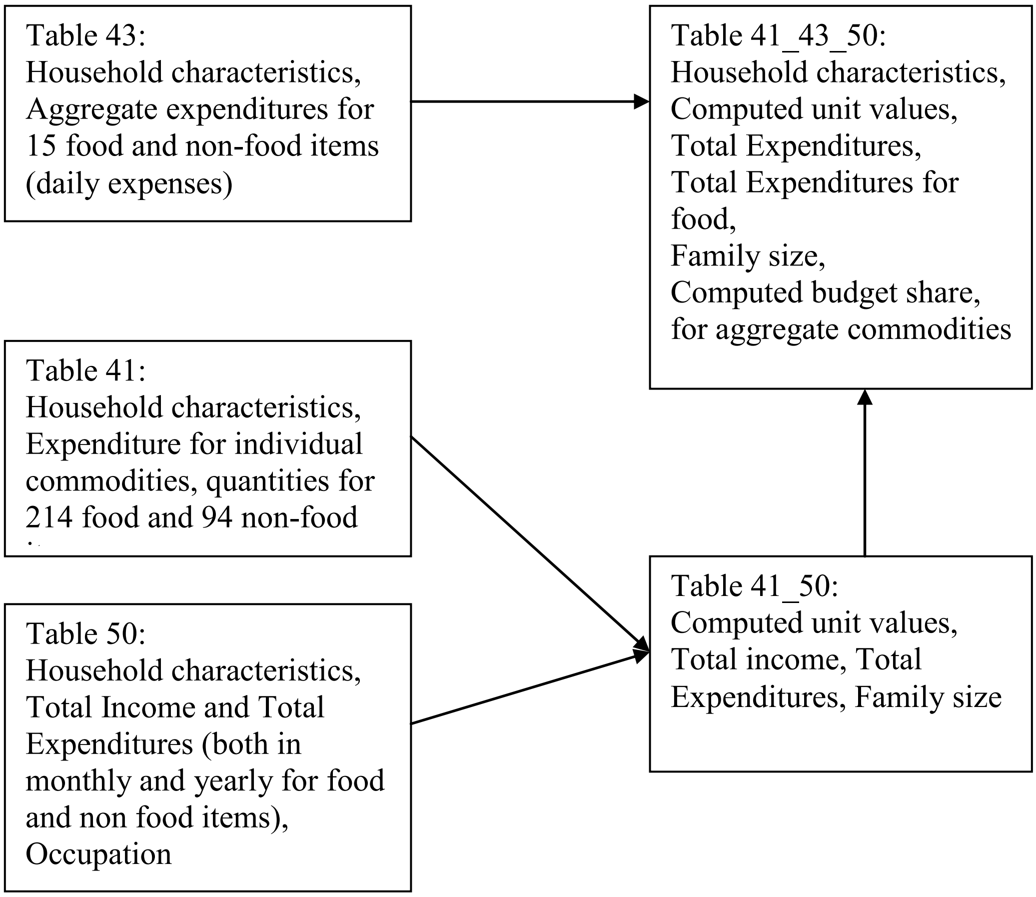
More specifically, the 2002 SUSENAS data has been sorted into three different data sets which are available to the present study, namely:

[4] The sample excludes Nanggroe Aceh Darussalam, North Maluku, Maluku and Papua.

1. Table 4.3 which provides detailed information about household expenditure on 15 'aggregate' food commodities (cereals, grains, tuber, fish, meat, egg and milk, vegetables, pulses (legumes), fruits, oil and fat, beverage flavour, spices, other consumption, prepared food and drink, alcoholic beverages, and tobacco and betel and 6 'aggregate' non - food commodities (housing and household facilities, goods and services, clothes, durable goods, tax and insurance, festivities and ceremonies.
2. Table 4.1 which provides detailed information about household expenditure on less aggregated commodities (214 different food expenditures and 94 different non-food expenditures). It also provides information about the quantities of food consumed (but quantity data is not available for non-food commodities).
3. Table 50 which consists of income and expenditure data. The income data includes labour - income received in the last month, farming and non-farming income, income from ownership and non - labour transfers, financial transactions, and net capital good. The expenditures contain only expenditure transfer and financial transactions made within the last year. This table also reports the monthly average of the household expenditure and income.

The available data had to be 'cleaned' before it could be used for empirical analysis, and variables from each of SUSENAS three different tables had to be combined into a single data set. The present study made use of Microsoft Access Database to conduct the data cleaning and to compile the data set (referred to as Table 41_43_50). Figure 3.2 below, shows how this was done.

Figure 3-2
Data compilation of Table 41, 43 and 50



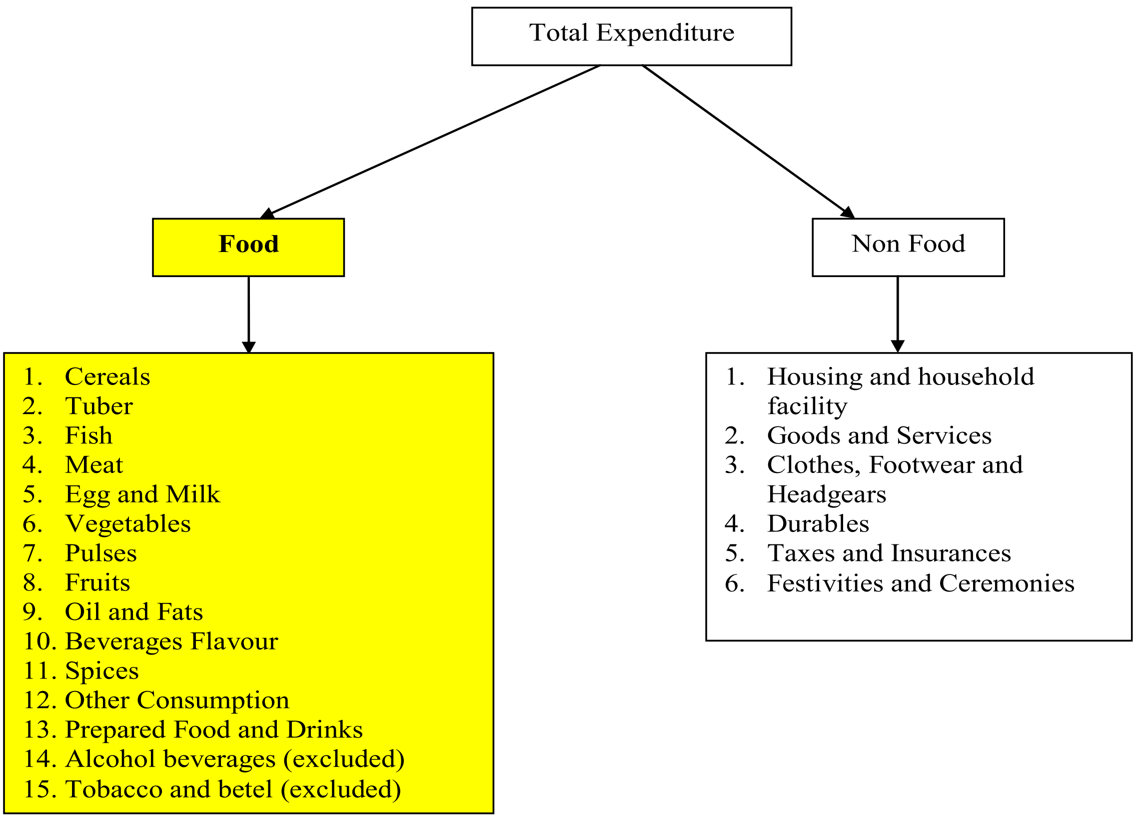
Here, the term ‘household characteristics’ is used to refer to data relating to the characteristics of the island, region, regency, sub-district, village, sample code and number of family members in the household.

The present study also made use of Excel to produce pivot tables and charts in order to descriptively analyse the observed data and make some preliminary observations.

3.3 The Expenditure Data

As discussed above, this study considers household total expenditure obtained from the 2002 SUSENAS, consisting of two spending categories of commodities, namely spending for food and non - food items (see Figure 3-3). Unfortunately, SUSENAS does not report quantities consumed for non - food commodities, but only reports them in terms of monthly average expenditure. Accordingly, the unit values cannot be computed, since to compute the unit values requires information concerning the quantities, as well as expenditure of a particular good consumed. The study, thus, focuses only on food commodities.

Figure 3-3
Spending categories according to the 2002 SUSENAS



Note: The shaded box is the focus of the study, except commodities 14 (Alcohol beverages) and 15 (Tobacco and betel). A justification for their exclusion can be found in sub-section 3.3.3 (unobservable prices: unit values and the missing values) and 3.5.4 (alcohol spending patterns).

Some households did not purchase some commodities within the survey period (zero expenditure). For example, the present study identifies that out of 64,422 households observed in the 2002 SUSENAS, only 2.2% consumed alcohol.

Indeed, food participation rates were low for several commodity groups, such as: alcohol; meat; and tuber (2.2%, 41.5%, and 51.9% respectively), as per Jensen and Manrique (1998). In contrast, cereals, spices, oil, fats, and vegetables had high food participation rates (97.9%, 97.2%, 97.1% and 96.9% respectively, see Table 3-2 for details). Interestingly, the participation rates for alcohol and for tobacco and betel are higher in rural than in urban areas, i.e. 2.7% and 73.8% compared to 1.5% and 60.7% respectively.

Table 3-2
Distribution of the consumption by Indonesian household sample of 15 commodities, tabulated by urban and rural areas

INDONESIA	ALL		URBAN		RURAL	
Commodities	N*)	%	N*)	%	N*)	%
	w					
Cereals	63,071	97.9	28,123	96.1	34,948	99.4
Tuber	33,459	51.9	14,673	50.1	18,786	53.5
Fish	56,192	87.2	25,200	86.1	30,992	88.2
Meat	26,715	41.5	17,081	58.3	9,634	27.4
Eggs&Milk	49,692	77.1	25,496	87.1	24,196	68.9
Vegetables	62,441	96.9	27,673	94.5	34,768	98.9
Pulses	51,250	79.6	25,203	86.1	26,047	74.1
Fruits	50,919	79.0	24,437	83.5	26,482	75.4
Oils&Fats	62,542	97.1	27,822	95.0	34,720	98.8
Beverages	61,904	96.1	28,256	96.5	33,648	95.7
Spices	62,637	97.2	27,828	95.0	34,809	99.0
Other Cons	39,786	61.8	20,603	70.4	19,183	54.6
Pfood&Drinks	58,410	90.7	28,134	96.1	30,276	86.2
Alcohol	1,399	2.2	440	1.5	959	2.7
Tobacco & Betel	43,721	67.9	17,776	60.7	25,945	73.8
Total Households	**64,422**		**29,279**		**35,143**	

Note: N): number of households who consumed commodities observed; w is budget share*

With respect to prepared food and beverages, the Javanese food participation rate is similar to the Indonesian one. Interestingly, prepared food and drinks have the highest participation rate in urban areas whereas tuber-consumption is the lowest in urban areas. Meat has the lowest consumption rate in rural areas, apart from alcohol (see Table 3-3 below).

Table 3-3
Distribution of the Javanese household sample who consumed 15 commodities, tabulated by urban and rural areas

JAVA	ALL		URBAN		RURAL	
Commodities	**N*)**	**%**	**N*)**	**%**	**N*)**	**%**
	w					
Cereals	32,502	96.8	17,846	95.1	14,656	98.9
Tuber	17,038	50.7	9,312	49.6	7,726	52.2
Fish	27,084	80.6	15,348	81.8	11,736	79.2
Meat	16,188	48.2	11,739	62.5	4,449	30.0
Eggs&Milk	27,158	80.9	16,465	87.7	10,693	72.2
Vegetables	32,103	95.6	17,563	93.6	14,540	98.2
Pulses	31,024	92.4	17,051	90.8	13,973	94.3
Fruits	26,642	79.3	15,713	83.7	10,929	73.8
Oils&Fats	32,280	96.1	17,684	94.2	14,596	98.5
Beverages	32,360	96.4	18,092	96.4	14,268	96.3
Spices	32,316	96.2	17,700	94.3	14,616	98.7
Other Cons	22,831	68.0	13,632	72.6	9,199	62.1
Pfood&Drinks	31,991	95.3	18,284	97.4	13,707	92.5
Alcohol	221	0.7	160	0.9	61	0.4
Tobacco & Betel	22,454	66.9	11,507	61.3	10,947	73.9
Total Households	33,584		18,771		14,813	

Note: N): number of households who consumed commodities observed; w is budget share*

Although Jensen and Manrique's (1998) findings suggest that the food participation rate of households for all income groups in Indonesia was generally about 90% for all commodity groups (rice, palawija, fish, meat, milk, fruit, other food and non foods), the present study finds that the rate for alcohol, meat, tuber, pulses, other consumptions, egg and milk, fruits, vegetables and tobacco are lower than the Jensen and Manrique figure (less than 90%, especially alcohol, which on average is about 2%). Also, Table 3.4 suggests that higher income households have higher food participation rates.

Table 3-4
Distribution of the Indonesian household sample who consumed 15 commodities according to income groups

	IC1		IC2		IC3	
Commodities	**N*)**	**%**	**N*)**	**%**	**N*)**	**%**
			w			
Cereals	31,087	97.7	23,811	98	8,173	98.2
Tuber	15,778	49.6	12,766	52.6	4,915	59.1
Fish	26,534	83.4	22,004	90.6	7,654	92
Meat	7,112	22.4	12,978	53.4	6,625	79.6
Eggs&Milk	20,732	65.2	21,100	86.9	7,860	94.5
Vegetables	30,767	96.7	23,601	97.2	8,073	97
Pulses	23,775	74.7	20,148	83	7,327	88.1
Fruits	22,307	70.1	20,772	85.5	7,840	94.2
Oils&Fats	30,785	96.8	23,656	97.4	8,101	97.4
Beverages	29,948	94.1	23,755	97.8	8,201	98.6
Spices	30,876	97.1	23,659	97.4	8,102	97.4
Other Cons	16,109	50.6	16,941	69.8	6,736	81
Pfood&Drinks	27,178	85.4	23,107	95.1	8,125	97.6
Alcohol	634	2	558	2.3	207	2.5
Tobacco & Betel	21,617	68	17,002	70	5,102	61.3
Total Households	**31,813**		**24,288**		**8,321**	

Note: IC1 – low income (the poor), IC2 – middle income (the average), IC3 – high income (the rich) – a detailed discussion for income categorisation could be found in Sub-section 3.4.1. And w is budget share

As noted in other studies, the present study is also aware of the fact that zero expenditure can occur for many reasons, i.e. the household cannot afford to buy an expensive good (e.g. meat), religious considerations prevent the household from buying the goods (e.g. alcohol), the household could not recall his/her expenses as the goods were bought infrequently (e.g. spices) or the household consumed from his/her own production (e.g. tubers, vegetables). Accordingly, zero expenditure should be part of the analysis and should be treated appropriately.

Jensen and Manrique (1998) suggest that researchers can deal with the zero-consumption problem by using a two - step decision process, in which individuals firstly decide to consume some non-zero amount of a particular good and then, conditional on this decision, choose the amount. This approach, they argue, *permits different sets of factors to explain expenditures on each outcome and different demand functions for the set of commodities when some of them are not consumed.* However, an alternative approach to the zero-expenditure problem was provided by Olivia and Gibson (2005). This approach also provides part of a solution to the problem of unobservable prices, so is discussed in more detail below.

As discussed in Chapter 2, price data is rarely collected in household expenditure surveys and is not available in the SUSENAS data set. But it is an essential variable in demand equation models, in particular for models replicating Deaton's procedure for computing own-price and cross-price elasticities. This is because Deaton's procedure cannot be used to calculate quality-adjusted unit values if there are zero-expenditure observations. As the present study will consider non-consuming households, the missing unit values will therefore be replaced by the cluster 'village' mean of the unit values adopted from the Olivia and Gibson' study (2005). Importantly, their study demonstrated that replacing missing values with the 'village' cluster mean produces final estimates which are similar to those that are produced when using Deaton's procedure, while omitting missing values. So this procedure will help raise the number of 'observations' without biasing final estimates. A detailed discussion can be found in Chapter 2 and Table 3-5 shows how this procedure increases the number of observations in unit values data after replacing the missing values by the 'village' cluster mean.

Table 3-5
Distribution of the Indonesian household sample who reported the quantity of 15 commodities bought including the replacement missing values

INDONESIA	ALL				URBAN				RURAL			
Commodities	N*)	%	N**)	%	N*)	%	N**)	%	N*)	%	N**)	%
	uv											
Cereals	63,071	97.9	64,405	99.97	28,123	96.1	29,262	100	34,948	99.4	35,143	100
Tuber	33,433	51.9	60,436	93.8	14,665	50.1	27,761	94.8	18,768	53.4	32,675	93
Fish	30,569	47.5	59,519	92.4	13,651	46.6	27,453	93.8	16,918	48.1	32,066	91.2
Meat	14,405	22.4	47,050	73	9,340	31.9	25,408	86.8	5,065	14	21,642	61.6
Eggs&Milk	13,476	20.9	45,065	70	9,046	30.9	25,128	85.8	4,430	13	19,937	56.7
Vegetables	13,468	20.9	45,033	69.9	9,042	30.9	25,112	85.8	4,426	12.6	19,921	56.7
Pulses	12,622	19.6	43,369	67.3	8,707	29.7	24,828	84.8	3,915	11.1	18,541	52.8
Fruits	12,004	18.6	42,349	65.7	8,351	28.5	24,498	83.7	3,653	10.4	17,851	50.8
Oils&Fats	11,979	18.6	42,318	65.7	8,333	28.5	24,467	83.6	3,646	10.4	17,851	50.8
Beverages	11,922	18.5	42,224	65.5	8,304	28.4	24,437	83.5	3,618	10.3	17,787	50.6
Spices	11,892	18.5	42,197	65.5	8,279	28.3	24,410	83.4	3,613	10.3	17,787	50.6
Other Cons	10,059	15.6	38,788	60.2	7,184	24.5	23,026	78.6	2,875	8.2	15,762	44.9
Pfood&Drinks	9,865	15.3	38,337	59.5	7,108	24.3	22,921	78.3	2,757	7.8	15,416	43.9
Alcohol	251	0.4	2,198	3.4	134	0.5	1,148	3.9	117	0.3	1,050	3
Tobacco & Betel	217	0.3	1,857	2.9	111	0.4	918	3.1	106	0.3	939	2.7
Total Households	**64,422**		**64,422**		**29,279**		**29,279**		**35,143**		**35,143**	

Note: N) is number of households who reported the quantities of 15 commodities bought so that the unit values can be computed (E_i/Q_i = Expenses for good i divided by Quantity of good i bought)*
*N**) is N*) with addition to a replacement of missing values of unit values with a cluster 'village' average of unit values.*

In addition, recognising that

(1) alcohol was consumed by only a very small proportion of the sample (2.2% as the alcohol participation rate); and

(1) the majority of the Indonesian population is Moslem (88.2% according to the 2000 Indonesian census), whose religious belief does not allow them to consume alcohol; and

(2) the unit value for tobacco and betel can only be increased by about 2.6% after replacing missing values with village means

This analysis will limit the analysis to just 13 commodities - excluding both alcohol and tobacco and betel. This exclusion of alcohol has also been considered by Olivia (2002) for the same reason.

As will be discussed in Chapter 5, excluding these commodities from the econometric model seemed to improve the prediction power of the variance-covariance matrix.

The chosen commodity groups are similar to the commodities which Olivia (2002) and Olivia and Gibson (2002) studied. The exceptions being: prepared food and drinks, which are included in the present study but not in the former studies. A detailed comparison of a number of commodities used in the present study and in other studies can be seen in Table 3.5 below.

Table 3-6 provides a summary of studies that have used Indonesian household expenditure data since 1979 (Timmer and Alderman). It highlights the fact that different studies have used different commodities, different regions and have also analysed different time frames. The Molineaux et al (2004) study made use of the 2002 SUSENAS data and similar aggregate commodities as referred to by the present study. The rest of the studies used different commodities where some of them were aggregated and others were disaggregated. For example, commodities such as vegetables and fruits are more aggregated than the present study, whereas commodities such as cereals were more disaggregated.

Table 3-6
Various demand studies on Indonesian data, 1979 – 2005

Authors	**Johanna**	**O & G**	**Molinex et al**	**O&G**	**Olivia**	**Hutasoit et al**	**J & M**
Year of public	**2006**	**2005**	**2004**	**2002**	**2002**	**2001**	**1998**
Comties	Cereals	Beef	Grains	Rice	Rice	Beef	Rice
	Tuber	Chicken	Tubers	Cereal Flours	Cereal Flours	Chicken	Wheat
	Fish	Other meat	Fish	Maize	Maize		Corn
	Meat		Meat & poultry	Cassava	Cassava		Palawija
	Egg&Milk		Dairy & Eggs	Fresh Fish	Fresh Fish		Cassava
	Vegetables		Vegetables	Dried Fish	Dried Fish		Fish
	Pulses		Bean & Nuts	Meat	Meat		Fresh fish
	Fruits		Fruits	Dairy&Eggs	Dairy&Eggs		Dry fish
	Oil&fats		Oil&fats	Vegetables	Vegetables		Meat
	Beverages		Sugar & drink mixes	Pulses	Pulses		Milk
	Spices		Spices	Fruits	Fruits		Nuts
	Other Cons		Other (proc.) food	Oil&fats	Oil&fats		Fruits
	PFoods&Drink		PFoods&Drink	Beverages	Beverages		Other food
	Alcohol		Alcohol	Sugar	Sugar		Non-food
	Tobacco & Betel		Tobacco & Betel	Spices	Spices		
				Other Cons	Other Cons		
No of comties	**15 comties**	**3 comties**	**15 comties**	**16 comties**	**16 comties**	**2 comties**	**14 comties**
Coverage	Indonesia	Java	Indonesia	Indonesia	Java	Jakarta & W.Java	Indonesia
Sources of Data	SUSENAS	SUSENAS	SUSENAS	SUSENAS	SUSENAS	SUSENAS	SUSENAS
Data	2002	1999	1996, 1999, 2002	1999	1999	1990, 1993, 1996	1981, 1984, 1987
Authors	**Deaton**	**T&J**	**Tabor**	**C & M**	**Dixon**	**T & A**	
Year of public	**1990**	**1987**	**1987**	**1984**	**1982**	**1979**	
Comties	Rice	Rice	Rice	Rice	Rice	Rice	
	Maize	Palawija	Corn	Wheat	Fresh cassava	Fresh Cassava	
	Roots	Fish	Cassava	Corn	Gaplek	Cal. intake from	
	Cassava	Meats & dairy	Peanut	Cassava		Rice, cassava, corn	
	Fresh fish	Beans	Mungbean	Potatos			
	Dried fish	Fruits & Veg	Soybean	Fish			
	Meat		Sugar	Meat			
	Vegetables			Eggs			
	Legumes			Dairy Products			
	Fruits			Vegetables			
				Legumes			
				Fruits			
No of comties	**10 comties**	**6 comties**	**7 comties**	**12 comties**	**3 comties**	**3 comties**	
Coverage	Java	Indonesia	Indonesia	Indonesia	Java	Indonesia	
Sources of Data	SUSENAS	SURGASAR	SUSENAS	SUSENAS	SUSENAS	SUSENAS	
Data	1981	1980	1965 - 1985	1978	1976	1976	

3.4 The Income Data

It is undeniable that the indirect tax policy reforms, on which the present study focuses, are likely to lead to commodity price adjustments. The price correction causes different impacts on the welfare of consumers in different income groups (Jensen and Manrique, 1998, Pinstrup-Andersen and Caicedo, 1978). Under these circumstances, these researchers argue that aggregate demand analysis is not worthwhile and may be unreliable if policy makers disregard the importance of target group classification. In addition, as observed by Jensen and Manrique (1998), differences in income groups lead to dissimilarities in consumer behaviour. Accordingly, Jensen and Manrique (1998) argue that there are at least three reasons to estimate demand systems for different income groups instead of in aggregate.

First, it is not easy to fit the income distribution effects into an aggregate demand analysis. Many studies thus make use of average expenditure as a proxy for income by assuming that the approximation error is relatively insignificant. This error, which was noted by Deaton and Muelbauer (1980), is reduced only if the distribution of expenditure and the composition of demography are kept reasonably constant. Unfortunately, as Jensen and Manrique (1998) observed, these assumptions, in general, do not hold.

Second, income class specific substitution effects that are important for policy formulation can be captured by income group specific demand parameters.

Third, the consumption patterns for low-income consumers are in general less variable and so this group consumed a smaller number of food commodities than other income groups. Therefore, methods for estimating demand parameters that do not take into account these income group categorisations will not produce unbiased and consistent estimated demand parameters and elasticities. Consequently, conclusions and recommendations that arise from such estimates could be flawed and/or unreliable.

To consider the importance of income classification for the demand analysis, the present study breaks down the 64,422 households into 9 income categorisations. These classifications are important for further econometric analysis in order to differentiate the poor and the rich. As an illustration, Table 3.6 suggests that out of 64,422 households, about 37.7% (income groups 4, 5 and 6) have a monthly income of between 800,000 – 2,000,000 Rupiahs. Those people represent the middle income groups. Only 2% of the households were considered as the richest, having a monthly income of 5000,000 Rupiahs and more, whereas 12.8% of the surveyed households had an income per month of less than 400,000 Rupiahs, and this group is categorised as the poorest. See details in Table 3-7 below.

Table 3-7
Distribution of surveyed households according to income categories SUSENAS, 2002

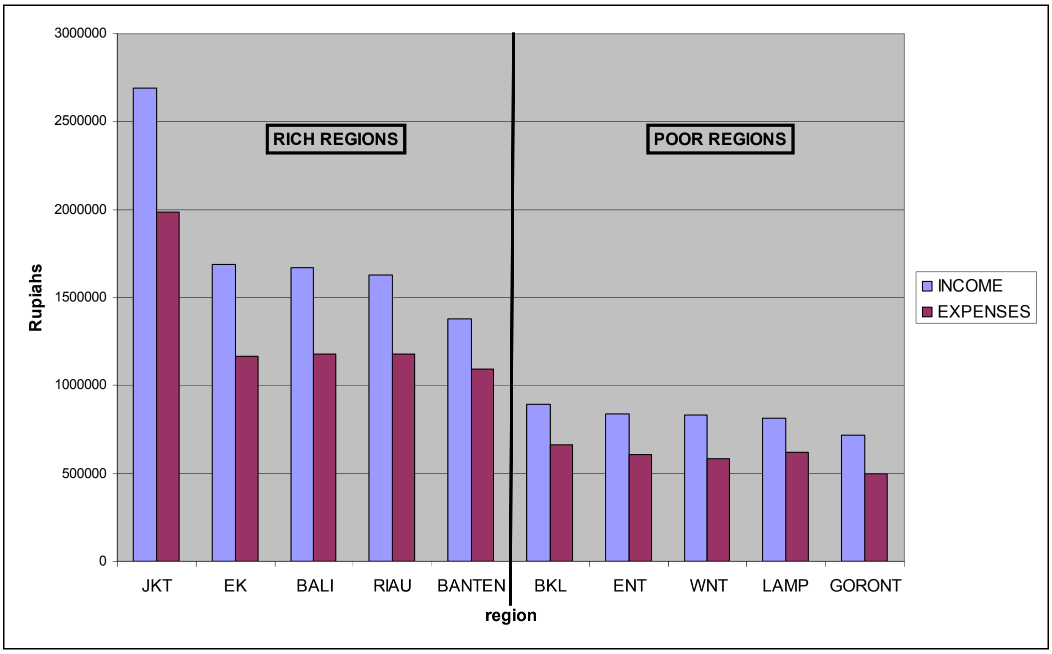
Code	Income Groups (Rupiahs)	No of HH	%	Income Groups for further econometric analysis (Rupiahs)	No. of HH	%
IC1	Less than 400,000	8,259	12.8			
IC2	400,000 - less than 600,000	12,288	19.1	**Less than 800,000**		
IC3	600,000 - less than 800,000	11,266	17.5	**(IC1 - Low Income)**	31,813	49.4
IC4	800,000 - less than 1,000,000	7,963	12.4			
IC5	1,000,000 - less than 1,500,000	10,976	17.0	**800,000 - less than 2,000,000**		
IC6	1,500,000 - less than 2,000,000	5,349	8.3	**(IC2 - Middle Income)**	24,288	37.7
IC7	2,000,000 - less than 3,000,000	4,549	7.1			
IC8	3,000,000 - less than 5,000,000	2,468	3.8	**2,000,000 and more**		
IC9	5,000,000 and more	1,304	2.0	**(IC3 - High Income)**	8,321	12.9
	Total sample size	**64,422**			**64,422**	

Note: Income data for one household in region 14 was missing and was therefore replaced by the cluster mean of income within that region

The advantage of these categories is that the poor, the middle income (average) and the richest can be easily identified. This study classifies the lowest three income classes as ‘poor’ and the three highest income groups as ‘rich’. Future tax policy recommendations which result from this study will take into account the households which fall into the middle income categories (the three income classes 4, 5 and 6) as a representative of average households according to income groups.

Using this classification system, the present study identifies that East Nusa Tenggara and West Nusa Tenggara, Lampung, Bengkulu, and Gorontalo are “poor” whereas Jakarta, East Kalimantan, Bali, Riau, and Banten are “rich” (see Figure 3.4).

Figure 3-4
Average monthly income and expenditure for Indonesian households According to poor and rich regions, 2002



More specifically, there are 19 out of 26 regions with an average income below the average income of Indonesians as a whole, i.e. less than Rp. 1,220,600 per month. Only 7 regions are above the Indonesian average income (see Table 3-8 for details).

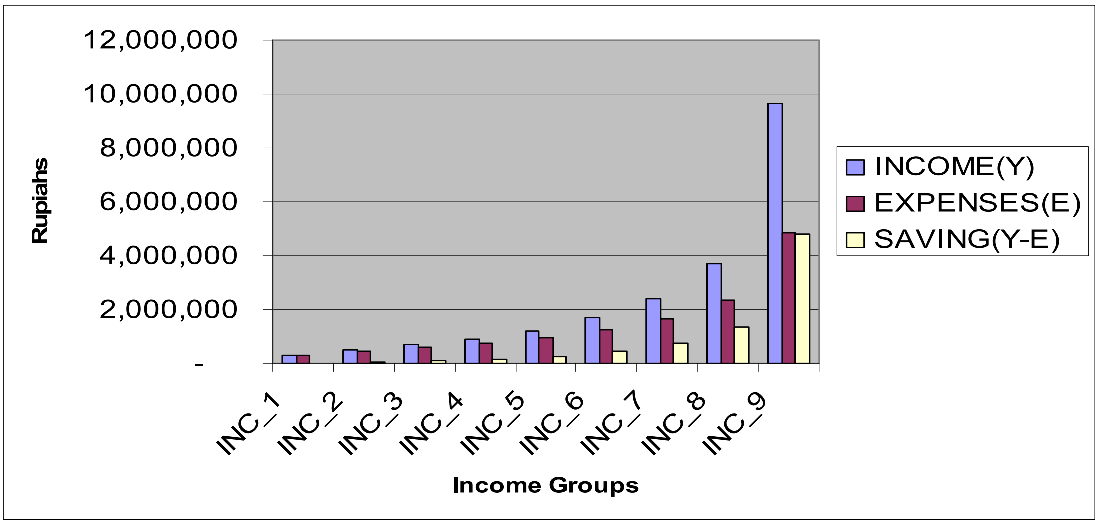
Table 3-8
Monthly average income according to 26 regions, 2002

REGION	N	INCOME MEAN	INCOME SD	INCOME CV
Gorontalo	774	715,820	717,710	1.00
Lampung	2,096	811,940	905,430	1.12
West Nusa Tenggara	2,131	829,940	1,036,000	1.25
East Nusa Tenggara	1,657	838,200	1,072,300	1.28
Bengkulu	996	893,870	919,510	1.03
East Java	8,621	930,800	1,078,600	1.16
Central Java	7,374	941,640	1,071,300	1.14
South Sumatera	1,792	1,001,000	1,293,900	1.29
South East Sulawesi	1,111	1,007,000	924,410	0.92
South Sulawesi	2,246	1,025,900	1,015,600	0.99
West Java	6,943	1,061,400	1,200,300	1.13
Central Sulawesi	1,099	1,067,000	1,122,800	1.05
Yogyakarta	2,905	1,090,400	1,782,200	1.63
West Kalimantan	1,862	1,118,600	1,097,700	0.98
Jambi	1,127	1,130,800	3,650,800	3.23
North Sumatera	3,332	1,162,300	2,027,700	1.74
North Sulawesi	1,116	1,187,200	1,334,200	1.12
South Kalimantan	1,739	1,202,300	1,912,600	1.59
Central Kalimantan	1,113	1,212,200	970,210	0.80
Indonesia	64,422	1,220,600	1,980,000	1.6
West Sumatera	1,746	1,251,100	1,118,600	0.89
Bangka Belitung	774	1,288,100	1,016,600	0.79
Banten	1,867	1,375,800	1,370,600	1.00
Riau	1,151	1,629,500	2,006,800	1.23
Bali	1,876	1,671,100	1,885,200	1.13
East Kalimantan	1,100	1,690,500	2,002,500	1.18
Jakarta	5,874	2,692,900	4,537,200	1.68

Note: N: number of households observed, SD: standard deviation, CV: coefficient variation

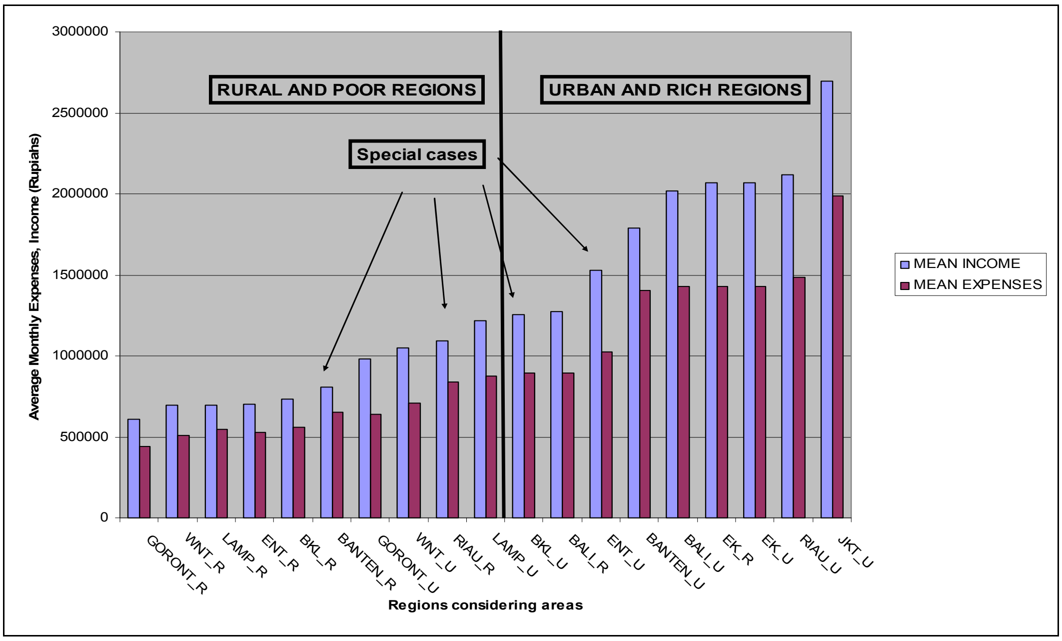
Figure 3.5 suggests that, on average, poor households (INC_1 – INC_3) spend all their income. Accordingly, the poor cannot save, but the richest households save almost as much as they spend. Furthermore, this study also finds that most households in rural and urban areas have similar income and spending patterns although expenditure is generally less than income.

Figure 3-5
Average monthly incomes, expenses and savings of the Indonesian households according to income groups, 2002



More specifically, if considering area categories, most rural people, regardless of region, are poorer than those people living in urban areas. This is particularly true of rural people in ‘poor’ regions.

Figure 3-6
Average monthly incomes and expenses of Indonesian householdsFor rich and poor regions considering urban and rural areas, 2002



It is interesting to note that city dwellers in East Nusa Tenggara and Bengkulu – both of which are categorised as poor regions - seem to be richer than the villagers living in Banten – a region which is categorised as rich, and, Banten villagers seem to be poorer than urban people living in Lampung, West Nusa Tenggara and Gorontalo which are categorised as poor regions (see Figure 3 – 6 above).

Not only are there large disparities between poor and rich households in terms of their expenditure, but there are also differences in saving patterns between urban and rural areas. Tables 3-9 and 3-10 below suggests that

(1) Rich people (the top 3 of the income groups) can save 31 - 50% from their income whereas poor people in the three lowest income groups can only save 7-14% of their incomes,

(2) Rural people save more of their income than urban people, i.e. 30.9% against 11% from their incomes respectively.

(3) Across the regions surveyed, Jakarta is the region that has the highest means for income and expenditure; whereas the rural area of Gorontalo has the lowest.

Table 3-9
Average monthly income and expenditure and its expenditure ratio of Indonesian Households across areas, 2002

CLASS	MEAN			SAVING RATIO
	INCOME(Y)	EXPENSES(E)	SAVING(Y-E)	
	(Rupiahs)			(%)
IND	1,220,564	888,650	331,914	27.19
URBAN	494,235	440,281	53,954	10.92
RURAL	1,825,697	1,262,203	563,494	30.86
INC_1	298,278	276,710	21,568	7.23
INC_2	500,538	449,902	50,637	10.12
INC_3	693,708	597,952	95,756	13.80
INC_4	891,437	739,027	152,410	17.10
INC_5	1,214,661	959,960	254,701	20.97
INC_6	1,713,835	1,255,130	458,705	26.76
INC_7	2,395,113	1,639,902	755,211	31.53
INC_8	3,709,549	2,339,304	1,370,245	36.94
INC_9	9,649,728	4,865,558	4,784,170	49.58

Table 3-10
Average monthly income and expenditure of Indonesian households across poor and rich regions, 2002

REGION	N	INCOME	EXPENSES
GORONT_R	554	610,010	440,510
WNT_R	1,323	695,480	507,150
LAMP_R	1,636	698,480	545,660
ENT_R	1,386	702,900	526,340
BKL_R	689	732,330	558,930
BANTEN_R	785	807,250	655,000
GORONT_U	220	982,260	637,260
WNT_U	808	1,050,100	708,150
IND_R	35,143	1,053,600	756,870
RIAU_R	549	1,095,700	838,330
BKL_U	307	1,256,400	893,700
BALI_R	878	1,273,800	892,080
IND_U	29,279	1,421,000	1,046,800
ENT_U	271	1,530,200	1,025,700
BANTEN_U	1,082	1,788,200	1,405,900
BALI_U	998	2,020,600	1,431,200
EK_U	643	2,065,400	1,430,900
EK_R	643	2,065,400	1,430,900
RIAU_U	602	2,116,300	1,485,700
JKT_U	5,874	2,692,900	1,985,000

Most previous demand studies have used total expenditure as a proxy for income, because expenditures are generally perceived to be less affected by short-term variations than income and are more reflective of longer-term economic status. However, it can be argued that higher expenditure does not necessarily reflect higher income as quality variations in the purchased product can be involved. The rich may want to buy goods of higher quality and this is reflected in a higher expense on the commodity bought. Furthermore, it is clear that expenditure more closely approximates the income of poor households than it does the rich. Accordingly, total expenditure may not be a good proxy for income.

Even so, the present study admits that total expenditure can be used as a good proxy for income when there is little or no saving. Indeed, the present study observes that the majority of Indonesian households are poor, meaning that their income and expenditure seem to closely move together. Accordingly, in general, the expenditure approach can be relatively implemented in the Indonesian data analysis for the lower income groups.

However, this treatment has to be undertaken with caution as the proxy cannot represent the rich who have significant amounts of savings; because the model that utilised the total expenditure as the income proxy will be biased towards lower income groups and it will mislead the policy recommendations for higher income group targeting.

Nicita (2004) found that urban and rural differences as considered by the present study, do not significantly drive the findings on consumption pattern differences in Mexican households. Accordingly, analysing the Indonesian consumption patterns by income groups following Nicita, is an alternative approach to complement the present analysis of urban and rural parameters. Similarly, the former study by Olivia and Gibson (2002) as well as some aspects of Jensen and Manrique (1998) will be modified and used in the present study. Specifically, the 'alternative' model presented in this study will include both price and income variables, thus estimating what are essentially Marshallian price (and income) elasticities.

3.5 Expenditure and income patterns in Indonesia

This section looks at expenditure patterns across households in different income groups. Here it is assumed that in economics, the formal definition of 'necessities', 'normal', 'luxury' and 'inferior' goods are linked to the income elasticity of demand.

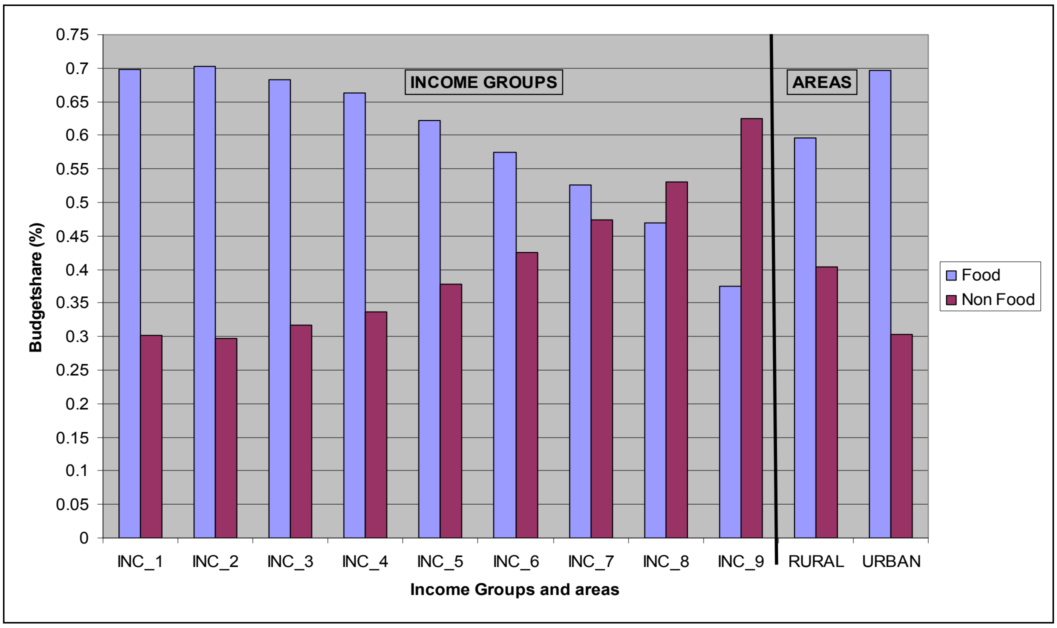
1. Goods are categorised as necessities if income elasticities are equal to zero. This means that demand for the product will not change in response to changes in income (formally, $\partial Q / \partial Y = 0$). All else constant (including price), one would therefore expect expenditure to be constant across income groups. In other words, goods where the absolute level of expenditure is similar across all income groups are identified as 'likely' necessities.
2. Goods are classified as inferior goods if the income elasticities of demand are less than zero ($\partial Q / \partial Y < 0$), meaning that expenditure falls as income increases. All else constant, one would therefore expect to see higher absolute levels of expenditure on these types of goods amongst poor households than amongst rich households. In other words, goods where the absolute level of expenditure is higher among poor households than among rich are identified as 'likely' inferior goods;
3. "Normal" goods are those where income increase leads to increase in quantity purchased, that is, $0 < \partial Q / \partial Y < 1$, so all else constant, absolute expenditures will be higher for high income groups, but budget shares may be reasonably constant across income groups. In other words, goods where the absolute level of expenditure is higher among rich households than among poor are identified as 'likely' normal goods;
4. Luxury goods are those where expenditure increases as income increases, and where the increase in expenditure is greater than the increase in income ($\partial Q / \partial Y > 1$). Ceteris paribus, one therefore expects the budget share of luxury goods to be higher for high income households than for low income households. In other words, goods where the budget share rises as income rises are identified as possible 'luxury' goods.

In brief, goods where expenditure rises with income are likely to be either 'normal', or 'luxury' goods, whereas goods where expenditure is similar across all income groups are likely to be 'necessities'. This category can also be identified where the ratio of consumer expenditure on these commodities to the total budget is relatively large. Goods where expenditure is highest in poor households are identified as likely 'inferior' goods. Accordingly, the following sub-sections will provide a descriptive summary of the way in which expenditure vary across income groups. It is a preliminary assessment of whether different types of goods are likely to be inferior, necessity, normal or luxury. A more thorough analysis of income elasticities is carried out in Chapter 5, where prices and other household characteristics are held constant.

3.5.1 Food and non-food budget share patterns

Rural consumption patterns, both for food and non food items, are relatively similar to those of the poor, i.e. the average budget share for food is larger than that for non-food (about 63 – 70% for food). The non-food budget share of Indonesians whose income is greater than 3,000,000 Rupiahs or more (IC_8 and IC_9) exceeds their food budget share (see Figure 3-7 below). On the basis of the types of goods definition, it seems that non food items are likely to be luxury goods as per point (3) above.

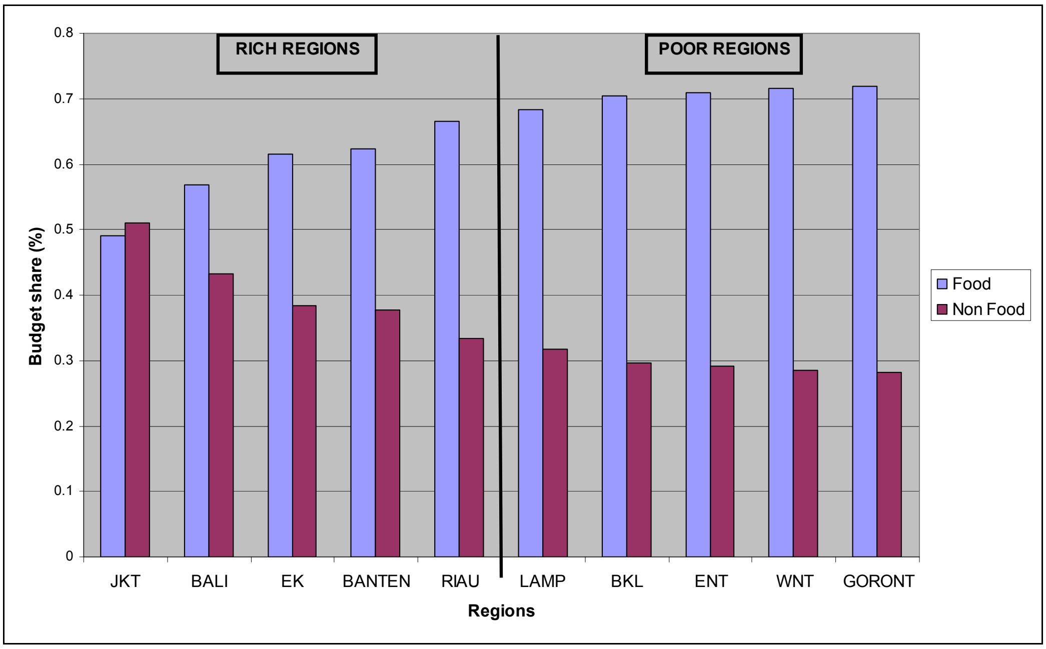
Figure 3-7
Average budget share of the Indonesian households for food and non food commodities according to income groups and areas, 2002



Furthermore, it seems that the consumption patterns of the 'average' urban household are similar to that of 'poor' households (INC_1 – INC_3). In contrast, the consumption pattern of the 'average' rural household is similar to that of households in the middle income category (INC_6).

However, considering the regions, only Jakarta, the richest region, has an average budget share for non-foods which exceeds its food budget share (51% versus 49%), as suggested by Figure 3-8 below.

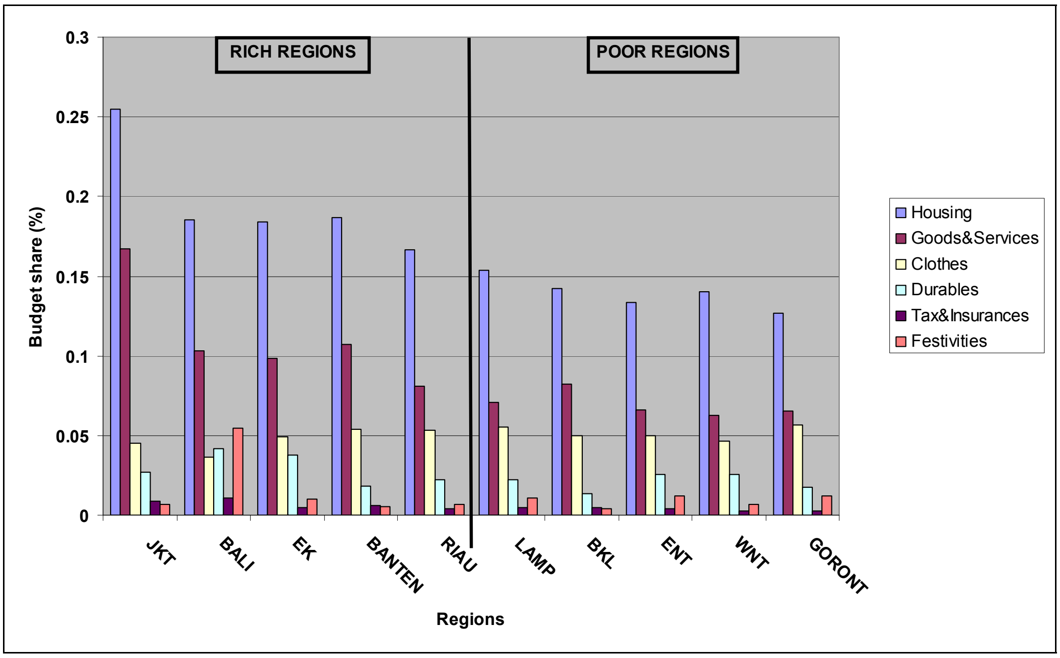
Figure 3-8
Average budget share of the Indonesian households for food and non food commodities in poor and rich regions, 2002



3.5.2 Non food expenditure patterns

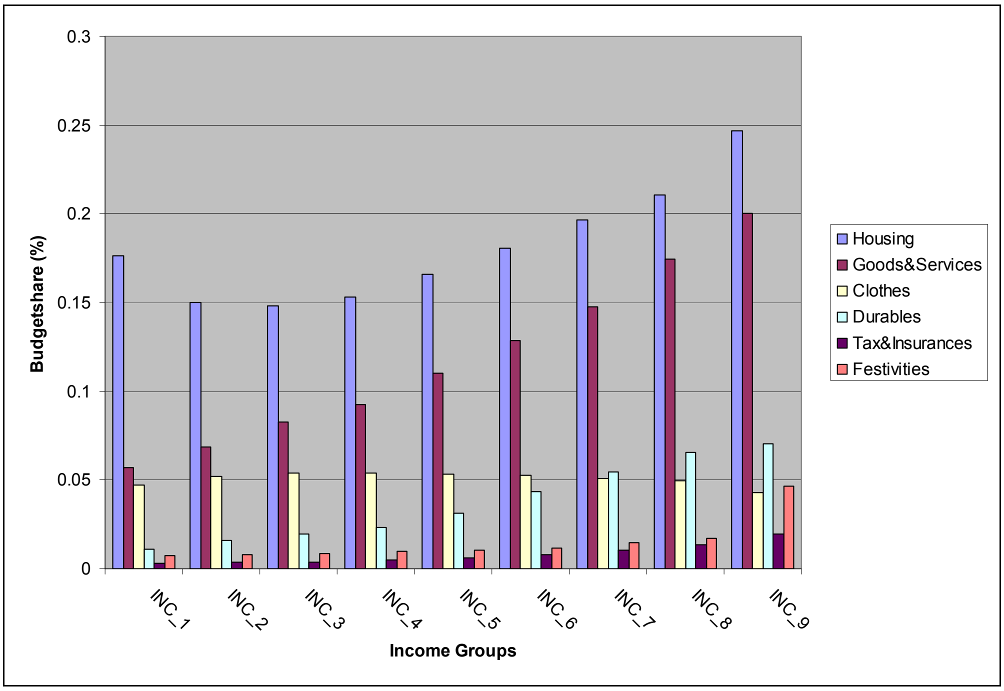
The study finds that the richer the region, the higher the budget share on housing and household facilities (see Figure 3-9 below). This seems to infer that non - food items are likely to be luxury goods – as per point (3) above.

Figure 3-9
Budget share pattern of Indonesian households for housing, goods and services, clothes, durables, taxes and insurances, festivities in poor and rich regions, 2002



The interesting thing to be noted is that Bali is the only region which has an extremely high expenditure on festivities and spending on clothes across poor and rich regions does not seem to vary with wealth. In the mean time, Figure 3-10 justifies this showing that clothes are likely to be normal goods as their budget share across income groups is approximately constant. In addition, Figure 3-10 supports Figure 3-9, clearly showing that the richer the household, the higher the average budget share on housing, on goods & services, and on durables. Therefore, these goods are likely to be luxuries.

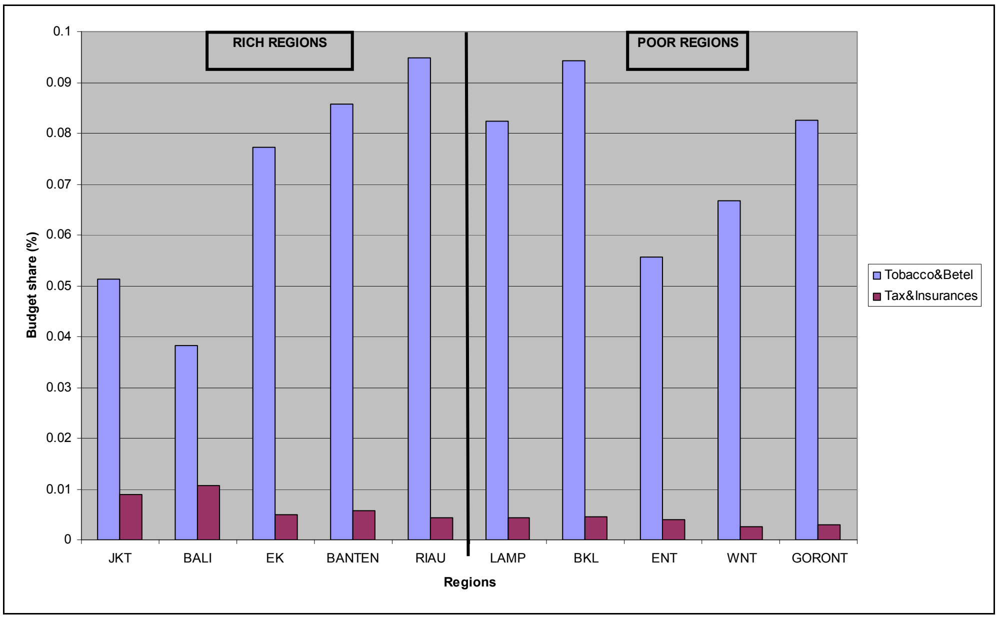
Figure 3-10
Budget share pattern of Indonesian households for housing, for goods and services, for clothes, for durables, for taxes and insurances, and for festivities according to income groups, 2002



3.5.3 Expenses for taxes and insurances versus expenses for tobacco and betel

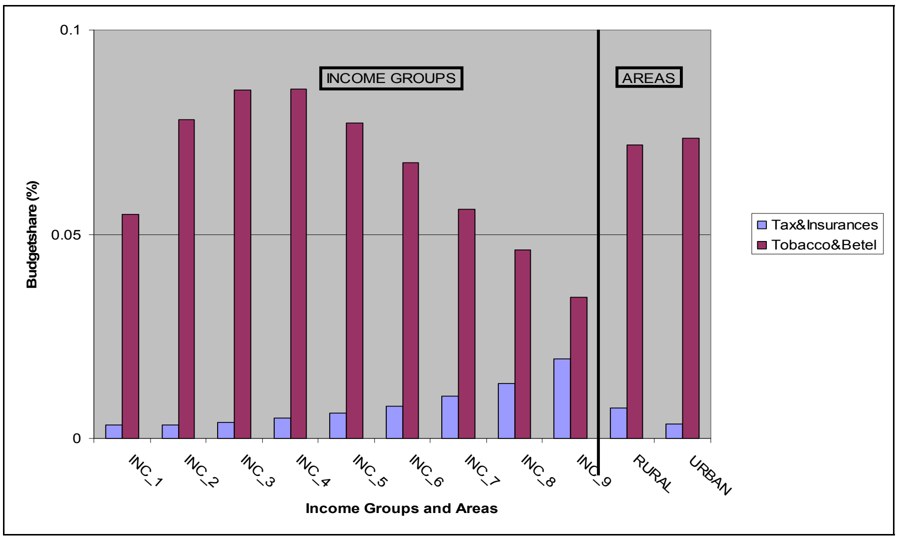
Figures 3-11 suggests that budget shares for taxes and insurance are generally very low (less than 0.02%), and more interestingly, much lower than that for tobacco and betel, i.e. 0.04 – 0.095%. Considering regional categorisation, there is no doubt that the highest budget shares for tax and insurance are in the richest regions, i.e. Bali and Jakarta.

Figure 3-11
Average budget share of Indonesian households for tobacco and betel and for taxes and insurances in rich and poor regions, 2002



More specifically, Figure 3-12 suggests that the higher the income of the group, the higher the budget share on tax and insurance, whereas the higher the income, the lower the budget allocation for tobacco and betel (starting from income group 4). This suggests that insurance may be a luxury good whereas tobacco and betel may be inferior. The fact that taxes are higher for higher income groups suggests that Indonesia's existing taxation system is somewhat progressive.

Figure 3-12
Average budget share for tobacco and betel and for taxes and insurances according to income groups and areas, 2002



3.5.4 Alcohol spending patterns

Although spending for alcohol is negligible (less than 4,000 Rupiahs per month on average), it is important to justify the present study's exclusion of this commodity from the demand system analysis. Figure 3-14 and 3-15 suggest that:

(1) The Indonesians allocate a very small budget for alcohol, i.e. on average about 0.001%;

(2) North Sumatera, Gorontalo, North Sulawesi, and East Nusa Tenggara are the top four regions for allocating their budget on alcohol;

(3) Poor regions where the majority of the people are Christians and where Dutch influences have been greater tend to consume more alcohol than the other regions. Examples of such regions are Gorontalo and East Nusa Tenggara.

Those facts infer that there are differences in regions, in religions and culture, leading to a difference in consumption patterns.

Figure 3-13
Average budget share for alcohol according to income groups and areas, 2002

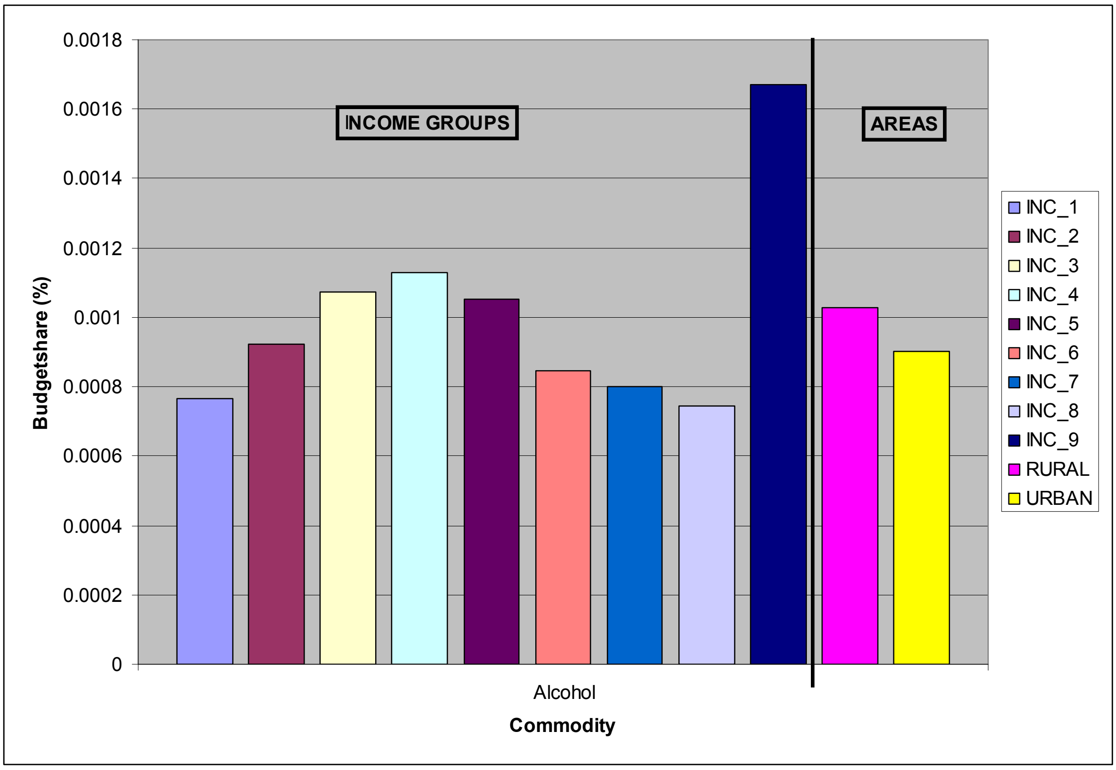
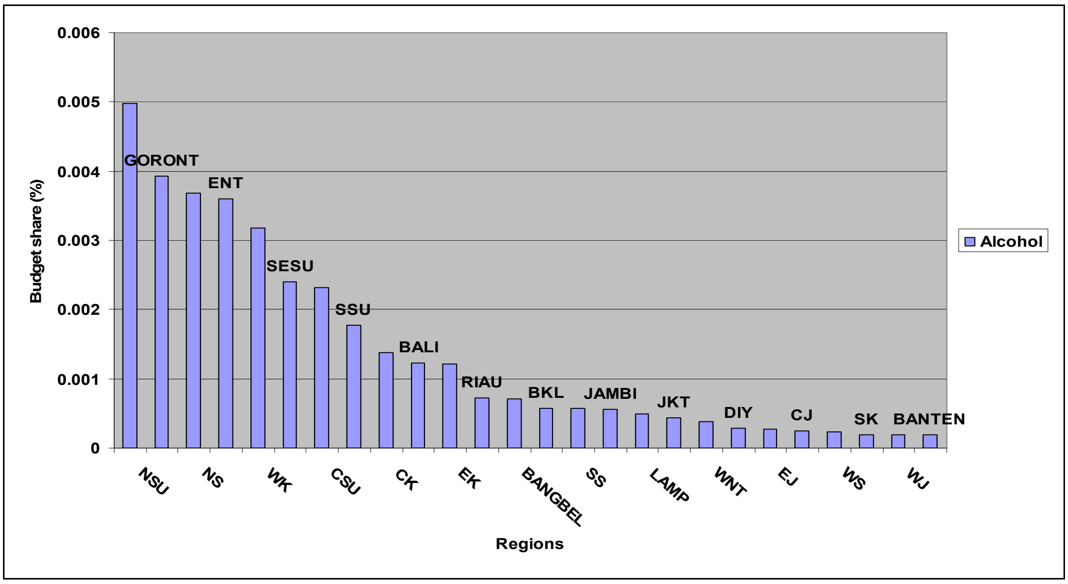


Figure 3-14
Average budget share on alcohol across 26 regions, 2002



3.5.5 Necessities, luxuries and inferior goods

This study finds that, as suggested by Figures 3-15 and 3-16, Fish, Vegetables, Oil and fats and Spices are likely to be classified as either normal or luxury goods as the expenditures for these commodities rise as income rises. Meanwhile, expenditure on Cereals is similar across income groups and regions (except Jakarta). In other words, all people from both rural and urban areas, regardless of whether they are poor or not, consumed Cereals. So this commodity group may be a necessity.

Figure 3-15
Average monthly expenditure of the Indonesian households for cereals, fish, vegetables, oil and fats, and spices according to income groups, 2002

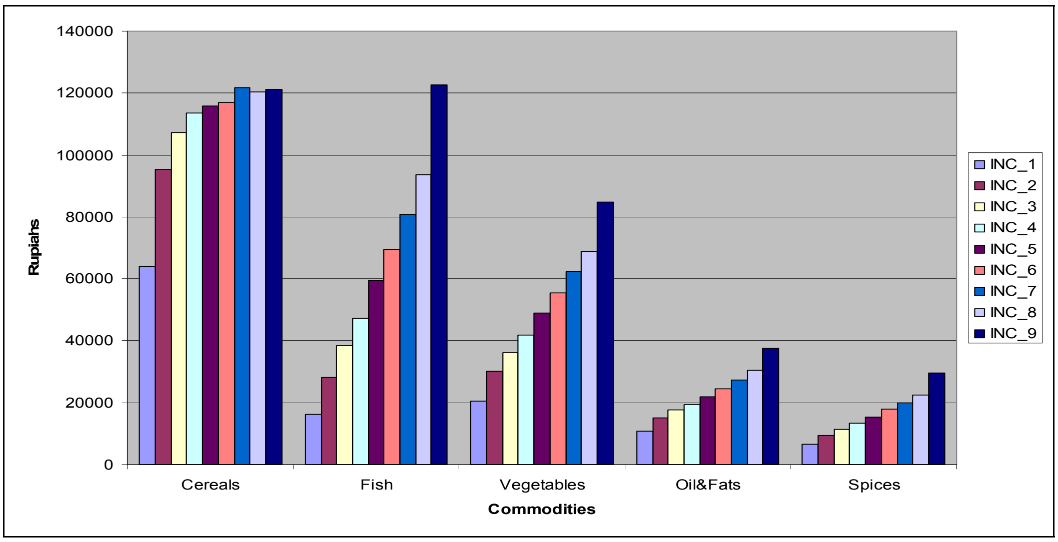
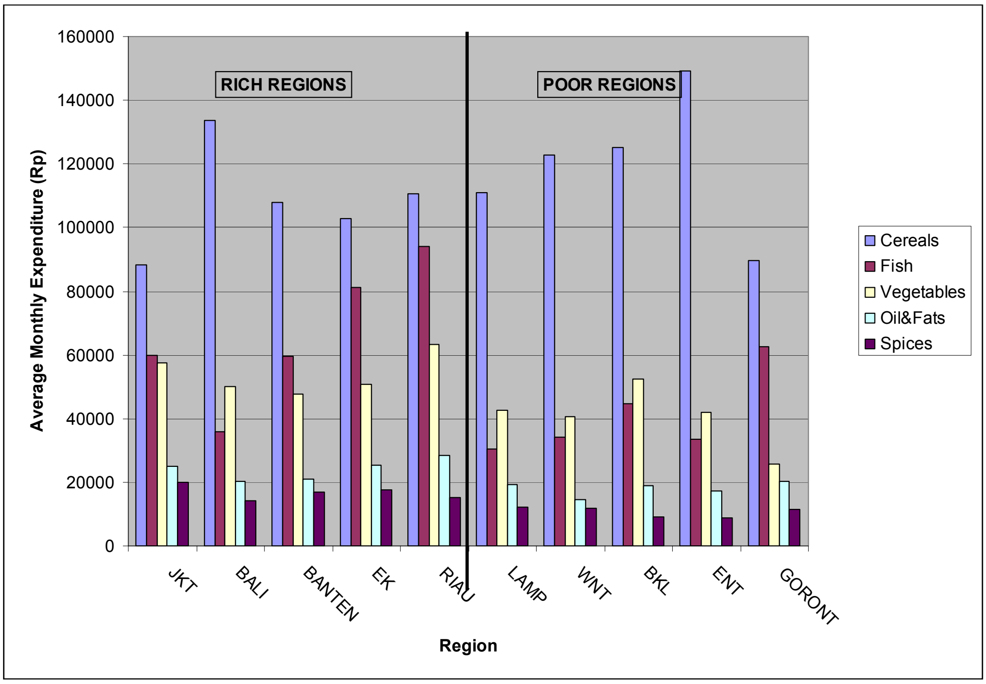


Figure 3-16
Average monthly expenditure of the Indonesian households for Cereals, Fish, Vegetables, Oil and fats, and Spices in poor and rich regions, 2002



Other interesting findings from Figures 3-16 – 3-18 suggest that: (1) the poor spent a larger proportion on Cereals; this can be seen from the figures that the highest budget shares for Cereals were allocated by the people living in East and West Nusa Tenggara, Lampung, Gorontalo, and Bengkulu, which are the poor regions; (2) Prepared foods and drinks have been popular consumption among the Indonesian households regardless of whether they live in poor or rich regions or in urban or rural areas; (3) Jakarta, is the richest region and has the lowest budget share for Cereals, but at the same time has the highest budget share for Prepared foods and drinks; (4) East Nusa Tenggara, conversely, has the highest budget share for Cereals but has the lowest budget share for Prepared foods and drinks.

Figure 3-17
Average budget share pattern of the Indonesian households for Cereals and Prepared food and drinks in poor and rich regions, 2002

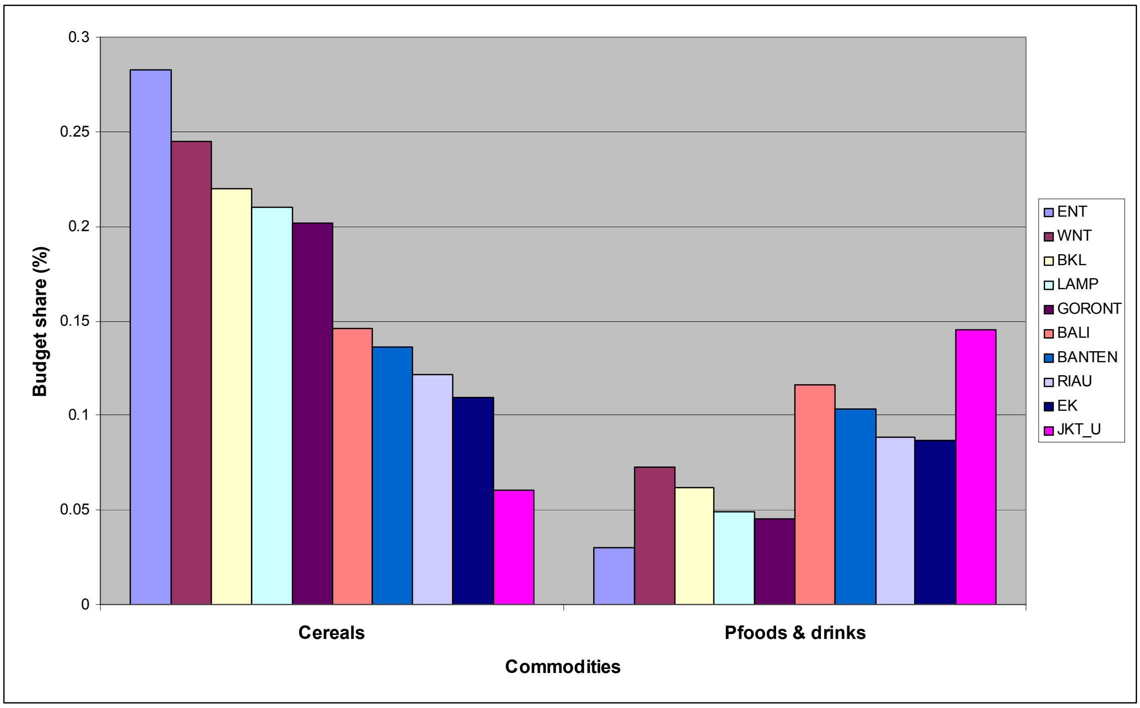


Figure 3-18
Average budget share pattern of the Indonesian households for Cereals and Prepared food and drinks according to income groups, 2002

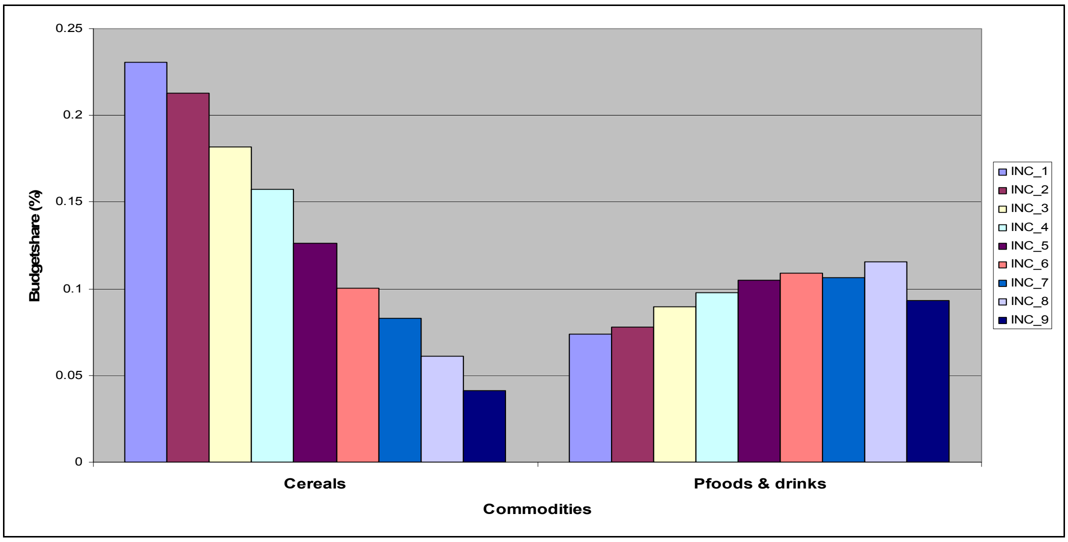
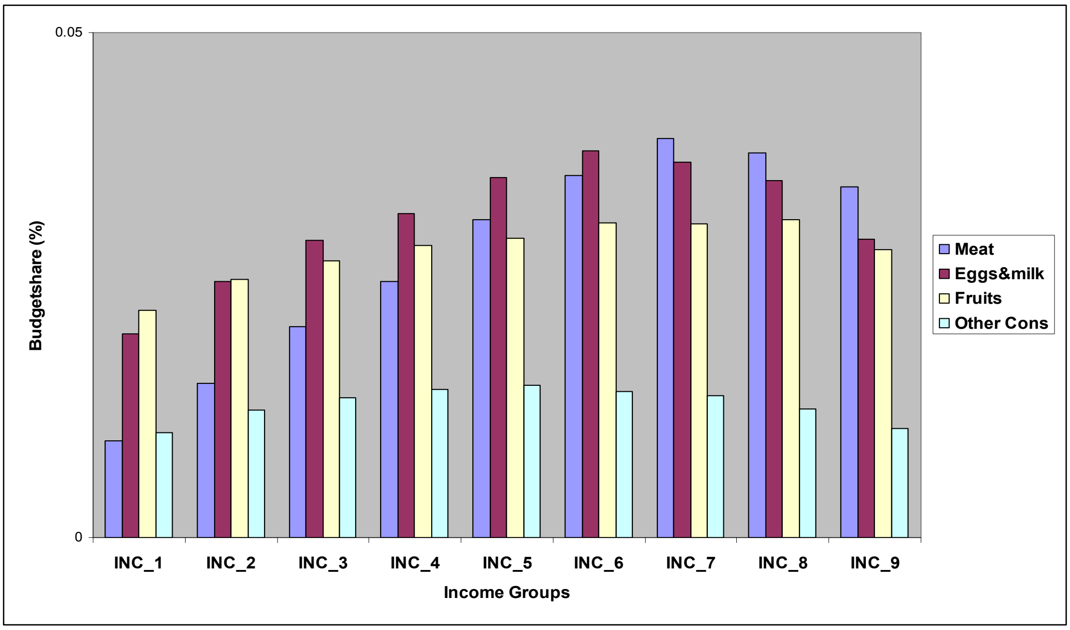
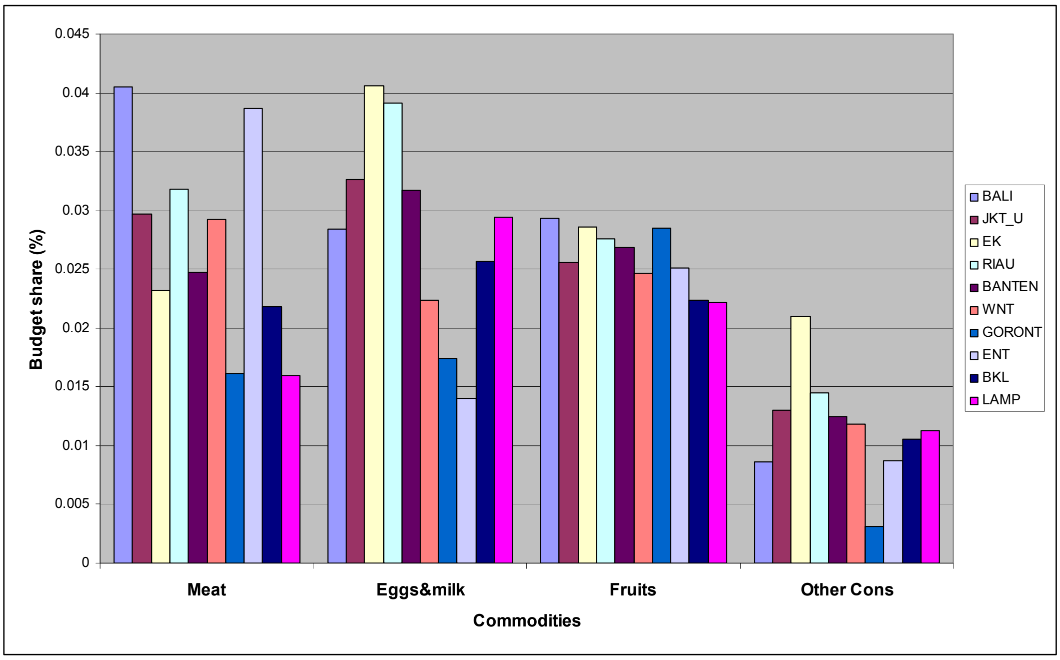


Figure 3-19
Average budget share of the Indonesian households for Meat, Eggs and milk, and Fruits and Other consumption, by income groups, 2002



In addition, as Figures 3-19 – 3-20 suggested, Meat, Eggs and milk and Fruits are likely to be categorised as luxuries as their consumption patterns tend to be varied across income groups (their budget share rises as income increases), in particular between the poor and the rich. Another indication is that the poor, including villagers, spent a low proportion on these commodities.

Figure 3-20
Average budget share of the Indonesian households for Meat, Eggs and milk, Fruits, and Other consumption in poor and rich regions, 2002



Figures 3-19 and 3-20 also demonstrate that it is difficult to tell type of goods although commodities of Fruits and Other consumption are certainly normal goods since spending on these goods increases as income rises. More sophisticated analysis (as produced in Chapter 5 later) is needed to determine if they are luxury goods or not.

3.6 Tax rates and their regulation

After understanding the whole data set of commodities obtained from the 2002 SUSENAS data, it is also important to be aware of current tax regulations which must be taken in to account when conducting the proposed tax reform simulations (outlined in chapter 2, and provided in chapter 6).

As background, the Indonesian tax system has undergone a series of tax reforms starting in 1983 and continuing in 1994, 2000 and 2005. The Asian Development Bank reports that 1983 was a very important impetus for the Indonesian taxation system, not only from a regulatory perspective, but also from an administrative and institutional standpoint.

Table 3-11 provides a short list of relevant reforms, specifically focusing on indirect tax rates, since they are most relevant to the proposed simulations. As can be seen, there is a uniform 10% VAT on some goods, and 0% VAT for exports. In contrast, the maximum sales tax rate on luxury goods was increased from 20% to 75% in one tax reform.

Table 3-11
Tax Reforms in Indonesia (1983 -2005)

1983 Taxation Reforms	
Law of RI no. 8/1983	**VAT on goods and services and Sales on luxurious goods**
	VAT rate was 10% VAT rate on the export of taxable goods was 0% Sales tax on luxury goods were 10% and 20% Sales tax on export of luxury goods was 0%
1994 Taxation Reforms	
Law of RI no. 11/1983 amended by Law RI no. 11/1994	**VAT on goods and services and Sales on luxurious goods**
	VAT rate was 10% VAT rate on the export of taxable goods was 0%

	Sales tax rate on luxury goods was a minimum of 10% and a maximum of 50% Sales tax rate on export of luxury goods was 0%
2000 Taxation Reforms	
Law of RI no. 11/1983 amended by Law RI no. 18/2000	**VAT on goods and services and Sales on luxurious goods**
	VAT was 10% VAT on export of taxable goods was 0% Sales tax on luxury goods was a minimum of 10% and a maximum of 75% Sales tax on export of luxury goods was 0%
2005 Taxation Reforms	
Law of RI no. 11/1983 to be amended in 2005	**VAT on goods and services and Sales on luxurious goods**
	VAT rate is 10% VAT rate on export of taxable goods is 0% Sales tax on luxury goods is a minimum of 10% and a maximum of 75% Sales tax on export of luxury goods is 0% VAT on the export of taxable service is 0%

Source: Asian Development Bank

The 15 commodities relevant to the empirical analysis in this present study are subject to certain taxes. Those relevant here include: the Value Added Tax (VAT); sales tax on luxury goods; excise tax and import duties; and local taxes (on prepared food and drinks consumed in restaurants). According to Government Regulation No. 144/2000, some commodities are exempted from tax; they are rice, salt, corn, soybeans, and sago as well as food and drinks consumed in a restaurant (in fact, the commodity is subject to the local tax of the restaurant). However, according to Government Regulation no. 145/2000, amended by Government Regulation no. 6/2003, it is suggested that some commodities be subject to a sales tax on luxury goods. More specifically, the regulation suggests that groups of commodities in the egg and milk category (dairy milk, cheese, margarine, butter) be subject to a 10% sales tax, and alcohol subject to a tax of between 40 – 75%. Alcohol is also subject to an excise - tax of between 13 – 25%. Meanwhile, tobacco and betel are subject to an excise tax of between 1 – 36%. In summary, some taxes are imposed on some commodities. For example, milk and cheese are subject to VAT and sales- tax on luxury goods, whereas alcohol is subject to VAT, sales- tax on luxury goods and excise- tax.

With regards to the above conditions, the present study will alternatively produce different tax- reform simulations according to two different scenarios. First, the study will conduct the tax simulation using of 10% uniform tax rates across commodity groups, except for Cereals, Beverages and Prepared foods and drinks (MIX Scenario). The tax rates use those were utilised not only by Olivia's (2002) study, but also by Olivia and Gibson's (2002).

Table 3-12
Tax- rates for commodities observed that will be utilised for tax reform analysis

Existing tax rates		
Commodity Groups	**MIX tax rate regime**	**MAX tax rate regime**
Cereals	0.5	1.17
Tuber	0.1	0.1
Fish	0.1	0.1
Meat	0.1	0.1
Eggs and milk	0.1	0.2
Vegetables	0.1	0.1
Pulses	0.1	0.1
Fruits	0.1	0.1
Oil and fats	0.1	0.2
Beverages	0.4	0.67
Spices	0.1	0.1
Other consumption	0.1	0.1
Prepared foods and drinks	0.15	0.15

Note: mix) means here as a combination tax rates selected from Olivia's study and the current study whereas max**) means the same as the mix tax rate but considering the max tax rates they have.*

Second, the study will assume that some commodities are also subject to other taxes such as excise tax and sales tax on luxury goods. Accordingly, it will conduct a tax simulation using a MAX Scenario (one where tax rates are selected according to maximum tax- rates possible). For further details please check Table 3-12.

3.7 Concluding remarks

The present study has found some interesting and noteworthy facts:

First, the average income of rich households is significantly larger than average expenditure, whereas the average income for urban households is close to expenditure. However, rural households have both higher income and expenditure than urban households. As a consequence, the rural savings ratio was also larger than the urban. In addition, the average budget share for food is generally relatively large compared to that for non-food. Only in Jakarta - the richest region – does the average budget share for non-food exceed that for food.

Second, expenses for Cereals, Prepared foods & drinks, Spices, Beverages flavour for food categories, and housing and household facilities and Goods and services for non food categories are the largest contributors to household budget expenditure.

Third, in general, expenditures for Clothes, Durables and Goods and services are high for urban areas, with Jakarta being the highest. Bali has the highest expenditure on Festivities because of their traditions. It is undoubtedly true that urban rich regions spend most of their income on Housing and household facility expenses – the highest being in Jakarta. Clothes tend to be categorised as normal goods as their budget share seems constant across income groups.

Fourth, although the highest spending was in the richest regions such as Jakarta and Bali, expenses for Taxes and insurance were still low, even lower than the expenses for Tobacco and betel across all regions and income groups.

Fifth, Alcohol consumption was relatively high in urban areas compared to rural areas. It was found that in poor urban regions, such as Gorontalo and East Nusa Tenggara where the majority of the people are Christian, more alcohol is consumed.

Finally, Cereals seem to be identified as normal goods. Meanwhile, Fish, Vegetables, Oil and fats and Spices appear to be necessities; whereas Meat, Eggs and milk, and Fruits are likely to be luxuries.

The Fish commodity can be regarded as a substitute for Meat as a majority of households, disregarding region and income variations, tends to have a high consumption of this commodity. This may be due to the fact that the majority of people live in coastal areas. Interestingly, people generally spend more on Tobacco and betel than Meat.

These preliminary findings are important inputs for justification of the further econometric analysis in terms of separability, analysis of food categories and of the exclusion of alcohol and tobacco and betel, which will be discussed thoroughly in Chapter 4 of Methodological Approach, as well as for equipping the analysis of price elasticities in Chapter 5.

Chapter 4
Methodology

4.1 Introduction

Although King's 1983 study is one of the earliest studies which dealt with the welfare analysis of tax reforms by making use of household data and employing the deadweight loss approach, the present study has been seminally inspired by a study of Ahmad & Stern (1984, 1991). The present study observes that the Ahmad & Stern study provides an influential contribution to the later studies which particularly relate to indirect tax reform and its impacts on the welfare of society (see Decoster and Schokkaert (1990), Madden (1995), Creedy (2001), Olivia (2002), Olivia & Gibson (2002), and Nicita (2004)).

At the same time, it has been observed that it is important to be able to estimate elasticities, if one wishes to make predictions about the impact of tax reform on the welfare of society. In this case, a series of Deaton's studies (1987, 1988, 1990, 1997), and his methodology in measuring the elasticities, has largely contributed to most the tax reform studies (see Olivia & Gibson (2002), Nicita (2004)) – particularly his method of circumventing unobservable commodity prices and of handling consumers who do not purchase the observed goods. It is therefore not surprising that these studies are also important references for the present study in selecting the model used for estimating the demand elasticities and, subsequently, for investigating the social welfare impacts of tax reforms.

Empirical welfare economics often attempt to employ data on individual or aggregate behaviour to deduce consequences for behaviour, and for the welfare of various actual or considered policy changes, relating to the calculation of optimal taxes and of welfare-improving tax change (Deaton, 1987). Deaton argues that the apparatus applied is no different from either cost-benefit analysis or any other policy measure and, in principle, the procedure is simple: (a) develop a model which associates with prices, taxes, quantities, welfare, and tax rules, characterised in terms of unknown but potentially observable empirical magnitudes; and then (b) use econometric analysis to estimate these magnitudes, permitting computation of the desired directions of reforms.

This chapter is organised as follows. Section 4.2 discusses procedures of analyses comprising (1) preparatory analysis and (2) tax reform 'lambda' analysis. Sub – section 4.2.1 of the preparatory analysis consists of (a) an estimation of the proposed models which have been remedied by HETCOV for the heteroscedasticity problem, (b) a specification 'Davidson and MacKinnon' test for family size as one of the independent variables of the equations involved. The analyses include a justification for the use of a *Marshallian* demand system to estimate the welfare effect of tax reform as an alternative to the *Hicksian* demand.

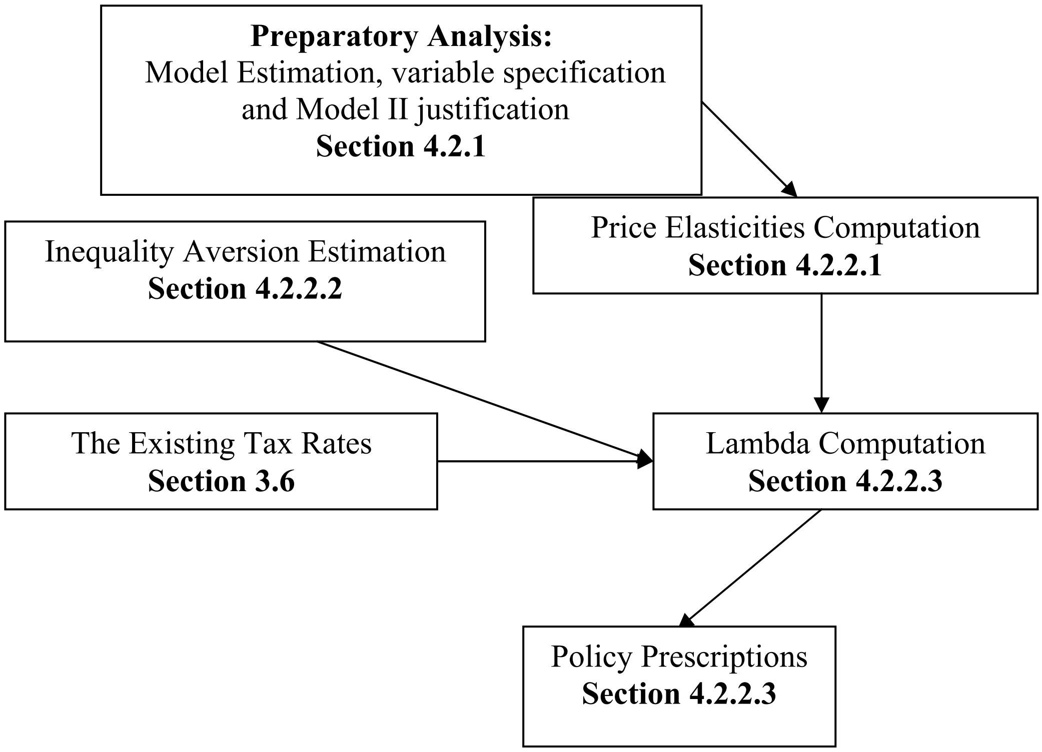
The tax reform 'lambda' analysis of Sub – section 4.2.2 is employed to investigate a direction for indirect tax reform. To do so, one needs to compute commodities' elasticities and to estimate a unique inequality aversion 'ε' parameter. The commodities' price and income elasticities are computed to determine the way in which demand for different commodities changes in response to: (a) changes in price and (b) changes in income.

The inequality aversion plays an important role in examining the way in which society takes into account the equality aspect, and, simultaneously, in answering the research questions. The more attention is focussed on distribution, the higher the inequality aversion. The values of the inequality aversion parameter for some typical and previous studies were randomly chosen between 0 and 2.5. However, the present study proposes a new method to obtain a unique value of ε by utilising the Atkinson Index, considering the existing income distribution. Subsequently, based on the commodities' elasticities, the obtained parameter estimate of inequality aversion and the existing indirect tax rates, Lambda for every commodity observed is computed. According to the Lambda (λ) criteria, the present study will rank the commodities in order to recommend which commodities are good candidates for tax increase or tax decrease in keeping government revenues neutral. The Lambda ranking is conducted based on Ahmad and Stern's approach, i.e. the computed lambda is ranked from 1 to 13 (as many as the commodities observed). Rank 1 is the highest priority to increase the tax on the ranked commodity and rank 13 is the lowest priority.

4.2 Procedures of Analyses

As briefly discussed in the organisation of the chapter, there are 2 steps of analyses, namely the diagram of procedures of analyses as seen below:

Diagram of Procedures of Analyses



1. **The Preparatory Analysis** deals with an estimation of the two proposed models: compensated Hicksian demand (Model I, hereafter) and uncompensated Marshallian demand (Model II, hereafter). In these estimations, variable specification tests for family size as one of the regressors of the equations are conducted, including an interpretation of the results. This step will also (a) describe how the study remedies the problem of heteroschedasticity that usually occurs in cross-sectional data analysis; and (b) provide a justification for using Marshallian demand to estimate the welfare effect of tax reform as an alternative to the Hicksian demand.

2. **Tax reform 'Lambda' Analysis** comprises two initial analyses and one comprehensive analysis:

a. Price elasticities computation: involving Deaton's three stage procedure of Deaton's approach to circumvent unobservable price and zero – consumption problems. This is done for both Hicksian and Marshallian Demand functions.

b. A Unique estimate of inequality aversion making use of the Atkinson Index and the existing income distribution;

c. Ahmad and Stern's approach of lambda computation for tax reform analysis to investigate a direction for future tax change, which uses:
   i. The price elasticity estimates from 2 (a);
   ii. The inequality aversion index from 2 (b); and
   iii. Existing tax rates from section 3.6 of tax rates and its regulation

4.2.1 Preparatory Analysis

The procedure is as follows: (1) to estimate the proposed models: Model I and Model II: with Z versus log of Z; (2) to determine which is best for the variable specification of family size (Z) by utilising the Davidson and MacKinnon test and plausible own price elasticities; (3) to interpret the price, expenditure and income elasticities; (4) to justify the use of Model II to conduct the tax reform analysis.

4.2.1.1 Specifying the Models

The present study estimates two models: compensated Hicksian demand (Model I) and uncompensated Marshallian demand (Model II). In fact, most previous studies utilise Model I, which economists prefer to use for their demand analysis, as well as for tax reform analysis. Model II is proposed by the present study, as it offers more information: income elasticities as well as price elasticities. Model I and Model II can be illustrated as follows.

Model I:

$$w_{ihc} = \alpha_i^0 + \beta_i^0 \ln x_{hc} + \gamma_i^0 z_{hc} + \theta_i^0 \ln p_{ihc} + f_c + u_{ihc}^0$$

$$\ln v_{ihc} = \alpha_i^1 + \beta_i^1 \ln x_{hc} + \gamma_i^1 z_{hc} + \theta_i^1 \ln p_{ihc} + u_{ihc}^1$$

Model II:

$$wf_{ihc} = \alpha_i^0 + \beta_i^0 \ln \ln TEF_{hc} + \gamma_i^0 z_{hc} + \rho_i^0 \ln IC_{hc} + \theta_i^0 \ln p_{ihc} + f_c + u_{ihc}^0$$

$$\ln v_{ihc} = \alpha_i^1 + \beta_i^1 \ln TEF_{hc} + \gamma_i^1 z_{hc} + \rho_i^1 \ln IC_{hc} + \theta_i^1 \ln p_{ihc} + u_{ihc}^1$$

Where

w_{ihc} = budget share of household *h* for aggregate commodity *i* in *c* cluster (as a ratio of total expenses)

wf_{ihc} = budget share of household *h* for aggregate commodity *i* in *c* cluster (as a ratio of total food expenses)

lx_{hc} = log of total expenses for each household *h* in *c* cluster

lv_{ihc} = log of unit value index of aggregate commodity *i* in *c* cluster

z_{hc} = family size for each household *h* in *c* cluster

$\ln IC_{hc}$ = log of income for each household *h* in *c* cluster

$\ln TEF_{hc}$ = log of expense for food for each household *h* in *c* cluster

f_c = unobserved fixed cluster effect capturing taste variation across clusters

u_{hic} = idiosyncratic error terms

c = cluster

Sub-scripts for 0 and 1 denote budget share and unit value equations respectively, following Deaton's procedure

The models will be used to estimate price and income elasticities by making use of Deaton's three stage procedure. To do this, the study deals with 2 equations, i.e. budget share equation and unit value equation; the detailed procedure will be thoroughly discussed in sub – section 4.2.2.1 of the computation and measurement of elasticities.

It is widely recognised that cross-sectional data, which this study utilises, suffers from heteroschedasticity and this makes the estimated parameters inefficient. This study therefore uses SHAZAM's procedure to rectify this problem.

4.2.1.2 Variable specification test

As observed by Thomas (1987), the major difficulty in estimating total expenditure elasticities from cross-sectional data is the existence of a number of 'nuisance' variables which, while they can be regarded as approximately constant over time, are certainly not constant over a cross-section of households. Possibly the most important of these are the size and the composition of households, as well as social class.

Thomas points out that if these variables were distributed independently of total expenditure across households, their effects could simply be included in the disturbance term of the estimating equation, without affecting the unbiasedness property; for example, ordinary least square estimators. However, household size is obviously likely to be positively correlated with total expenditure, so that its omission from a demand equation will lead to an upward bias in the Ordinary Least Squares estimators of total expenditure elasticities. Estimated elasticities reflect variations not only in total expenditure but also those in household size. Correlation between any such nuisance variable and total expenditure will lead to similar biases. Accordingly, to obtain unbiased estimators, it is important either explicitly to introduce the relevant nuisance variables into the estimating equation or to concentrate on sub-samples according to income group for example, of the overall cross-section within which these nuisance variables can be regarded as constant.

With regard to these notions, the present study, like the former studies, considers the family size, and (a) conducts separate analysis for sub-samples according to income categories in the case of Model I and (b) uses income as a separate regressor in the case of Model II.

In econometrics, researchers are constantly faced with the fundamental problem of choosing between models. The current study also finds a similar problem to choose a model with log of family size (Z) or a model with only Z. Coincidently, the current study finds that the Z – model (a model with Z as one of its explanatory variables) produces more plausible estimates than the log of Z – model (a model with log of Z as one of its explanatory variables). To ensure that the right choice of models is in hand the Davidson and MacKinnon test was also carried out in order to test the non-nested model specification.

The procedure of the test can be briefly discussed as follows. The model postulates a linear relationship between budget share of a particular good *i* (or log of unit value of a particular good *i*), total expenditure, and family size. Denoting budget share by w, total expenditure by *X*, and family size by z, then an alternative is to estimate an equation containing similar explanatory variables except but the family size is not in log form. The model can be postulated as the following Table.

Equation	H1	VS	H2
Budget share	$w_i = \beta_1^0 \ln X_h + \gamma_1^0 \ln z_h + u_1^0$	VS	$w_i = \beta_2^0 \ln X_h + \gamma_2^0 z_h + u_2^0$
Unit value	$\ln v_i = \beta_1^1 \ln X_h + \gamma_1^1 \ln z_h + u_1^1$	VS	$\ln v_i = \beta_2^1 \ln X_h + \gamma_2^1 z_h + u_2^1$

Where u_1 and u_2 denote a normally distributed disturbance vector.

The two-models in H1 above are the models used by the former studies which are referred to by the present study, whereas the two-models postulated in H2 are the models proposed as an alternative by the current study. As seen above, the H_1 and H_2 models are non-nested.

In fact, the comprehensive models are as follows:

$$w_i = \beta_1^0 \ln X_h + \gamma_1^0 \ln z_h + \lambda_1^0 \hat{w}_{1i}$$
$$\ln v_i = \beta_1^1 \ln X_h + \gamma_1^1 \ln z_h + \lambda_1^1 \ln \hat{v}_{1i}$$

and

$$w_i = \beta_2^0 \ln X_h + \gamma_2^0 z_h + \lambda_2^0 \hat{w}_{2i}$$
$$\ln v_i = \beta_2^1 \ln X_h + \gamma_2^1 z_h + \lambda_2^1 \ln \hat{v}_{2i}$$

Where λ_1 and λ_2 are the coefficients of the fitted values under H_1 and H_2, respectively, and both are estimated. The *J*-test is applied by testing the mixing parameter, λ, for significance in each model.

Model II in H3 is a linear relationship between budget share of a particular good *i* (or log of unit value of a particular good *i*), total food expense, total income and family size. All the explanatory variables are in log-form. As an alternative, the Models in H4 are similar to the models in H3 with the exception of the Z variable (family size) which is not in log-form. The model can be postulated as follows:

Equation	H3	VS	H4
Budget share	$wf_i = \beta_3^0 \ln TEF_h + \rho_3^0 \ln IC_h + \gamma_3^0 \ln z_h + u_3^0$	VS	$wf_i = \beta_4^0 \ln TEF_h + \rho_4^0 \ln IC_h + \gamma_4^0 z_h + u_4^0$
Unit value	$\ln v_i = \beta_3^1 \ln TEF_h + \rho_3^1 \ln IC_h + \gamma_3^1 \ln z_h + u_3^1$	VS	$\ln v_i = \beta_4^1 \ln TEF_h + \rho_4^1 \ln IC_h + \gamma_4^1 z_h + u_4^1$

In fact, the comprehensive models are as follows:

$$wf_i = \beta_3^0 \ln TEF_h + \rho_3^0 \ln IC_h + \gamma_3^0 z_h + \lambda_3^0 \hat{w}_{1i}$$
$$\ln v_i = \beta_3^1 \ln TEF_h + \rho_3^1 \ln IC_h + \gamma_3^1 z_h + \lambda_3^1 \ln \hat{v}_{1i}$$

and

$$wf_i = \beta_4^0 \ln TEF_h + \rho_4^0 \ln IC_h + \gamma_4^0 \ln z_h + \lambda_4^0 \hat{w}_{1i}$$
$$\ln v_i = \beta_4^1 \ln TEF_h + \rho_4^1 \ln IC_h + \gamma_4^1 \ln z_h + \lambda_4^1 \ln \hat{v}_{1i}$$

Where λ_3 and λ_4 are the coefficients of the fitted values under H_3 and H_4, respectively, both are estimated. The *J*-test is also applied by testing the mixing parameter, λ, for significance in each model.

In this study, urban Indonesian data is employed to test both Model I and Model II.

4.2.1.3 Testing the size of Model II's income effect

In economic theory, Model I is the "best" model to use for tax reform analysis. However, the present study also considers Model II. The use of Model II for tax reform analysis has been supported by Vives (1987), Hausman (1981) and Willig (1976) as discussed in Chapter 2.

More specifically, Vives (1987) attempts *to formalise* the Marshallian idea, i.e. permitting the consumer surplus of Model II to be closely approximate to and equivalent to compensating variations (from Model I), in which the income elasticities and the budget shares of the commodities observed are small, to ensure the income effect is negligible. If the proportion of income spent on any commodity is small then the income effects are small, considering that, by definition, *the own price elasticity of a good equals the compensated price elasticity minus the expenditure of the good times the income elasticity of demand*.

In brief, Vives (1987), Hausman (1981) and Willig (1976) reach a similar conclusion that the conditions which must be met if consumer surplus of Model II is to be a reasonable approximation of equivalent and compensating variations of Model I, then income elaticities and the budget shares of the commodities observed must be small to ensure the income effect is negligible.

In order to justify the formalisation of Model II, it is important to compute income elasticity as one of the elements considered for the existence of the income effect. In computing income elasticity, a three stage procedure has been carried out:

9. Running a regression for budget share equation, i.e. a ratio of expenditure of commodity *i* to total food expenditure (*wf*) as a function of log of total expenditure for food (LTEF), log of income (LIC) and family size (Z) to obtain estimated β_i and ρ_i.

   $$wf_{ih} = \hat{\beta}_i LTEF_h + \hat{\rho}_i LIC + \hat{\pi}_i Z \qquad \textbf{4-1}$$

10. Running a regression of log for expenditure (*LX*) as a function of log of income (*LIC*) to obtain estimated α:

    $$LX_h = \hat{\alpha} LIC_h \qquad \textbf{4-2}$$

    And comparing $\hat{\alpha}$ with a simple computation of a ratio between Average of Household's Expenditure to Average of Household's Income can be used to estimate the (α''), as computed in Table 3.10; For more detail see Chapter 3.

11. Computing income elasticity by making use of the following formula, in which the parameters such as β, α, and ρ have been earlier estimated in the previous stages:

    $$\eta_i = (\hat{\beta}_i / \overline{WF}_i * \hat{\alpha}) + (\hat{\rho}_i / \overline{WF}_i) \qquad \textbf{4-3}$$

    η_i = Income elasticity for commodity i

$\overline{WF_i}$ = Average Budget share, a ratio of an expense for commodity *i* to total food expenditure.

$\hat{\beta}_i, \hat{\rho}_i \hat{\alpha}$ = coefficient regressions derived from equation 5.1 and 5.2.

To make use of the estimated income elasticities in identifying types of goods, it is important to compute their t – ratios. The following formula is used:

$$\text{t ratio} = \frac{\hat{\eta}_i}{se_{(\eta_i)}}$$

Where,

$se_{(\eta_i)} = \sqrt{(\text{var}(\hat{\eta}_i)}$ and

$$\text{var}(\hat{\eta}_i) = \left[\frac{\hat{\alpha}}{\overline{WF_i}}\right]^2 \times \text{var}(\hat{\beta}_i) + \left[\frac{1}{\overline{WF_i}}\right]^2 \times \text{var}(\hat{\rho}_i) + \left[\frac{\hat{\alpha}}{\overline{WF_i}}\right] \times \left[\frac{1}{\overline{WF_i}}\right] \times \text{cov}(\hat{\beta}_i, \hat{\rho}_i)$$

It has been recognised that the identification problem and the existence of nuisance variables are two important econometric issues when selecting variables for an inclusion in a demand equation. Phillips (1974) provides a pattern for dealing with this by raising the question of how the economists, having established the theoretical plausibility, ensure that the estimated equation is a demand equation, and not something else. In fact, a justification for choosing a model, in particular Model II, has also been guided by those econometric issues as set out below.

Model II is justified by considering that **First**; income is one of the important variables in constructing demand functions. Engel curve analysis proves that people in different income have systematically different structures of consumption. By computing the income elasticities with respect to their budget shares, it is possible to classify the types of goods, as well as to allocate their budget according to one's ordering preferences of consumption. Unfortunately, the Engel curve assumes the price as constant. Accordingly, it seems that Engel curve analysis should be treated with caution, unless price is included as one of the explanatory variables in the model, as in Model II.

Second, the present study acknowledges that previous demand studies used the total expenditure as a proxy for income, because expenditures are generally perceived to be less affected by short-term variation than income, and are more reflective of longer-term economic status. However, when Y equals E plus S, and if S is a function of Y, then the gap between S and Y will differ across income groups. Accordingly, the total expenditure may not be a good proxy for income.

Even so, the present study admits that total expenditure can be used as a good proxy for income, in cases where little or no savings is done. Indeed, the present study observes that the majority of Indonesian households are poor, so that their income and expenditure seem closely bound together. Accordingly, in general, the expenditure approach can be relatively implemented in the Indonesian data analysis for the lower income groups.

However, this treatment must be carried out with caution as the proxy cannot represent the rich who have significant amounts of savings; because the model which utilises the total expenditure as the income proxy will be biased towards lower income groups, and it will mislead the policy recommendations for higher income group targeting.

Other relatively less-important arguments can be made concerning the unreliability of income data from cross sectional budget survey data. Many studies argue that income data from cross-sectional budget surveys may not be reliable when used for demand estimation. The present study quotes one example of these, Thomas (1987) who observed that:

> *Cross-sectional data, in fact, seldom provide accurate information on household incomes, since responses to questions concerning income are notoriously unreliable. For this reason, the explanatory variable in cross-sectional demand studies is almost invariably total expenditure rather than income (p.19).*

However, it has been found that the studies which claimed this still used expenditure data from the same survey. It seems inconsistent to argue that different data obtained from the same source produce different data in terms of reliability.

4.2.1.4 Comparing the models

The present study makes use of two different economic models when estimating the demand system. Model I is chosen because the model provides estimates of compensated elasticities which are required to generate estimates of the welfare effect of the change in price. Model II is used to generate estimates of uncompensated price and income elasticities which provide a frame of reference when discussing results. This model is an alternative model to the first model, in order to include both income and 'expenditure for food' variables and to examine how these two variables contribute to the change in the price response resulting from tax change.

It is important to note that definitions of budget – share for the two models also differ. The first model defines budget – share on good *i* (w_{ihc}) as a ratio of expenditure *i* to total expenditure of household *h*, both for food and non-food items. Whereas the second model defines its budget share on good *i* (wf_{ihc}) as a ratio of expenditure for good *i* to total food expenses only.

In other words, Model II considers the way in which the share of a households' food budget that is spent on a particular commodity group varies with changes in price and income. This contrasts with Model I which examines the way in which the share of a households total expenditure budget varies with changes in price.

Nicita (2004) found that urban and rural differences (as considered by the present study) do not significantly drive the findings on consumption pattern differences in Mexican households. Accordingly, analysing the Indonesian consumption patterns by income groups, following Nicita, is an alternative approach to complement the present analysis of urban and rural parameters. Similarly, the study by Olivia and Gibson (2002) as well as some aspects of Jensen and Manrique (1998) will be modified and used in the present study.

Jensen and Manrique (1998) argue that specific demand parameters according to income group can be employed not only for accurately measuring the welfare effects resulting from given policies but also permit the compensation scheme designed for the poor, based on specific commodities (Pinstrup-Andersen *et al*., 1976; Pinstrup-Andersen and Caicedo, 1978; Savadogo and Brandt, 1988; Burney and Akmal, 1991, as noted by Jensen and Manrique, 1998).

In summary, some interesting features of the present study are as follows:

1. To add income variable as one of the determining variables to capture income elasticities and to define types of goods in Model II. Similarly, to carry out data analysis based on income groups as expressed in Model I it is important to investigate a change in the responsiveness – level of particular goods according to household income level and simultaneously to provide a comparison with the previous study of Jensen and Manrique (1996 and 1998);

2. To remedy the heteroscedasticity problem which frequently occurs in cross-sectional data analysis by using SHAZAM "HETCOV" approach;

3. To conduct a separate analysis exclusively for both urban and rural areas of Java to facilitate a comparison with the studies of Olivia (2002) and Deaton (1990). Analysis of Indonesian data, including urban and rural areas, will also be conducted, in order to examine a change of future tax reform recommendations as well as to facilitate comparison with Olivia and Gibson. In fact, both uncompensated price and income elasticities from Model II in which the Engel curve and the income elasticities help interpret and provide contexts for the policy recommendations.

4.2.2 Estimating λ - the Marginal Social Cost of Taxation

As noted earlier, the basic model of tax reform used in this study is mainly derived from the approaches outlined by Ahmad & Stern (1984, 1991), Madden (1995), Deaton (1997), Olivia and Gibson (2002), and Nicita (2004).

It is assumed that the existing tax system is given and the model focuses on the welfare of consumers and the government revenue constraints. This approach identifies optimal tax changes at the margin.

The approach makes use of the Marginal Social Cost (MSC) of taxation of every good, calculated as:

$$\lambda_i = -\frac{\partial V / \partial t_i}{\partial R / \partial t_i} \qquad \textbf{4-4}$$

Where λ_i measures the marginal social cost of raising one unit of revenue from increasing the tax on good *i*.

The above formula implies that an increase in the tax rate on good *i*, will cause both a change in welfare $(\partial V/\partial t_i)$ and a change in revenue $(\partial R/\partial t_i)$.

In brief, a measure of the effects of the tax reform or change can be given by the ratio of (negative) welfare costs to (positive) revenue or benefits, which is lambda. A detailed discussion of the derivation of lambda can be found in appendix C.

$$\lambda = \frac{\cos t}{benefit} = \frac{\partial w/\partial t}{\partial R/\partial t}$$

$$\lambda_i = \frac{Costs}{benefits} = \frac{\sum_{h=1}^{H} \eta_h q_{ih}}{\sum_{h=1}^{H} q_{ih} + \sum_{h=1}^{H}\sum_{j=1}^{M} t_j \frac{\partial q_{jh}}{\partial p_i}} \qquad \textbf{4-5}$$

Where η_h is the social marginal utility of money in the hands of household *h*

Intuitively, equation 4-5 suggests that at the optimum level, *the MSC* (=λ_i) *of raising funds (government revenues) from different sources (by increasing commodity taxes) should be the same*. This means that all λ_i should be equal, meaning that the taxes are optimally set and there is no scope for further beneficial tax reform. Otherwise, the tax on goods with high MSC could be lowered; the tax on goods with low MSC could be raised and this could improve welfare, while keeping government revenue neutral.

However, as discussed in Chapter 2, Nicita (2004) and Olivia (2002) have noted that when calculating the denominator of λ_i (the marginal social cost of revenue from the tax on each of the products) both quality and quantity responses to price changes should be considered. This can be done using Deaton's (1997) method where λ_i becomes:

$$\lambda_i = \frac{w_i^{\varepsilon} / \tilde{w}_i}{1 + \frac{t_i}{1+t_i}\left(\frac{\theta_{ii}}{\tilde{w}_i} - 1\right) + \sum_{k \neq i} \frac{t_k}{1+t_k}\left(\frac{\theta_{ki}}{\tilde{w}_i}\right)} \qquad \textbf{4-6}$$

The two terms in the numerator w_i^{ε} and $\widetilde{w}_i$ are defined as (Olivia (2002), Nicita (2004)):

$$w_i^{\varepsilon} = \left(\sum_{h=1}^{H} \left(\frac{x_h}{z_h} \right)^{-\varepsilon} x_h w_{ih} \right) \Bigg/ \sum_{h=1}^{H} x_h \qquad \textbf{4-7a}$$

$$\widetilde{w}_i = \left(\sum_{h=1}^{H} x_h w_{ih} \right) \Bigg/ \sum_{h=1}^{H} x_h \qquad \textbf{4.7b}$$

Where,

x_h	=	total expenditure of household, *h*
w_i	=	budget share for good *i*:
ε	=	inequality aversion ranging from 0 to 2.5 (appropriate value of ε is computed by a new and modified method of Atkinson Index utilisation, discussed in subsection 4.2.3)
t_i and t_k	=	tax rates for good *i* and *k*
θ_{ii} and θ_{ik}	=	own- and cross- price elasticities
i	=	commodity 1, …, 13,
k	=	other commodity 2, …, 13, $(k \neq i)$
z_h	=	number of family members in household *h*
h	=	household 1, …, 64422 comprises the following

It is important to note that the analysis will be based on areas: urban versus rural; Java versus Indonesia; and for Model I the analysis will consider different income categories: low, middle and high incomes.

Data for 29,279 households in urban areas and 35,143 households in rural areas are subject to the analysis. In relation to income group categorisation, 32,813 households whose income is less than Rp. 800,000 were categorised as being part of the low income group. 24,288 households whose income ranges between Rp. 800,000 to less than Rp. 2,000,000 were categorised as "middle income" and 31,813 households whose income is Rp. 2,000,000 or more were categorised as "high income".

Here, the denominator of equation of λ is the tax factor multiplied by the elasticity of good *i* with respect to its price, quality and quantity effects taken together. The first term of the denominator measures the own-price effect of the tax, whereas the last term is the cross-price effect which captures the effect on other goods due to the change in tax on good *i*. If the denominator is large (and negative) then it would be costly to further increase revenue through taxes on this commodity.

It is possible to treat individuals equally or to give more weight to a particular group of individuals when calculating λ_i as per Nicita's suggestion. For example, if more weight is given to poor individuals, it is possible to obtain the social cost of the tax with regard to the poor. Similar exercises can be carried out according to geographic location or ethnic group.

The numerator is a pure distributional measure of the good *i* which can be varied according to a variation of the "inequality aversion" parameters, ε, focusing more on the poorer households. The higher the ε, the more attention is focused on the poor, as $\varepsilon = 0$ means that there are no distributional concerns. In this case the result will be optimal in equity rather than in efficiency. The aversion parameter can also be interpreted as the relative shares of the market-representative individual and the socially-representative individual whose income is lower, the higher the inequality aversion parameter ε.

In this study, recommended directions for future tax reform will be made by ranking the computed lambda corresponding to various levels of inequality- aversion. As candidates for additional taxation, the commodities ranked higher are preferred to lower-ranked commodities. The results of rankings will be used for policy prescriptions.

It is important to note that, as observed by Madden (1995), the welfare effect of tax change will always be negative, whereas the revenue effect would be expected, in general, to be positive., In principle, however, it could be greater, less than, or equal to, zero. Madden (1995) further argues that as the revenue effect becomes smaller, the MSC ratio becomes larger and then approaches infinity in the limit. Accordingly, this approach raises two problems, namely, (1) the discontinuity of the relationship between λ_i and the revenue effect; (2) the comparison between the two λ_is when either or both has a negative value.

In order to overcome those problems, Madden proposes $\rho_i = 1/\lambda_i$ be used for ranking the goods. Intuitively, ρ_i – Marginal (Social) Revenue Cost (MSRC) – denotes the MC in revenue forgone when a tax is lowered, so as to provide one extra unit in welfare. In general, the approach recommends that if $\rho_i < \rho_j$ then the indirect tax on good *i* should be lowered and that on good *j* should be increased (for detailed discussion of ρ see Madden, 1995).

Irrespective of whether one looks at λ or ρ it is clear that there are two sets of variables playing important roles in providing good direction for the future tax reform analysis, namely, price elasticities (both own-price (θ_{ii}) and cross-price elasticities (θ_{ik})) and inequality aversion (ε). These variables must be computed before λ or ρ can be estimated – and the following sub – sections explain how that was done in this study.

4.2.2.1 Estimating price elasticities

In this sub – section the following issues will be presented: (1) the implementation of Deaton's unit value-based method; (2) a justification and details of the method; (3) a simplified two – commodity model.

As discussed in Chapter 2, Deaton, in his series of articles starting in 1987 (1987, 1988, 1990, 1997), developed a methodology to estimate a complete demand system including own- and cross-price elasticities from cross-section data. The unique feature of his approach was its ability to estimate a set of unit value and expenditure share equations, and then recover the price effect from the estimated covariance matrices of residuals. Since his research has largely contributed to demand system studies, the present study also adopts his approach, with a modification in utilising different demand models.

In principle, the framework for the analysis is a model of consumer behaviour, in which households select how much of a commodity to purchase and in what quality or grade. Commodities are taken into account as a set of heterogeneous goods within which consumers are able to select more – or less – expensive items, so that the unit value of a commodity, which Deaton defined as the price paid per physical unit, is a matter of selection. In following Deaton's procedure, both quantity and quality choice are functions of household income, household characteristics, and price. The prices of any one commodity will typically affect both the quantities and qualities selected for all goods.

More specifically, the Deaton procedure is as follows:

1. Use of within-cluster information, i.e. household demand, income and products' unit values to obtain OLS estimates of total expenditure and quality elasticities, as well as estimates of error-measurement variances and co-variances.
2. Use of the 1st stage estimates to net out the effect of the total expenditure, quality, and households characteristics, and therefore to compute the "corrected" budget shares and unit values. A regression of "corrected" budget shares on "corrected" unit values, averaged by cluster, produces an estimate of the ratio of the responses to the price of the budget share and the unit value.
3. Use of the theory linking quality and quantity elasticities to extract the effect of the price on the budget share from the ratio of the responses to the price of the budget share and the unit value.

The model is comprised of two basic equations. The first equation (4.5), which is a double logarithm demand function, describes the quantity of a commodity consumed as a function of total expenditure (x), family size (z), unobservable cluster price (p) and f (unobservable fixed cluster effect). The second equation (4.6), which is the unit value equation, illustrates the unit value of the commodity observed (v) as a function of x, z and p. More specifically, those equations can be illustrated as follows.

$$lq_{hic} = \alpha_i^0 + \beta_i^0 lx_{hc} + \gamma_i^0 z_{hc} + \theta_i^0 lp_{hc} + f_c + u_{hic}^0 \qquad \textbf{4-8a}$$

$$lv_{hic} = \alpha_i^1 + \beta_i^1 lx_{hc} + \gamma_i^1 z_{hc} + \theta_i^1 lp_{hc} + u_{hic}^1 \qquad \textbf{4-8b}$$

Where: *h* `denotes the household

c spatial cluster

lq_{hic} = log of quantity purchased by household h in cluster c of the good *i*

lx_{hc} = log of total expenditures for household *h* in cluster *c*

z_{hc} = family size

lp_{hc} = log of unobserved cluster price,

f_c = unobserved fixed cluster effect capturing taste variation across clusters,

lv_{hic} = log of unit value,

u_{hic} = idiosyncratic error terms.

There are at least three non-standard features in these equations, as observed by Olivia (2002) and Nicita (2004). **First,** a problem with the estimation of equations (4.5) and 4.6) arises in the case where households do not purchase a particular category of goods. This is because the logarithmic specification can be used only to describe the behaviour of those households who purchase. Hence, the logarithmic form can exclude a large proportion of households for narrowly defined product groups.

Jensen and Manrique (1998) introduce a notion of 'food participation rates'. They argue that the rates provide a good indication of expenditure patterns and that is important for understanding the degree of a problem of zero-expenditure for further econometric analysis. They argue that from a statistical viewpoint, a great number of observations at the zero – expenditure level contribute to boundary causes a non – zero means for the residual terms, and a zero-spending probability is not negligible. Therefore, they further argue that under these circumstances standard estimation methods produce biased and inconsistent estimates of the parameters, because the methods do not take into account the residuals' non-zero mean (Wales & Woodland, 1983; Maddala, 1983 in Jensen and Manrique, 1998). In fact, the zero-expenditure problem is fairly frequent; in particular when disaggregated cross-sectional data on commodity consumption are employed in the demand systems estimation (Wales and Woodland, 1983; Yen and Roe, 1989, as noted from Jensen and Manrique, 1997).

Some studies acknowledge, and the present study is also aware of, the fact that the zero expenditure problems arise for many reasons. e.g. the household cannot afford to buy an expensive good (e.g. meat), religious considerations may prevent the household from buying the goods (e.g. alcohol), and it is often impossible for the household to recall the expenses for goods bought only infrequently (eg spices) or for goods consumed from its own production (e.g. vegetables). Accordingly, zero expenditure should be allowed to enter the analysis and be treated appropriately

Jensen and Manrique (1998) suggest an alternative approach to deal with the zero-consumption problem by introducing a two – step decision process, in which individuals: first decide to consume some non-zero amount of a particular good and then, conditional on this decision, they choose the amount. This approach, they argue, permits different sets of factors to explain expenditures on each outcome, and different demand functions for the set of commodities when some of them are not consumed. On the other hand, Deaton and Muellbauer (1980) suggest estimating the model by substituting budget shares for the logarithm of quantity purchased.

As explained in Chapter 3 there are many different ways of dealing with the zero – expenditure problem. This study follows Deaton in circumventing the non-consuming problem, that is, by utilising a budget share equation as follows.

$$w_{hic} = \alpha_i^0 + \beta_i^0 lx_{hc} + \gamma_i^0 z_{hc} + \sum_{k=1}^{M} \theta_{ik}^0 lp_{ik} + (f_c + u_{hic}^0) \qquad \textbf{4-9a}$$

$$lv_{hic} = \alpha_i^1 + \beta_i^1 lx_{hc} + \gamma_i^1 z_{hc} + \sum_{k=1}^{M} \theta_{ik}^1 lp_{ik} + u_{hic}^1 \qquad \textbf{4-9b}$$

The equations above have already captured cross-price effects (θ_{ik})

Where,

β_1^0 is the expenditure elasticity (with respect to total expenditure *x*)

β_1^1 is quality elasticity of good *i* (with respect to total expenditure *x*)

θ_{ik}^0 is the cross-price elasticity of good *i* (with respect to the price of good k)

Second, as shown in the above equations, the price variable is an important determinant of demand, but unfortunately it is unobservable in household surveys and this makes it impossible to obtain direct parameter estimates for this variable. Meanwhile, a unit value (equals to expenditure divided by quantity) which is available in the survey captures both the choice of quality and actual market prices.. Nevertheless, as argued by Deaton (1997), it is possible to consistently estimate non-price parameters, by assuming that all households in the same cluster face the same vector of prices. Therefore, as suggested by Deaton and tested by other researchers such as Olivia (2002) and Nicita (2004), the estimation of equation (4.5) is conducted by adding dummies for each cluster. This is equivalent to estimating the regression of deviations from cluster means (demeaned regression). In fact, Olivia utilised dummies for each cluster, whereas Nicita made use of demeaned regressions. The present study will conduct demeaned regression, as price is assumed to be the same within each cluster at village level as follows:

$$w_{hic} - \overline{w_{hic}} = \beta_i^0 (lx_{hc} - \overline{lx_{hc}}) + \gamma_i^0 (z_{hc} - \overline{z_{hc}}) + (u_{hic}^0 - \overline{u_{hic}^0}) \quad \textbf{4.10a}$$

$$lv_{hic} - \overline{lv_{hic}} = \beta_i^1 (lx_{hc} - \overline{lx_{hc}}) + \gamma_i^1 (z_{hc} - \overline{z_{hc}}) + (u_{hic}^1 - \overline{u_{hic}^1}) \quad \textbf{4.10b}$$

In addition, it is important to note that here the unit value is defined as a unit value index for an aggregate commodity group. The index is computed by adopting the formula proposed by Olivia and Gibson (2005) with a little modification as follows:

$$UV = \sum \overline{w} \ln v_{jk} \quad \textbf{4-9}$$

Where $\overline{w}$ = average budget shares for each component of food- commodities in the group (k), computed over all households in the survey. This study modifies the UV formula by the following:

$$UV = lv_{hic} = \sum_{j=1}^{M} (E_j / E_i) \ \ lv_{ji} \quad \textbf{4-12}$$

$\overline{w} = E_j / E_i$ = a ratio of the expenditure for each component of food - commodities in the group (sub – commodity *j*) to the expenditure for the aggregate commodity group

lv_{ji} = Log of unit value for each component food commodities in the group (*j*) forming the aggregate commodity group (*i*)

Third, consumers select both quantity and quality, so that expenditure on good *i* is the product of price, quantity and quality. In addition, as the present study utilises the budget-share equation (equation 4.5a) instead of the double logarithm demand function (4.5) the expenditure elasticity can be computed as follows:

$\varepsilon_x^0 = (1-\beta_1^1) + \beta_i^0 / \overline{w}_i$ = expenditure elasticity (refers to equation 4.5a)

It should also be noted that Model I will be extended by introducing an income variable to estimate Marshallian demand from which uncompensated price and income variables can be calculated (Model II). Accordingly, Model II is as follows.

$$lq_{hic} = \alpha_i^0 + \varepsilon_x^0 \ln x_{hc} + \gamma_i^0 z_{hc} + \varepsilon_p^0 \ln p_{hc} + \varepsilon_I^0 \ln IC_{hc} + f_c + u_{hic}^0 \qquad \textbf{4-13a}$$

$$lv_{hic} = \alpha_i^1 + \varepsilon_{quality}^1 \ln x_{hc} + \gamma_i^1 z_{hc} + \theta_i^1 \ln p_{hc} + \varepsilon_I^1 \ln IC_{hc} + u_{hic}^1 \qquad \textbf{4-13b}$$

A computation of the income elasticity refers to equation 4.1 (see Sub section 4.2.1.3 more details)

For convenience, the model is simplified to a two-commodity model (commodity 1 and commodity 4), and the mathematical derivation is given below. The full computer program used for Model II in the more complex 13 commodity group case is provided in Appendix G[5].

In household survey data, for household *i* cluster, there are two equations for goods 1 and 4. One is the budget share equation and the other is the unit value equation as in the following:

$$w_{h1c} = \alpha_1^0 + \beta_1^0 lx_{hc} + \gamma_1^0 z_{hc} + \theta_{11}^0 lp_{1c} + \theta_{14}^0 lp_{4c} + f_{1c}^0 + u_{h1c}^0 \qquad \textbf{4-10a}$$

$$lv_{h1c} = \alpha_1^1 + \beta_1^1 lx_{hc} + \gamma_1^1 z_{hc} + \theta_{11}^0 lp_{1c} + \theta_{14}^1 lp_{4c} + u_{h1c}^1 \qquad \textbf{4-14b}$$

$$w_{h4c} = \alpha_4^0 + \beta_4^0 lx_{hc} + \gamma_4^0 z_{hc} + \theta_{44}^0 lp_{4c} + \theta_{41}^0 lp_{1c} + f_{4c}^0 + u_{h4c}^0 \qquad \textbf{4-11a}$$

$$lv_{h4c} = \alpha_4^1 + \beta_4^1 lx_{hc} + \gamma_4^1 z_{hc} + \theta_{44}^0 lp_{4c} + \theta_{41}^1 lp_{1c} + u_{h4c}^1 \qquad \textbf{4-15b}$$

Where w_{h1c} and w_{h1c} are the budget share of good 1 and 4 in *h*-the household's budget, x_{hc} is total expenditure on all goods and services of household *h*, z_{hc} is family size, p_{1c} and p_{4c} are the prices of good 1 and 4 respectively in a total of the *n* goods (*n* = 2 goods) v_{h1c} and v_{h4c} are the unit value of good 1 and 4 (defined as the expenditure on the good divided by the quantity bought) whereas f_{1c} and f_{4c} are a cluster-fixed

[5] The computer code for Model I is available on request but is not included here for space constraints

effect for good 1 and 4, and u^0_{h1c}, u^1_{h1c}, u^0_{h4c} and u^1_{h4c} are idiosyncratic random disturbances.

The expenditure share equation is assumed to be a linear function of the logarithm of total expenditure, of the prices, and of a vector of household characteristics. Each household in a cluster is assumed to face the same prices for market goods. The logarithm of the unit value, which is the logarithm of quality plus the logarithm of price, is a function of the same variables that appear in the share equation, with the exception of the cluster-fixed effect.

Moreover, if one considers the budget allocation of a representative consumer; that is, the subscripts of household h in cluster c are temporarily disregarded, and the equations of cluster means may be represented as in the following:

$$w_{1c} = \alpha^0_1 + \beta^0_1 lx_c + \gamma^0_1 z_c + \theta^0_{11} lp_{1c} + \theta^0_{14} lp_{4c} + f^0_{1c} + u^0_{1c}$$
$$lv_{1c} = \alpha^1_1 + \beta^1_1 lx_c + \gamma^1_1 z_c + \theta^0_{11} lp_{1c} + \theta^1_{14} lp_{4c} + u^1_{1c}$$
$$w_{4c} = \alpha^0_4 + \beta^0_4 lx_c + \gamma^0_4 z_c + \theta^0_{44} lp_{4c} + \theta^0_{41} lp_{1c} + f^0_{4c} + u^0_{4c}$$
$$lv_{4c} = \alpha^1_4 + \beta^1_4 lx_c + \gamma^1_4 z_c + \theta^0_{44} lp_{4c} + \theta^1_{41} lp_{1c} + u^1_{4c}$$

Since the price variables p_1 and p_4 in the model are not observable, it is impossible to estimate the price coefficients from the equations directly. Instead, price coefficients must be estimated indirectly.

In the first stage of estimation, both equations are estimated separately by Ordinary Least Squares (OLS), with cluster means subtracted from all data. The subtraction of cluster means removes not only the fixed effects, but also the cluster invariant prices in both equations as in the following:

$$(w_{h1c} - \overline{w_{1c}}) = \beta^0_1 (lx_{hc} - \overline{lx_{hc}}) + \gamma^0_1 (z_{hc} - \overline{z_{hc}}) + (u^0_{h1c} - \overline{u^0_{1c}})$$
$$(lv_{h1c} - \overline{lv_{1c}}) = \beta^1_1 (lx_{hc} - \overline{lx_{hc}}) + \gamma^1_1 (z_{hc} - \overline{z_{hc}}) + (u^1_{h1c} - \overline{u^1_{1c}})$$
$$(w_{h4c} - \overline{w_{4c}}) = \beta^0_4 (lx_{hc} - \overline{lx_{hc}}) + \gamma^0_4 (z_{hc} - \overline{z_{hc}}) + (u^0_{h4c} - \overline{u^0_{4c}})$$
$$(lv_{h4c} - \overline{lv_{4c}}) = \beta^1_4 (lx_{hc} - \overline{lx_{hc}}) + \gamma^1_4 (z_{hc} - \overline{z_{hc}}) + (u^1_{h4c} - \overline{u^1_{4c}})$$

Based on the estimates of $\beta_1^0, \gamma_1^0, \beta_1^1$ and γ_1^1 as well as $\beta_4^0, \gamma_4^0, \beta_4^1$ and γ_4^1 the residuals associated with each equation can be generated. Using these estimated residuals, the matrices of covariance in each equation, and across equations respectively can be estimated.

In the second stage of estimation, the first-stage estimates are used to calculate the parts of mean cluster shares and unit values which are not accounted for by the first-stage variables. To obtain the covariance matrices, comprised of price components and residuals ε_{h1c}^0, ε_{h1c}^1, ε_{h4c}^0 and ε_{h4c}^1 are defined as follows:

$$\varepsilon_{h1c}^0 = w_{h1c} - \beta_1^0 lx_{hc} - \gamma_1^0 z_{hc} = \alpha_1^0 + \theta_{11}^0 lp_{1c} + \theta_{14}^0 lp_{4c} + f_{1c}^0 + u_{h1c}^0$$

$$\varepsilon_{h1c}^1 = lv_{h1c} - \beta_1^1 lx_{hc} - \gamma_1^1 z_{hc} = \alpha_1^1 + \theta_{11}^0 lp_{1c} + \theta_{14}^1 lp_{4c} + u_{h1c}^1$$

$$\varepsilon_{h4c}^0 = w_{h4c} - \beta_4^0 lx_{hc} - \gamma_4^0 z_{hc} = \alpha_4^0 + \theta_{44}^0 lp_{4c} + \theta_{41}^0 lp_{1c} + f_{4c}^0 + u_{h4c}^0$$

$$\varepsilon_{h4c}^1 = lv_{h4c} - \beta_4^1 lx_{hc} - \gamma_4^1 z_{hc} = \alpha_4^1 + \theta_{44}^0 lp_{4c} + \theta_{41}^1 lp_{1c} + u_{h4c}^1$$

Accordingly, the cluster mean can be computed as:

$$\tilde{y}_{1c}^0 = n_c^{-1} \sum_c \varepsilon_{h1c}^0$$

$$\tilde{y}_{1c}^1 = n_c^{+-1} \sum \varepsilon_{h1c}^1$$

$$\tilde{y}_{4c}^0 = n_c^{-1} \sum_c \varepsilon_{h4c}^0$$

$$\tilde{y}_{4c}^1 = n_c^{+-1} \sum_c \varepsilon_{h4c}^1$$

Then the matrices of covariance associated with $\tilde{y}_{1c}^0$, $\tilde{y}_{1c}^1$, $\tilde{y}_{4c}^0$ and $\tilde{y}_{4c}^1$ are computed as:

$$S_{11} = Cov(\tilde{y}_{1c}^1, \tilde{y}_{1c}^1)$$

$$S_{14} = Cov(\tilde{y}_{1c}^1, \tilde{y}_{4c}^1)$$

$$S_{41} = Cov(\tilde{y}_{4c}^1, \tilde{y}_{1c}^1)$$

$$S_{44} = Cov(\tilde{y}_{4c}^1, \tilde{y}_{4c}^1)$$

$$R_{11} = Cov(\tilde{y}_{1c}^0, \tilde{y}_{1c}^1)$$

$$R_{14} = Cov(\tilde{y}^0_{1c}, \tilde{y}^1_{4c})$$

$$R_{41} = Cov(\tilde{y}^0_{4c}, \tilde{y}^1_{1c})$$

$$R_{44} = Cov(\tilde{y}^0_{4c}, \tilde{y}^1_{4c})$$

In matrix expression:

$$\begin{pmatrix} \tilde{y}^{00}_{11} & \tilde{y}^{00}_{14} & \tilde{y}^{01}_{11} & \tilde{y}^{01}_{14} \\ \tilde{y}^{00}_{41} & \tilde{y}^{00}_{44} & \tilde{y}^{01}_{41} & \tilde{y}^{01}_{44} \\ \tilde{y}^{10}_{11} & \tilde{y}^{10}_{14} & \tilde{y}^{11}_{11} & \tilde{y}^{11}_{14} \\ \tilde{y}^{10}_{41} & \tilde{y}^{10}_{44} & \tilde{y}^{11}_{41} & \tilde{y}^{11}_{44} \end{pmatrix} = \begin{pmatrix} \tilde{q}^{00}_{11} & \tilde{q}^{00}_{14} & \tilde{r}^{01}_{11} & \dddot{r}^{01}_{14} \\ \tilde{q}^{00}_{41} & \tilde{q}^{00}_{44} & \tilde{r}^{01}_{41} & \tilde{r}^{01}_{44} \\ \tilde{r}^{10}_{11} & \tilde{r}^{10}_{14} & \tilde{s}^{11}_{11} & \tilde{s}^{11}_{14} \\ \tilde{r}^{10}_{41} & \tilde{r}^{10}_{44} & \tilde{s}^{11}_{41} & \tilde{s}^{11}_{44} \end{pmatrix} = \begin{pmatrix} Q & R \\ R & S \end{pmatrix}$$

Where

$$Q = \begin{pmatrix} \tilde{q}^{00}_{11} & \tilde{q}^{00}_{14} \\ \tilde{q}^{00}_{41} & \tilde{q}^{00}_{44} \end{pmatrix} \quad \text{R} = \begin{pmatrix} \tilde{r}^{10}_{11} & \tilde{r}^{10}_{14} \\ \tilde{r}^{10}_{41} & \tilde{r}^{10}_{44} \end{pmatrix} \text{ or } \begin{pmatrix} \tilde{r}^{01}_{11} & \tilde{r}^{01}_{14} \\ \tilde{r}^{01}_{41} & \tilde{r}^{01}_{44} \end{pmatrix} \qquad \text{S} = \begin{pmatrix} \tilde{s}^{11}_{11} & \tilde{s}^{11}_{14} \\ \tilde{s}^{11}_{41} & \tilde{s}^{11}_{44} \end{pmatrix}$$

Meanwhile, ω and χ can be calculated as:

$$\omega_{11} = (n - c - k)^{-1} \sum_{c} \sum_{h \in c} e^1_{h1} e^1_{h1}$$

$$\omega_{14} = (n - c - k)^{-1} \sum_{c} \sum_{i \in c} e^1_{h1} e^1_{h4}$$

$$\omega_{41} = (n - c - k)^{-1} \sum_{c} \sum_{h \in c} e^1_{h4} e^1_{h1}$$

$$\omega_{44} = (N - c - k)^{-1} \sum_{c} \sum_{h \in c} e^1_{h4} e^1_{h4}$$

$$\chi_{11} = (N - c - k)^{-1} \sum_{c} \sum_{i \in c} e^1_{h1} e^0_{h1}$$

$$\chi_{14} = (N - c - k)^{-1} \sum_{c} \sum_{h \in c} e^1_{h1} e^0_{h4}$$

$$\chi_{41} = (N - c - k)^{-1} \sum_{c} \sum_{h \in c} e^1_{h4} e^0_{h1}$$

$$\chi_{44} = (N - c - k)^{-1} \sum_{c} \sum_{h \in c} e^1_{h4} e^0_{h4}$$

Where

e_{h1}^{0} is the residuals from first stage regression, budget share equation of 4.1 for good 1

e_{h4}^{1} is the residuals from first stage regression, budget share equation of 4.1 for good 4

e_{h1}^{1} is the residuals from first stage regression, unit value equation of 4.2 for good 1

e_{h4}^{1} is the residuals from first stage regression, unit value equation of 4.2 for good 4

N is number of households in the survey

c is number of clusters

k is number of parameters

In matrix expression:

$$\begin{pmatrix} e_{11}^{00} & e_{14}^{00} & e_{11}^{01} & e_{14}^{01} \\ e_{41}^{00} & e_{44}^{00} & e_{41}^{01} & e_{44}^{01} \\ e_{11}^{10} & e_{14}^{10} & e_{11}^{11} & e_{14}^{11} \\ e_{41}^{10} & e_{44}^{10} & e_{41}^{11} & e_{44}^{11} \end{pmatrix} = \begin{pmatrix} \sigma_{11}^{00} & \sigma_{44}^{00} & \chi_{11}^{01} & \chi_{14}^{01} \\ \sigma_{41}^{00} & \sigma_{44}^{00} & \chi_{41}^{01} & \chi_{44}^{01} \\ \chi_{11}^{10} & \chi_{14}^{10} & \omega_{11}^{11} & \omega_{14}^{11} \\ \chi_{41}^{10} & \chi_{44}^{10} & \omega_{41}^{11} & \omega_{44}^{11} \end{pmatrix} = \begin{pmatrix} \sigma & \chi \\ \chi & \omega \end{pmatrix}$$

$$\sigma = \begin{pmatrix} \sigma_{11}^{00} & \sigma_{14}^{00} \\ \sigma_{41}^{00} & \sigma_{44}^{00} \end{pmatrix} \quad \chi = \begin{pmatrix} \chi_{11}^{01} & \chi_{14}^{01} \\ \chi_{41}^{01} & \chi_{44}^{01} \end{pmatrix} \text{ or } \begin{pmatrix} \chi_{11}^{10} & \chi_{14}^{10} \\ \chi_{41}^{10} & \chi_{44}^{10} \end{pmatrix} \quad \omega = \begin{pmatrix} \omega_{11}^{11} & \omega_{14}^{11} \\ \omega_{41}^{11} & \omega_{44}^{11} \end{pmatrix}$$

For any given S, R, ω, and χ, a matrix B can be obtained:

$$B = \left[S - \omega \tilde{N}_{+}^{-1}\right]^{-1}\left[R - \chi \tilde{N}^{-1}\right]$$

Where,

$\tilde{N}_{+}^{-1} = C^{-1}\sum_{c} D(n_{c}^{+})^{-1}$, where $D(n_{c}^{+})$ is diagonal matrix formed from the elements of n_{ic}^{+} (number of households who consume good *i*), Matrix $\widetilde{N}^{-1}$ is the corresponding quantity formed from the n_c's (number of households in the survey whether they consume or not).

In the two-good case, B can be expressed as:

$$\begin{bmatrix} B_{11} & B_{14} \\ B_{41} & B_{44} \end{bmatrix} =$$

$$\left[\begin{bmatrix} S_{11} & S_{14} \\ S_{41} & S_{44} \end{bmatrix} - \begin{pmatrix} \omega_{11} & \omega_{14} \\ \omega_{41} & \omega_{44} \end{pmatrix} (1/c) \begin{pmatrix} n_1^+ & \\ & n_4^+ \end{pmatrix}\right]^{-1} \left[\begin{bmatrix} R_{11} & R_{14} \\ R_{41} & R_{44} \end{bmatrix} - \begin{pmatrix} \chi_{11} & \chi_{14} \\ \chi_{41} & \chi_{44} \end{pmatrix} \begin{pmatrix} n_1 & \\ & n_4 \end{pmatrix}\right]$$

By applying a separability assumption, in which the demand for individual commodities depends on the associated group expenditures and on the prices of the individual commodities in that group, information derivation on the price effects can be found from the estimated covariance of residuals as follows:

$$E = [D(\overline{w}_i)^{-1} B' - I][I - D(\xi_i)B' + D(\xi_i)D(\overline{w}_i)]^{-1}$$

Where,

E is a matrix of all own- and cross-price elasticities,

I is an identity matrix,

$D(\overline{w}_i)$ is a diagonal matrix with $(1/\overline{w}_i)$'s as entries,

D(ξ_i) is a diagonal matrix with (1/ ξ_i) as entries, in which ξ_i is defined as $\beta_i^1 / [[1-\beta_i^1]\overline{w}_i + \beta_i^0]$.

For illustration, in the two-good case,

$$\mathbf{E} = \begin{bmatrix} \theta_{11} & \theta_{14} \\ \theta_{41} & \theta_{44} \end{bmatrix} = \qquad \mathbf{4\text{-}12}$$

$$\left[\begin{bmatrix} \overline{w}_1 & \\ & \overline{w}_4 \end{bmatrix}^{-1} \begin{bmatrix} B_{11} & B_{41} \\ B_{14} & B_{44} \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right] \left[\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - \begin{bmatrix} \xi_1 & \\ & \xi_4 \end{bmatrix} \begin{bmatrix} B_{11} & B_{41} \\ B_{14} & B_{44} \end{bmatrix} + \begin{bmatrix} \xi_1 & \\ & \xi_4 \end{bmatrix} * \begin{bmatrix} \overline{w}_1 & \\ & \overline{w}_4 \end{bmatrix}\right]^{-1}$$

Where:

$$\xi_1 = \left[(1-\beta_1^1)\overline{w}_1 + \beta_1^0\right]^{-1}\beta_1^1$$

$$\xi_4 = \left[(1-\beta_4^1)\overline{w}_4 + \beta_4^0\right]^{-1}\beta_4^1$$

It should be noted that the later analysis is much more complex, since the study uses the above approach to compute own- and cross-price elasticities for 13 different commodities observed.

4.2.2.2 Estimating ε - the degree of Inequality Aversion

As mentioned in the previous sub-section, the MSC of taxation does not depend only on elasticity; it also depends on inequality aversion. It is, therefore, important to understand the concept. Inequality aversion is defined as the extent to which an individual prefers a society with a more equal distribution of income (Kroll and Davidovitz, 1999). The degree of inequality aversion is measured by the amount society is willing to forgo in order to achieve a more egalitarian distribution of income; that is, the more convex the overall *social* indifference curve, the more averse the society is to inequality (Kroll and Davidovitz, 1999)

Olivia and Gibson (2002) point out that the different values of ε reflect different judgements about the desirability of making transfers to reduce income inequality. Due to this value judgment element, a range of values is commonly employed to find out whether recommendations of tax reform are consistent with particular ethical judgments. The present study proposes a new approach in order to provide an appropriate value of ε by utilising the Atkinson Index. A full discussion can be found below.

Inequality measurement involves explicit or implicit value judgements. It is also "subjective", in the sense that it takes account of peoples' views on distributional comparisons (Amiel et. al, 1996).

There seems to be a lack of consensus in selecting the appropriate value for the inequality aversion parameter when evaluating tax reform (Olivia, 2002). As observed by Olivia, various studies of indirect taxes on food (Christiansen and Jansen, 1978;

Stern, 1977, and Dalton, 1939) found typical values of ε ranging from 0 to 2, Olivia's study, by adopting the approach of Ravallion and Dearden (1988) suggests that the values of ε for Java range from 3.7 (rural) to 6.3 (urban) whereas Gibson et al (1998, 2002) find the values of ε equal to 6.42 (1998) and ε = 4.18 and 5.47 for Papua New Guinea. Consequently, this study will use the Aitkinson Index to generate an estimate for use in subsequent analyses.

The Atkinson Index explicitly incorporates normative judgments about social welfare (Atkinson 1970), and explicitly uses ε (inequality aversion).

The Atkinson Index (AI) is then given by:

$$AI = 1 - ye/\mu$$

Where μ is the actual mean income; the more equal the income distribution the closer y_e will be to μ and the lower the value of the Atkinson Index. For any income distribution, the value of AI lies between 0 and 1.

In the Atkinson Index, y_e is the equity-sensitive average income

$$y_e = \left(\sum_i^n (y_i).y_i^{1-\varepsilon} \right)^{1/1-\varepsilon}$$

Where y_i is the ratio of total income earned by the *i*th group, and ε is the inequality aversion parameter.

The ε reflects the strength of society's preference for equality (0 ≤ ε ≤ ∞). As ε rises, society attaches more weight to income transfers at the lower end of the distribution scale and less weight to transfers at the top.

In the equation of y_e, both *ye* and ε are unknown. However, most of the literature suggests that the likely values of ε are between 0 and 2.

By making use of a series of ε values, y_e can be estimated from the y_e equation and by using a maximum principle theory, that is,

$$\frac{Max\ y_e}{z}$$

The max value of y_e which is then inserted into the equation of the Atkinson Index (AI) produces the modified Atkinson Index. Meanwhile, the ε where the max value of y_e is reached will be used in computing lambda λ.

4.3 Conclusions

As discussed in the previous sub – sections, the procedure of the analyses can be summarised as follows:

1. **A Preparatory Analysis** which deals with an estimation of the two proposed models: compensated Hicksian demand (Model I, hereafter) and uncompensated Marshallian demand (Model II, hereafter). In these estimations, variable specification tests for family size as one of the regressors of the equations are conducted, including the interpretation of the results. This step will also (a) describe how the study remedies the problem of heteroschedasticity that usually occurs in cross-sectional data analysis; and (b) provide a justification for using Marshallian demand to estimate the welfare effect of tax reform (as an alternative to the Hicksian demand).

2. **Tax reform 'Lambda' Analysis** comprises two initial analyses and one comprehensive analysis:
   a. A price elasticities computation: involving Deaton's three stage procedure to circumvent unobservable price and zero – consumption problem. This is done for both Hicksian and Marshallian Demand functions.
   b. A unique estimate of inequality aversion making use of the Atkinson Index and the existing income distribution;
   c. Ahmad and Stern's approach of Lambda computation for tax reform analysis to investigate a direction for future tax change which uses:
      iv. The price elasticity estimates from 2 (a);
      v. The inequality aversion index from 2 (b); and
      vi. Existing tax rates from section 3.6 of tax rates and its regulation

Where,

$$\lambda_i = \frac{w_i^{\varepsilon} / \widetilde{w}_i}{1 + \frac{t_i}{1 + t_i}\left(\frac{\theta_{ii}}{\widetilde{w}_i} - 1\right) + \sum_{k \neq i} \frac{t_k}{1 + t_k}\left(\frac{\theta_{ki}}{\widetilde{w}_i}\right)}$$

Where

$$w_i^{\varepsilon} = \frac{\left[\sum_{h=1}^{H}\left(\frac{x_h}{z_h}\right)^{-\varepsilon} x_h w_{ih}\right]}{\sum_{h=1}^{H} x_h} \quad and \quad \widetilde{w}_i = \frac{\left[\sum_{h=1}^{H} x_h w_{ih}\right]}{\sum_{h=1}^{H} x_h}$$

In fact, the first term of the efficiency aspect of λ comprises $\frac{\tau_i}{1+\tau_i}$ which are the tax factors and ($\frac{\theta_i}{\widetilde{w}_i} - 1$) which are the own – commodity contributions to the tax distortion, i.e. the own price elasticities of quality and quantity together. The product of these two is referred to as own – price effect, that is, the effect that adds the contribution of the own – price effects to the measure of the distortion that would be caused by a marginal increase in price of good *i*. The second term of the λ denominator is called as cross – price effects which captures the effect on other goods (*k*) due to the change in tax on good *i* In sum, the denominator of λ shows the efficiency effects of raising taxes on each of the commodities in which nothing has as yet been said about distributional issues (e = 0). If this term is large (and negative) then it would be costly to further increase revenue through taxes on this commodity.

In addition, the numerator of the equation of λ which is an equity aspect in fact, is a pure distributional measure of the good *i* which can be varied according to a variation of the "inequality aversion" parameters, ε, focusing more on the poorer households. $w^{\varepsilon}/\widetilde{w}$ shows the relative budget share of an increasingly poor individual relative to a market – representative individual, moves away from luxuries and towards necessities as the distributional parameter (ε) increases. The higher the ε, the more attention is focused on the poorer, as ε = 0 means that there are no distributional concerns. In this case, the result will be optimal in efficiency rather than in equity. The aversion parameter can also be interpreted as the relative shares of the market-representative individual and the socially-representative individual whose income is lower, the higher the inequality aversion parameter ε.

As a decision rule, values of the computed lambdas (λ) have to be ranked from 1 (the lowest value) to 13 (the highest value) i.e. as many as the commodities observed. Rank 1 has the highest priority to increase the tax on the ranked commodity and rank 13 has the lowest.

Chapter 5
Empirical Results I: price elasticities

5.1 Introduction

Empirical results will be presented in two consecutive chapters: Chapters 5 and 6. Chapter 5 presents empirical results of price elasticities, whereas Chapter 6 will demonstrate tax reform analysis. Both of these chapters are based on the methodology that was first introduced in Chapter 2 and then discussed in more detail in Chapter 4.

The organisation of Chapter 5 is structured as follows. The introduction will be followed by Section 5.2 which discusses a preparatory analysis. This includes a discussion of the characteristics of key variables involved not only in demand analysis, but also in tax reform analysis. The discussion will also cover a test for the variable specification of either variable Z or Log of Z, applied both in Model I and II and utilising the Davidson and MacKinnon approach. Indonesian data is used for this approach. Section 5.3 presents price elasticity estimates derived from Model I following Deaton's three – stage procedure. Results of the current study are compared with previous studies Section 5.4 discusses price responses derived from Model II. A justification for using this as an alternative to Model I is discussed at the start of this section. The discussion will include income elasticities computation. Section 5.5 provides some concluding remarks.

5.2 Preparatory Analysis

Deaton (1997) observes that *larger demand systems are harder to deal with than small ones; the more goods, the greater the computational problem, and the harder it is to report the results* (p.316). Accordingly, many different issues could be explored but the preparatory analysis here will only focus on the following three issues:

(a) The Unit Value Index (the UVI) – see Section 5.2.1;

(b) Determining the best way to allow for other household characteristics / family size, 'David and MacKinnon' variable specification test for Z versus Ln Z – see Section 5.2.2; and

(c) Methods to correct for heteroscedasticity. To do so, the study utilises the SHAZAM package which is different from the package which most of previous studies utilised, viz: STATA.

After all preparations are done, this study starts to work with Models I and II (see Sections 5.3 and 5.4).

5.2.1 Estimating Unit Values

It is not possible to observe price as the SUSENAS of household survey data, which the present study relies on, does not include the market price. Accordingly, it is important to discuss unit value data (expenditure for a particular good divided by the quantity bought) in order to conduct Deaton's three-stage procedure in which two important equations of budget share and unit values are involved. Since many households did not fully report the quantity of commodities bought, unit values for some commodities could not be computed. In dealing with aggregated data, the present study utilises the unit value index (UVI) adopted from the study of Olivia and Gibson (2005) with some modification (for detailed discussion, see Chapter 4 of Methodology).

For the sake of convenience, a formula of the unit value index is represented as follows:

$$UV_i = lv_{hic} = \sum_{j=1}^{M} (E_j \big/ E_i) \ \ lv_{ji} \qquad \textbf{5-1}$$

Where,

UV_i is Unit Value Index for commodity group i

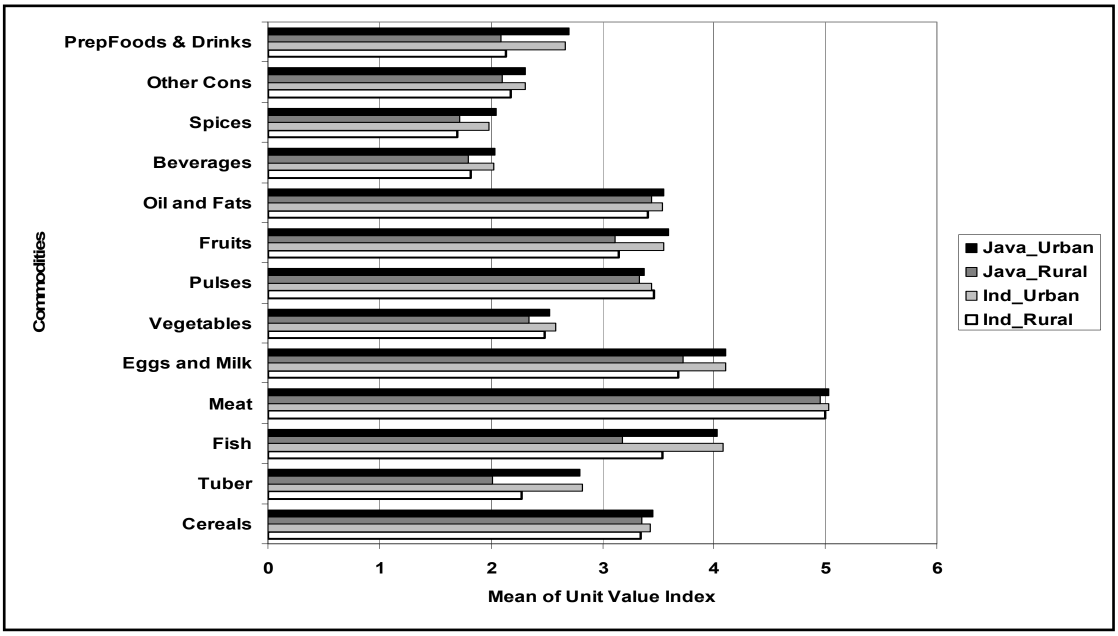
$\overline{w} = E_j / E_i$ = a ratio of the expenditure for each component of food - commodities in the group (sub – commodity j) to the expenditure for the aggregate commodity group i

lv_{ji} =Log of unit value for each component food commodity in the group (j) forming the aggregate commodity group (i)

Heterogeneity of the unit value of the 13 commodities observed can be depicted by their mean. As the mean of budget share for all categories has been discussed in Chapter 3, in this sub – section, only discusses the mean of UVI.

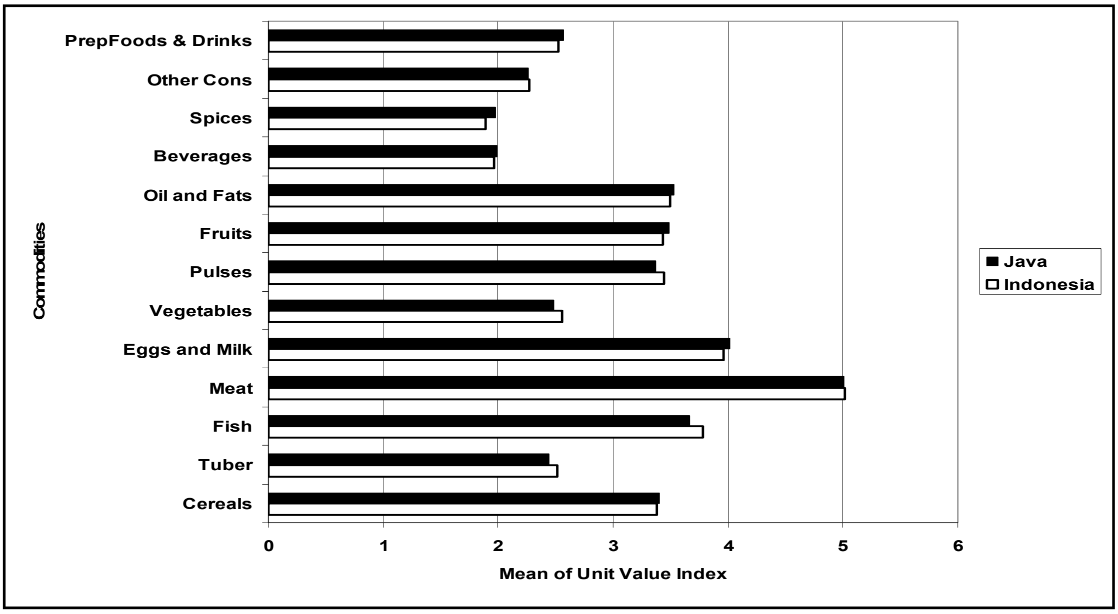
Figures 5-1, 5-2 and 5-3 depict the average UVI across the 13 commodity groups, not only according to urban or rural areas, low, middle, or high income groups, but also for Java in particular, and Indonesia in general.

Figure 5-1
Average of UVI for 13 commodities observed for
Urban and Rural Java, Urban and Rural Indonesia, 2002



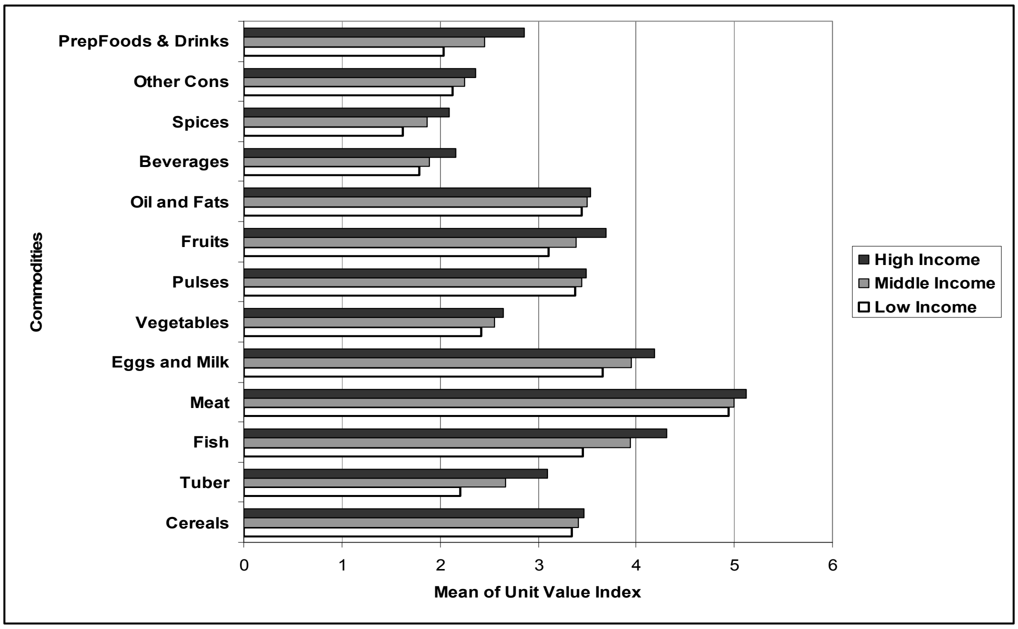
The study suggests that there is a significant variation in mean UVI for most commodities between urban and rural areas, whereas there is little or virtually no cross-regional variation: between Java and Indonesia. More specifically, UVIs for oils and fats, pulses, meats, and cereals demonstrate almost no variation across areas and regions. Other than in these commodities, the difference in UVI seems to be dictated by urban and rural areas where Eggs and milk and Fish are the greatest average UVI (see Figures 5-1 and 5-2).

Figure 5-2
Comparison of Average of UVI for 13 commodities observed between Javanese and Indonesian Households, 2002



In addition, across income groups, Figure 5-3 suggests that the richer the households the higher average UVI they have, with the UVI for Meat having the largest value; the UVIs associated with Spices and Beverages are the smallest (in particular those for the low and the middle income groups).

Figure 5-3
Average of UVI for 13 commodities observed according to income groups, 2002



These findings imply that UVI not only reflects, as predicted by Deaton (discussed in Chapter 4), unobservable prices, but also demonstrates consideration of quality. Accordingly, the rich have more purchasing options as they have fewer budgetary constraints, although the average UVI of oils and fats is homogeneous across all income groups, indicating that the level of household income does not affect their purchase. For a detailed description in number for these key variables see Appendix B.

5.2.2 Variable specification test

As suggested in Chapter 4 of Methodology, researchers are very often confronted with the fundamental problem of choosing between models in econometrics. The current study also faces the same problem of choosing between a model with log of family size (Z) or a model with only Z. Interestingly, the current study finds that the results of empirical analysis by using the Z-model (a model with Z as one of its explanatory variables) produce more plausible outcomes than the log of Z-model (a model with log of Z as one of its explanatory variables). The "Davidson and MacKinnon" non – nested model specification test has been carried out in order to ensure the correct selection of the models. A detailed procedure of the test can be found in Chapter 4.

The comprehensive models of Model I with a variant of Z variable, i.e., the model most used by the previous studies, are as follows:

H1: $$\begin{aligned} w_{1i} &= \beta_1^0 \ln X_h + \gamma_1^0 z_h + \lambda_1^0 \hat{w}_{1i} \\ \ln v_{1i} &= \beta_1^1 \ln X_h + \gamma_1^1 z_h + \lambda_1^1 \ln \hat{v}_{1i} \end{aligned}$$

and

H2: $$\begin{aligned} w_{2i} &= \beta_2^0 \ln X_h + \gamma_2^0 \ln z_h + \lambda_2^0 \hat{w}_{2i} \\ \ln v_{2i} &= \beta_2^1 \ln X_h + \gamma_2^1 \ln z_h + \lambda_2^1 \ln \hat{v}_{2i} \end{aligned}$$

This study also undertook a similar test for Model II, in which a variant of Model I added income as an explanatory variable, replacing total expenditure with total food expense, and replacing budget share as a share of total expense with budget share as a share of total food expense.

The comprehensive models of Model II with a variant of Z variable are as follows:

H3:
$$wf_{3i} = \beta_3^0 \ln TEF_h + \rho_3^0 \ln IC_h + \gamma_3^0 z_h + \lambda_3^0 \hat{w}f_{3i}$$
$$\ln v_{3i} = \beta_3^1 \ln TEF_h + \rho_3^1 \ln IC_h + \gamma_3^1 z_h + \lambda_3^1 \ln \hat{v}_{3i}$$

And

H4:
$$wf_{4i} = \beta_4^0 \ln TEF_h + \rho_4^0 \ln IC_h + \gamma_4^0 \ln z_h + \lambda_4^0 \hat{w}_{4i}$$
$$\ln v_{4i} = \beta_4^1 \ln TEF_h + \rho_4^1 \ln IC_h + \gamma_4^1 \ln z_h + \lambda_4^1 \ln \hat{v}_{4i}$$

Where λ_1, λ_2, λ_3 and λ_4 are the coefficients of the fitted values under H_1, H_2, H_3 and H_4, respectively, are both estimated.

The *J*-test is also applied by testing the mixing parameter, λ, for significance in each model.

In other words, the 'Davidson and MacKinnon' test was used to examine variable specification of the model with Z versus the one with log of Z. The proposed hypotheses are as follows:

- H1: Model I with Z versus H2: Model I with log of Z
- H3: Model II with Z versus H4: Model II with log of Z

By estimating the proposed models, it can be determined which is the best specification for variable "family size" (Z), namely the one which passes this Davidson and MacKinnon test and which also produces plausible own – price elasticities.

The Indonesian data has been employed to test both Models. The outcomes of the tests can be found in the following sub-sections. Sub-section 5.2.2.1 presents results from the Davidson and MacKinnon test for Model I whereas 5.2.2.2 presents the similar test for Model II.

5.2.2.1 Model I variable specification test: urban Indonesian case

Tables 5-1 and 5-2 report the results of the Davidson and MacKinnon test for Model I in which those tables demonstrate that neither model (Model I with Z and Model I with Log of Z) have significant t ratios for their predicted values of budget share and unit values. The outcome of the test infers that both models can be both accepted or rejected. This implies that, for the purpose of the current study, both models can be used for further econometric analysis. Thus, the Model with Z (as preferred and proposed by the present study) can be an alternative model for Model with log of Z which was mostly employed by the previous studies.

Table 5-1
Budget share and UV equations with predicted values for 13 commodities observed in Urban Indonesian Households (Model I with Log of Z)

	Budget share equation with predicted w							Unit value equation with predicted UV						
Commodities	LnX	t	LZ	t	Yhat*)	t	R^2	LnX	t	LZ	t	Yhat*)	t	R^2
Cereals	-0.188	- 0.011	0.193	0.011	- 2.673	- 0.011	0.436	3.408	0.055	- 2.225	- 0.055	- 64.125	- 0.055	0.030
Tuber	0.006	0.002	- 0.006	- 0.002	3.099	0.002	0.016	-0.495	- 0.004	0.270	0.004	3.182	0.004	0.030
Fish	-0.438	- 0.042	0.553	0.042	- 45.158	- 0.042	0.033	1.695	0.014	- 0.937	- 0.014	- 9.136	- 0.014	0.040
Meat	-0.966	- 0.086	0.078	0.086	83.104	0.086	0.035	8.904	0.127	- 4.691	- 0.127	- 152.430	- 0.127	0.014
Eggs & Milks	1.226	0.146	2.005	0.146	- 576.864	- 0.146	0.006	-25.230	- 0.131	3.145	0.131	686.631	0.131	0.002
Vegetables	0.052	0.006	- 0.038	- 0.006	2.351	0.006	0.187	8.339	0.152	- 1.343	- 0.152	- 551.925	- 0.152	0.002
Pulses	-0.042	- 0.008	0.029	0.008	- 4.013	- 0.008	0.105	0.518	0.007	- 0.243	- 0.007	- 17.421	- 0.007	0.004
Fruits	-0.246	- 0.031	0.201	0.031	45.778	0.031	0.013	4.942	0.060	- 3.016	- 0.060	- 49.295	- 0.060	0.030
Oils and Fats	0.254	0.078	- 0.174	- 0.078	27.566	0.078	0.160	23.659	0.547	22.457	0.547	5,716.755	0.547	- 0.000
Beverages	0.022	0.005	- 0.012	- 0.005	2.324	0.005	0.098	4.962	0.072	- 2.564	- 0.072	- 68.389	- 0.072	0.015
Spices	-0.102	- 0.036	0.057	0.036	- 17.542	- 0.036	0.106	0.618	0.006	- 0.250	- 0.006	- 7.311	- 0.006	0.014
Other Cons	-0.411	- 0.067	0.275	0.067	- 231.253	- 0.067	0.003	-15.306	- 0.191	7.016	0.191	432.586	0.191	0.005
Pfood & Drinks	0.039	0.076	6.643	0.076	130.082	0.076	0.076	-10.056	- 0.104	6.593	0.104	110.895	0.104	0.026
*) in 10X+E9														

Table 5-2
Budget share and UV equations with predicted values for 13 commodities observed in Urban Indonesian Households (Model I with Z)

	Budget share equation with predicted w							Unit value equation with predicted UV						
Commodities	LnX	t	Z	t	Yhat*)	t	R^2	LnX	t	Z	t	Yhat*)	t	R^2
Cereals	0.01	0.00	0.00	0.11	0.08	0.00	0.39	3.26	0.07	-0.59	-0.07	-63.92	-0.07	0.03
Tuber	-0.36	-0.15	0.11	0.15	-232.57	-0.15	0.01	2.69	0.02	-0.41	-0.02	-17.86	-0.02	0.03
Fish	-0.39	-0.03	0.13	0.03	-52.31	-0.03	0.02	9.46	0.04	-1.46	-0.04	-52.43	-0.04	0.04
Meat	-0.45	-0.04	0.03	0.04	34.88	0.04	0.04	2.07	0.02	-0.27	-0.02	-37.90	-0.02	0.01
Eggs & Milks	2.85	0.25	0.09	0.25	-735.07	-0.25	0.00	34.69	0.31	-0.32	-0.31	-998.76	-0.31	0.00
Vegetables	0.10	0.01	-0.02	-0.01	5.34	0.01	0.15	-2.62	-0.06	0.00	0.06	191.00	0.06	0.00
Pulses	0.05	0.01	-0.01	-0.01	5.15	0.01	0.09	2.11	0.04	-0.24	-0.04	-75.66	-0.04	0.00
Fruits	1.19	0.11	-0.29	-0.11	-220.07	-0.11	0.01	-0.26	0.00	0.04	0.00	2.76	0.00	0.03
Oils and Fats	0.27	0.08	-0.04	-0.08	33.42	0.08	0.13	10.13	0.22	0.73	0.22	1804.02	0.22	0.00
Beverages	-0.14	-0.03	0.02	0.11	-15.53	-0.03	0.09	7.53	0.08	-1.04	-0.08	-108.05	-0.08	0.01
Spices	-0.09	-0.04	0.01	0.11	-18.13	-0.04	0.09	0.22	0.00	-0.02	0.00	-2.74	0.00	0.01
Other Cons	2.08	0.30	-0.28	0.11	1403.91	0.30	0.00	-11.00	-0.13	1.31	0.13	324.76	0.13	0.01
Pfood & Drinks	3.01	0.11	1.75	0.11	215.39	0.11	0.05	-0.43	-0.01	0.07	0.01	5.07	0.01	0.02
*) in 10 X+E9														

It is important to note that the model with Z is preferable to Model with log of Z, as the model produces more robust own - price elasticities. This means that the expected sign of own-price elasticities for most commodities is negative, in particular for rural Indonesian cases, whereas in the case of urban Indonesia, only commodities, i.e. Fish, vegetables and fruits are 'giffen' good (positive sign). Table 5-3 provides detailed data for own price elasticities of 13 commodities observed by making use of Indonesian data with different Z variable specifications (Z versus log of Z).

Table 5-3
Own-Price Elasticities for 13 commodities observed in Indonesia by making use of Model I

Own Price Elasticities	MODEL I: w = f (ln X, ln Z)					
Commodities	**Az**	**Alz**	**Uz**	**Ulz**	**Rz**	**Rlz**
Cereals	-3.05	-2.78	-2.13	-1.98	-3.70	-3.59
Tuber	-1.83	-0.51	-1.58	2.81	-1.00	0.57
Fish	0.31	-0.25	0.03	0.25	-1.00	-0.17
Meat	-0.47	-0.55	-1.77	2.04	-1.00	-1.10
Egg&Milk	-0.36	-0.73	-2.90	3.42	-1.01	-1.19
Vegetables	-0.98	5.88	2.70	-4.01	-1.00	0.33
Pulses	-1.06	-1.54	-1.34	-0.74	-1.00	-0.91
Fruits	-0.68	-0.42	0.28	0.69	-0.99	0.93
Oil&fats	-1.02	-0.67	-1.01	-1.01	-1.00	-0.99
Beverages	-0.97	4.45	-1.63	-2.18	-1.00	0.06
Spices	-1.10	-2.87	-1.17	-0.15	-1.00	-0.99
Other Cons	-1.00	-2.07	-1.28	-1.28	-1.00	-1.03
PFoods&Drink	-1.11	-0.99	-1.42	-1.41	-1.39	-1.41

Note: Az (Data for all Indonesians with z variable) and Alz (Data for all Indonesians with log of z variable); Uz for urban Indonesians with z and Rz for rural Indonesians with z. The shaded areas are unexpected signs of own price elasticities (positive signs).

5.2.2.2 Model II variable specification test: urban Indonesia case

The Davidson and MacKinnon test was also undertaken for Model II, making use of urban Indonesian data. Table 5-4 and 5-5 provide a detailed analysis for this non-nested model test.

Table 5-4
Budget share and UV equations with predicted values for 13 commodities observed in Urban Indonesian Households (Model II with Log of Z)

Ln Z	Budget share equation with predicted w							Unit Value equation with predicted UV						
Commodities	Ln TEF*)	t	Ln Z*)	t	y0hat*)	t	R2	Ln TEF*)	t	Ln Z*)	t	y1hat*)	t	R2
Cereals	3.1	0.01	0.1	0.01	-16.8	-0.04	0.45	19.2	0.04	6.5	0.04	-3.1	-0.01	0.03
Tuber	2.1	0.05	-0.0	-0.05	25.0	0.02	0.01	-25.3	-0.02	-20.4	-0.02	-2.3	-0.05	0.03
Fish	3.6	0.02	-1.7	-0.02	-30.5	-0.03	0.02	35.7	0.03	18.5	0.03	-3.3	-0.02	0.04
Meat	-0.2	-0.00	-0.1	-0.00	21.0	0.04	0.08	-28.2	-0.04	-10.8	-0.04	0.1	0.00	0.01
Eggs & Milks	11.9	0.06	4.3	0.06	-11.1	-0.03	0.02	40.9	0.03	7.8	0.03	-2.5	-0.06	0.00
Vegetables	-1.7	-0.02	0.1	0.02	-10.4	-0.06	0.15	36.0	0.06	-3.8	-0.06	1.1	0.02	0.00
Pulses	0.9	0.01	0.0	0.01	42.5	0.10	0.08	-73.3	-0.10	-10.3	-0.10	-0.7	-0.01	0.00
Fruits	-2.4	-0.02	-3.0	-0.02	-53.4	-0.07	0.07	50.9	0.07	36.1	0.07	3.9	0.02	0.03
Oils and Fats	-0.1	-0.00	0.0	0.00	1.8	0.07	0.12	37.6	0.07	-12.5	-0.07	0.1	0.00	0.00
Beverages	-0.2	-0.00	0.0	0.00	63.0	0.09	0.05	-90.6	-0.09	-25.8	-0.09	0.1	0.00	0.02
Spices	0.5	0.01	-0.1	-0.01	6.1	0.01	0.07	-10.7	-0.01	-3.0	-0.01	-0.2	-0.01	0.02
Other Cons	342.5	2.97	-791.3	-2.97	36.3	0.08	0.00	-61.1	-0.08	-14.5	-0.08	208.8	2.97	0.00
Pfood & Drinks	-20.7	-0.04	0.4	0.04	16.6	0.02	0.13	-17.4	-0.02	-7.9	-0.02	35.3	0.04	0.03
*) in 10XE+8														

It is interesting to note that among 13 commodities observed and analysed, only model II with log of Z (in predicted value terms of their dependent variables) for ***Other consumptions*** (shaded cells) has significant coefficients for both equations involved. This means that Model II with Z for this commodity has been rejected by Model II with log of Z, for one of the 13 commodity groups.

Table 5-5
Budget share and UV equations with predicted values for 13 commodities observed in Urban Indonesian Households (Model II with Z)

Z	Budget share equation with predicted w							Unit Value equation with predicted UV						
Commodities	Ln TEF*)	t	Z*)	t	w0hat*)	t	R2	Ln TEF*)	t	Z*)	t	w1hat*)	t	R2
Cereals	0.3	0.01	0.0	-0.00	-0.1	-0.01	0.38	-0.3	-0.01	-0.1	-0.01	0.1	0.01	0.03
Tuber	0.7	0.16	-0.0	-0.16	-0.2	-0.16	0.01	-1.7	-0.02	-1.5	-0.02	0.5	0.02	0.03
Fish	2.3	0.11	-1.5	-0.11	-0.5	-0.11	0.01	-3.2	-0.01	-1.7	-0.01	0.8	0.01	0.04
Meat	0.4	0.02	0.2	0.02	-0.1	-0.02	0.09	-4.1	-0.06	-1.8	-0.06	0.8	0.06	0.01
Eggs & Milks	-1.0	-0.05	-0.3	-0.05	0.1	0.05	0.03	-39.9	-0.27	-8.4	-0.27	1.8	0.27	0.00
Vegetables	-0.3	-0.02	0.0	0.02	0.1	0.02	0.11	1.4	0.02	-0.2	-0.02	-0.1	-0.02	0.00
Pulses	0.1	0.01	0.0	0.01	-0.0	-0.01	0.06	-7.0	-0.10	-1.1	-0.10	1.0	0.10	0.00
Fruits	-0.3	-0.02	-0.3	-0.02	0.1	0.02	0.07	6.7	0.10	5.4	0.10	-2.0	-0.10	0.03
Oils and Fats	0.0	0.00	-0.0	-0.00	-0.0	-0.00	0.09	-5.0	-0.09	1.5	0.09	0.2	0.09	0.00
Beverages	0.4	0.05	-0.0	-0.00	-0.0	-0.05	0.05	-2.8	-0.04	-0.9	-0.04	0.5	0.04	0.02
Spices	-0.0	-0.00	0.0	-0.00	0.0	0.00	0.06	-4.4	-0.05	-1.4	-0.05	0.6	0.05	0.01
Other Cons	11.8	1.76	-61.2	-0.00	10.9	1.76	0.00	-11.8	-0.15	-3.0	-0.15	1.8	0.15	0.00
Pfood & Drinks	0.2	0.00	-0.0	-0.00	-0.1	-0.00	0.06	3.3	0.05	1.7	0.05	-0.9	-0.05	0.03
*) in 10XE+9														

However, considering that the present study deals with an entire system of demand, it is undesirable to use different functional forms for different commodity groups. Accordingly, this study uses Z. The justification for this is that both models, whether with Z or with log of Z, produce relatively robust outcomes of own price elasticities, i.e., the expected sign for the elasticities is negative, even though the absolute amount of the elasticities tends to be larger for those derived from Model II with Z than those with Log of Z.

Table 5-6
Own-Price Elasticities for 13 commodities observed in Indonesia by making use of Model II

Own Price Elasticities	MODEL II: wf = f(ln TEF, ln IC, z)					
Commodities	Az	Alz	Uz	Ulz	Rz	Rlz
Cereals	-4.58	-3.97	-4.36	-3.61	-5.79	-4.54
Tuber	-1.00	-1.00	-0.51	-0.26	-1.00	-1.00
Fish	-0.99	-0.99	-1.04	-1.01	-1.03	-1.04
Meat	-1.29	-1.17	-0.98	-0.99	-0.97	-0.98
Egg&Milk	-2.04	-1.73	-1.19	-0.77	-0.51	-0.29
Vegetables	-1.00	-1.00	-1.02	-1.09	-1.00	-1.00
Pulses	-1.00	-1.00	-0.97	-1.25	-0.85	-0.85
Fruits	-1.00	-1.00	-0.86	-0.85	-1.49	-1.16
Oil&fats	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Beverages	-1.00	-1.00	-0.98	-0.93	-1.00	-1.00
Spices	-1.00	-1.00	-0.99	-0.99	-1.00	-1.00
Other Cons	-1.00	-1.00	-0.96	-0.93	-1.20	-1.06
PFoods&Drink	-0.99	-0.99	-3.14	-1.26	-4.46	-2.89

5.1 Model I

This section discusses the outcomes of Deaton's three stage procedure in computing price elasticities and expenditure elasticities derived from Model I. Sub – section 5.3.1 presents the first stage estimates of the Deaton procedure. This stage demonstrates the expenditure elasticities for Indonesian households according to both income groups and areas. Sub – section 5.3.2 presents the second stage estimates of the procedure present price elasticities of the Indonesian households' demand according to both income groups and areas including Java. Sub – section 5.3.3 compares the outcomes of the study with those of the previous studies.

5.3.1 First stage estimates

The outcomes of the first stage estimates of Deaton's three stage procedure will be presented here in order to analyse expenditure elasticities both in terms of quantity and quality elasticities.

5.3.1.1 Expenditure Elasticities by Income groups

Tables 5-7, 5-8, and 5-9 present a series of coefficients from the corresponding within-village regressions for the budget shares and unit values (equation 4.2.1 and 4.2.2 See Chapter 4 for details). This sub-section focuses only on household behaviour according to income groups. The last two columns list the sample average of budget shares for each commodity and the total expenditure elasticities (EE $=(1-\beta_1^1)+\beta_1^0/\overline{w}_i)$.

Most studies use a magnitude of expenditure elasticities (EE) as an indicator for types of goods. The indicator has similar criteria to income elasticities which were derived from Model II and will be discussed in the later section.

The tables infer that the better-off the households, the smaller the budget share for Cereals, i.e. 6%, 13% and 20%, whereas the budget share for other commodities seems to be relatively similar across income groups. This empirical result confirms the outcomes of descriptive analysis discussed in Chapter 3. It is interesting to note that Prepared foods and drinks seem to have a larger budget share in urban areas than in rural areas, i.e. 12% and 6% respectively.

If there is a price increase, consumers adjust, not only by purchasing less, but also by purchasing lower – quality goods, thus spreading the consequences of the price increase over more than one dimension. In fact, if the response of quality to income is close to zero, it is also plausible that quality shading in response to price increases is also negligible.

Apart from Oil and fats, all the expenditure elasticities of quality (coefficient of expenditure from unit value equation) are positive. In fact, the Fish commodity has the highest quality elasticities; and the elasticities of 20% for middle income are the highest in either table. Cereals have small quality elasticities: 4 – 5%. This reflects price control for some components of Cereals in very low quality elasticities. The response of quality to family size is negative for all middle – income and high – income households (with the exception of Vegetables, and Eggs and milk). However, for low incomes, it seems that for some commodities, such as Meat, Eggs and milk, Vegetables, Oils and fats and Other consumptions, family size does not affect the quality elasticities. As was the case for the Engel curve, the elasticities with respect to family size tend to be large and negative when the elasticities on total expenditure are large and positive, suggesting that increases in family size act like reductions in income. Deaton's finding, suggesting that the estimated coefficients on household size are mostly smaller in absolute size than the coefficients on total expenditure are the result of the presence of economies of scale, has been confirmed for middle – and high – income households only, but is not relevant for low – income households. These results, as those of similar studies (Deaton, 1990, 1997), demonstrate that the quality effects in unit value are as expected, - with well – off households paying more per unit, - but that the size of these effects is fairly small.

Table 5-7
Budget share and UV equations for 13 commodities observed for low income group, 2002 (Derived from Model I)

	Budgetshare equation					Unit value Equation						
Comties	ln X	t	Z	t	R2	ln X	t	Z	t	R2	W	EE
Cereals	-0.10	-86.63	-0.01	105.73	0.32	0.05	21.01	0.03	-16.00	0.02	0.20	0.47
Tuber	-0.00	-13.16	-0.01	12.24	0.01	0.10	19.08	0.00	-9.00	0.01	0.01	0.48
Fish	-0.00	-6.32	-0.03	2.28	0.00	0.17	24.20	0.00	-15.50	0.01	0.06	0.77
Meat	0.02	38.94	-0.00	-21.03	0.04	0.01	3.70	-0.00	-1.67	-0.00	0.01	2.40
Egg & Milk	0.01	20.56	0.00	-13.31	0.01	0.01	2.91	-0.00	0.11	0.00	0.02	1.42
Vegetables	-0.02	-43.64	-0.00	23.78	0.08	0.00	2.15	0.00	-0.58	0.00	0.06	0.65
Pulses	-0.01	-21.76	-0.00	14.06	0.02	0.01	4.28	0.00	-2.85	0.00	0.02	0.65
Fruits	0.01	22.39	-0.00	-16.90	0.02	0.02	8.77	-0.00	-6.61	0.00	0.02	1.34
Oil & Fats	-0.01	-39.61	-0.00	19.68	0.07	-0.00	-0.62	0.00	-0.15	0.00	0.03	0.66
Beverages	-0.01	-27.19	-0.00	9.34	0.03	0.01	4.34	0.00	-2.05	0.00	0.04	0.75
Spices	-0.01	-32.45	-0.00	8.45	0.06	0.01	6.47	0.00	-4.15	0.00	0.02	0.67
Other Cons	0.00	10.61	0.00	-6.94	0.00	0.00	1.62	-0.00	0.38	0.00	0.01	1.25
Pfood&Drink	0.01	4.56	-0.00	-19.92	0.02	0.02	8.26	-0.01	-4.32	0.00	0.08	1.09

It is true that it is possible to find very expensive and very cheap varieties within any commodity group so that most people will purchase a range of qualities, so there would be a large difference if rich households were to spend twice as much as poor households, even for a heterogeneous commodity such as meat.

Although the quality effects on unit values are relatively small, it is wise to be cautious about treating unit values as if they were prices. Any positive effect of incomes on unit values will cause price response to be (absolutely) overstated. The higher prices result in consumers shading down the quality.

Table 5-8
Budget share and UV equations for 13 commodities observed for middle income group, 2002 (Derived from Model I)

	Budgetshare equation					Unit value Equation						
Comties	ln X	t	Z	t	R2	ln X	t	Z	t	R2	W	EE
Cereals	- 0.09	- 103.35	0.02	104.08	0.46	0.05	21.11	- 0.01	- 15.78	0.24	0.13	0.24
Tuber	- 0.00	- 18.01	0.00	13.67	0.01	0.16	20.67	- 0.02	- 14.91	0.35	0.01	0.35
Fish	- 0.01	- 13.52	0.00	13.27	0.01	0.20	24.06	- 0.03	- 15.65	0.66	0.06	0.66
Meat	0.02	30.80	- 0.00	- 15.80	0.04	0.04	11.87	- 0.01	- 8.58	1.71	0.03	1.71
Egg & Milk	0.01	14.07	- 0.00	- 7.57	0.00	0.03	3.96	- 0.00	- 0.31	1.25	0.03	1.25
Vegetables	- 0.02	- 58.53	0.00	35.35	0.14	0.02	6.47	- 0.00	- 1.66	0.50	0.05	0.50
Pulses	- 0.01	- 32.26	0.00	23.14	0.05	0.03	8.56	- 0.00	- 5.81	0.45	0.02	0.45
Fruits	0.01	15.56	- 0.00	- 15.75	0.01	0.08	18.32	- 0.01	- 13.02	1.18	0.03	1.18
Oil & Fats	- 0.01	- 62.29	0.00	30.96	0.14	- 0.00	- 0.31	- 0.00	- 1.65	0.47	0.02	0.47
Beverages	- 0.01	- 46.77	0.00	26.36	0.08	0.04	10.17	- 0.01	- 8.99	0.55	0.03	0.55
Spices	- 0.01	- 44.55	0.00	14.88	0.08	0.09	16.83	- 0.01	- 8.11	0.46	0.01	0.46
Other Cons	0.00	0.93	0.00	0.27	- 0.00	0.03	7.66	- 0.00	- 4.02	0.99	0.01	0.99
Pfood&Drink	0.00	1.90	- 0.01	- 16.38	0.02	0.09	18.92	- 0.01	- 13.40	0.94	0.10	0.94

Table 5-9
Budget share and UV equations for 13 commodities observed for high income group, 2002 (Derived from Model I)

	Budgetshare equation					Unit value Equation						
Comties	Ln X	t	Z	t	R2	Ln X	t	Z	t	R2	W	EE
Cereals	- 0.06	- 72.63	0.01	47.60	0.48	0.04	19.24	- 0.01	- 6.80	0.02	0.06	0.03
Tuber	- 0.00	- 22.48	0.00	9.85	0.03	0.14	17.79	- 0.02	- 6.43	0.02	0.00	0.27
Fish	- 0.01	- 19.75	0.00	15.08	0.06	0.17	21.77	- 0.02	- 8.17	0.03	0.04	0.57
Meat	0.01	12.03	0.00	4.01	- 0.01	0.06	14.44	- 0.00	- 2.49	0.01	0.03	1.14
Egg & Milk	- 0.00	- 0.57	0.00	5.21	0.00	0.06	6.22	0.00	0.80	0.00	0.03	0.93
Vegetables	- 0.02	- 60.79	0.00	23.22	0.27	0.02	5.75	0.00	2.71	0.00	0.03	0.34
Pulses	- 0.01	- 40.44	0.00	16.90	0.13	0.03	8.01	- 0.00	- 0.65	0.00	0.01	0.23
Fruits	0.00	3.46	- 0.00	- 2.00	- 0.00	0.12	21.12	- 0.02	- 8.90	0.04	0.03	0.93
Oil & Fats	- 0.01	- 57.49	0.00	20.17	0.22	- 0.00	- 1.21	- 0.00	- 1.16	0.00	0.01	0.35
Beverages	- 0.01	- 45.02	0.00	16.80	0.14	0.09	13.92	- 0.01	- 3.40	0.02	0.02	0.35
Spices	- 0.01	- 52.05	0.00	12.19	0.15	0.11	17.48	- 0.00	- 0.34	0.02	0.01	0.33
Other Cons	- 0.00	- 11.99	0.00	5.49	0.01	0.04	9.54	- 0.00	- 2.72	0.01	0.01	0.74
Pfood&Drink	- 0.02	- 16.93	- 0.00	- 2.67	0.04	0.11	18.86	- 0.01	- 6.88	0.03	0.10	0.67

5.3.1.2 Expenditure Elasticities by Area (Urban and Rural)

Similar findings by income groups discussed in the previous sub-section are also reflected in urban and rural household behaviour. Except for oils and fats, the negative relationship between the coefficients of total expenditure (Ln *X*) and family size (Z) has been confirmed.

Table 5-10
Budget share and UV equations for 13 commodities observed In Urban Indonesia, 2002 (Derived from Model I)

	Budget share equation					Unit value Equation						
Comties	**ln X**	**t**	**Z**	**t**	**R2**	**ln X**	**t**	**Z**	**t**	**R2**	**W**	**EE**
Cereals	-0.06	-91.49	0.02	94.58	0.39	0.05	26.77	-0.01	-16.99	0.03	0.10	0.33
Tuber	-0.00	-17.94	0.00	18.13	0.01	0.15	27.49	-0.02	-14.89	0.03	0.00	0.50
Fish	-0.01	-18.47	0.00	21.07	0.02	0.18	31.24	-0.03	-17.76	0.04	0.05	0.66
Meat	0.01	28.99	-0.00	-7.15	0.04	0.05	18.19	-0.01	-8.52	0.01	0.03	1.42
Egg & Milk	0.00	8.37	0.00	1.06	0.00	0.03	5.84	-0.00	-0.21	0.00	0.03	1.09
Vegetables	-0.02	-61.81	0.00	40.99	0.15	0.01	6.84	-0.00	-0.03	0.00	0.04	0.54
Pulses	-0.01	-42.70	0.00	31.85	0.09	0.03	9.73	-0.00	-4.04	0.00	0.02	0.43
Fruits	0.01	17.72	-0.00	-16.01	0.01	0.09	25.89	-0.02	-15.83	0.03	0.02	1.13
Oil & Fats	-0.01	-57.82	0.00	36.67	0.13	-0.01	-2.55	-0.00	-0.69	-0.00	0.02	0.55
Beverages	-0.01	-48.31	0.00	25.32	0.09	0.07	16.83	-0.01	-9.84	0.01	0.02	0.54
Spices	-0.01	-47.46	0.00	21.27	0.09	0.08	19.94	-0.01	-7.05	0.01	0.01	0.52
Other Cons	-0.00	-7.76	0.00	3.74	0.00	0.03	11.34	-0.00	-5.09	0.01	0.01	0.85
Pfood&Drink	-0.01	-10.00	-0.01	-21.62	0.05	0.08	23.58	-0.01	-14.54	0.02	0.12	0.80

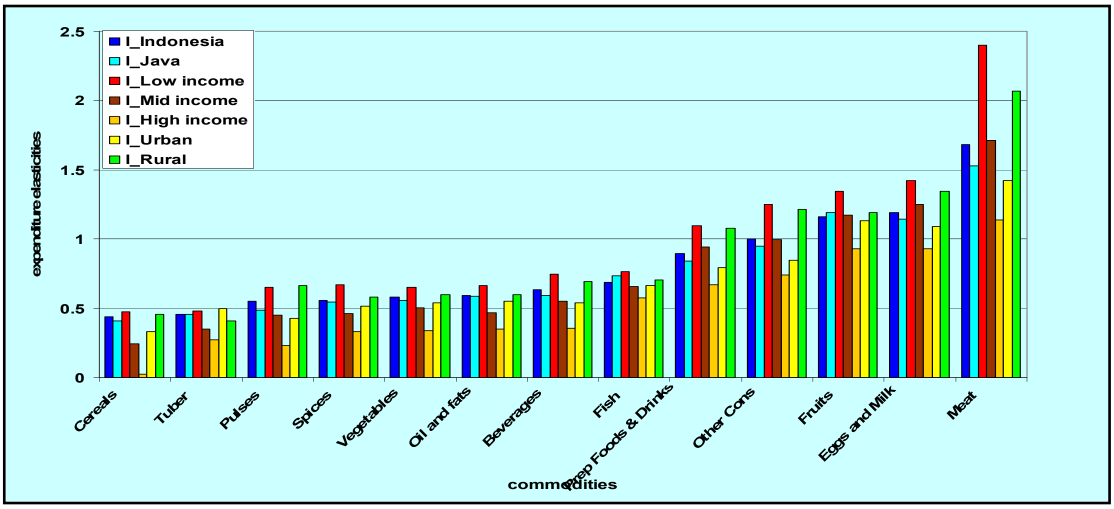
From Tables 5.10 and 5.11 it can be inferred that a difference of consumption behaviour between urban and rural has been driven by positive β^0 coefficients. These indicate that budget shares of the following commodities: Meat, Eggs and milk, Fruits, Other consumptions and Prepared foods and drinks rise as household expenditures increase. The descriptive charts in Chapter 3 are somewhat inclusive – without data on price, household characteristics (e.g. family size) there is not enough evidence to conclusively determine which goods were normal or otherwise. It was only possible to identify groups which were likely to belong to different categories. However, here we are able to control for price, village and family size, and can therefore formally identify those types of the commodity groups. More luxuries are found in rural areas than in urban, namely, Meat, Eggs and milk and Fruits in urban areas whereas in rural areas similar commodities plus Other consumptions and Prepared foods and drinks as their total expenditure elasticities are greater than one. In the meantime, the negative relationship between total expenditure and family size is also confirmed in urban and rural cases.

Table 5-11
Budget share and UV equations for 13 commodities observed In Rural Indonesia, 2002 (Derived from Model I)

	Budget share equation					Unit value Equation						
Comties	ln X	t	Z	t	R2	ln X	t	Z	t	R2	W	EE
Cereals	- 0.10	- 108.25	0.03	114.76	0.38	0.05	22.99	- 0.01	- 16.27	0.02	0.20	0.46
Tuber	- 0.00	- 19.57	0.00	14.57	0.02	0.11	19.82	- 0.02	- 10.92	0.01	0.01	0.41
Fish	- 0.01	- 13.51	0.00	5.06	0.01	0.17	26.01	- 0.03	- 15.94	0.02	0.06	0.71
Meat	0.02	35.72	- 0.00	- 20.43	0.04	0.01	6.88	- 0.00	- 4.38	0.00	0.02	2.07
Egg & Milk	0.01	20.25	- 0.00	- 14.40	0.01	0.03	5.28	- 0.00	- 0.76	0.00	0.02	1.34
Vegetables	- 0.02	- 61.52	0.00	27.52	0.15	0.01	5.31	- 0.00	- 0.95	0.00	0.06	0.60
Pulses	- 0.01	- 24.19	0.00	12.27	0.03	0.02	7.93	- 0.00	- 5.41	0.00	0.02	0.66
Fruits	0.01	15.26	- 0.00	- 11.79	0.01	0.04	13.84	- 0.01	- 10.42	0.01	0.02	1.19
Oil & Fats	- 0.01	- 57.49	0.00	22.54	0.14	0.00	1.60	- 0.00	- 2.04	0.00	0.03	0.60
Beverages	- 0.01	- 39.54	0.00	16.76	0.06	0.01	6.07	- 0.00	- 4.27	0.00	0.04	0.69
Spices	- 0.01	- 47.45	0.00	8.19	0.10	0.05	14.60	- 0.01	- 7.26	0.01	0.02	0.58
Other Cons	0.00	11.51	- 0.00	- 5.41	0.00	0.01	4.98	- 0.00	- 2.31	0.00	0.01	1.22
Pfood&Drink	0.01	6.06	- 0.00	- 10.92	0.00	0.05	15.21	- 0.01	- 9.16	0.01	0.06	1.08

As Figure 5.4 demonstrates, in general, except for the high- income group, demands for fruits, eggs and milk, and meat are the most expenditure elastic; all three commodity groups have expenditure elasticities which are larger than one.

Figure 5-4
Expenditure Elasticities of 13 commodities observed across income groups, areas and regions derived from Model I, 2002



Sources: Tables 5-7 – 5-11 of column EE

5.3.2 Second Stage Estimates: Quantity and quality price-elasticities

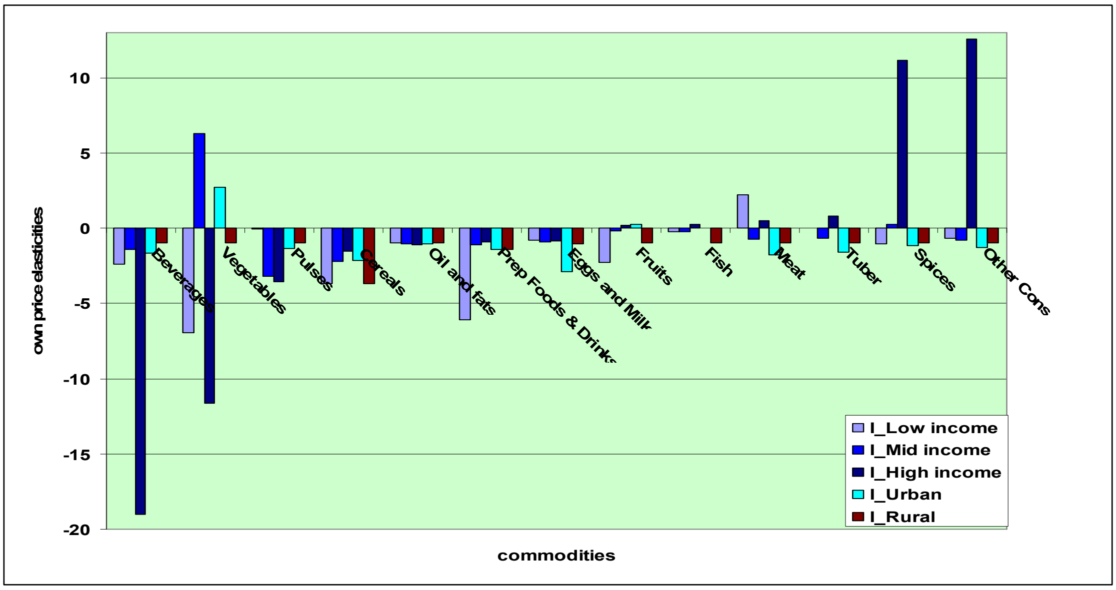
The second stage estimates produce complete sets of own – and cross price elasticities not only by income groups but also by areas, both for Javanese and Indonesian households (see Tables 5-12, 5-13, 5-14 and Figure 5-5).

More specifically, Table 5-12 suggests that in general, own price elasticity for Cereals is more elastic in rural than in urban Java (-4.44 versus -2.48 respectively) than in urban Java, whereas the magnitude of those for Tuber is the other way round (-22.32 for urban Java versus -3.36 for rural Java). In urban Java, demands for Tuber, Meat, Fish, Eggs and milk, Fruits, Beverages, Other consumptions and Prepared foods and drinks are categorised as price elastic, with Tuber, Fish, Fruits, and Meat as the most elastic, whereas in rural Java Tuber, Fruits and Prepared foods and drinks are the most price elastic.

Table 5-13 suggests the findings from Java cases are also confirmed in Indonesian cases. Own price elasticity for Cereals in rural areas is more elastic than that in urban areas, i.e. – 3.70 and – 2.13 respectively. Interestingly, the demands for commodities such as Meat, Tuber, Eggs and milk, Pulses, Beverages and prepared foods are price elastic in urban cases whereas in rural cases many close to unitary, with the exception of demand for Prepared foods and drinks.

Table 5-14 attempts to identify the difference of own price elasticities more accurately according to their level of incomes. The table suggests that across income groups, demand for Cereals is price elastic, but the absolute amounts decline as incomes increase, i.e. -3.68 for low income, -2.22 for middle income and -1.52 high income groups. More specifically, demands for Vegetables, Fruits, Beverages and Prepared foods and drinks are price elastic for low income groups, whereas the demands for Pulses, Beverages and prepared foods are for middle income groups (but less elastic than the low income groups) and the demands for Vegetables and Beverages are for high income groups. It is interesting to note that demands for Oil and fats are almost unit elastic but there is a tendency for demand to become more price elastic as income increases. Demand for Prepared foods and drinks are price elastic for the low income –, less elastic for middle income – but inelastic to unitary for high income households.

Figure 5-5
Own Price Elasticities of 13 commodities observed across income groups and areas derived from Model I, 2002



In terms of own price elasticities, the findings of the study suggest that the demand for Cereals and Prepared foods and drinks have the highest price elasticity compared to the other commodities, disregarding not only the categories they belong to: urban or rural, low or middle income but also the models they are derived from. More specifically, Model I suggests that the demand for Vegetables and Beverages have the most price elastic for high income groups, whereas Eggs and milk are the most price elastic in urban areas and Cereals are the most price elastic in rural areas.

Table 5-12

Own – and Cross – Price Elasticities of 13 Commodities observed according to income groups derived from Model I

Price Elasticities for Low Income Group (Model I)													
Commodities	**Cereals**	**Tuber**	**Fish**	**Meat**	**Egg&Milk**	**Vegetables**	**Pulses**	**Fruits**	**Oil&fats**	**Beverages**	**Spices**	**Other Cons**	**PFoods&Drink**
Cereals	-3.68	0.07	0.00	1.72	-0.05	1.82	1.21	0.28	0.06	0.04	0.04	0.49	-0.41
Tuber	-0.10	0.02	0.01	-3.76	-0.04	-22.72	-19.21	5.76	-0.60	-1.18	-0.75	-3.74	-0.33
Fish	-0.03	-0.22	-0.25	-1.51	-0.03	-4.74	-2.13	0.06	-0.11	-0.03	-0.06	-0.76	0.77
Meat	0.03	0.04	-0.02	2.21	0.02	4.72	4.49	-1.60	0.15	0.24	0.14	0.92	-0.09
Egg&Milk	0.02	0.01	-0.01	0.45	-0.79	2.86	1.54	1.28	0.06	-0.05	0.09	1.21	-0.71
Vegetables	0.06	0.09	0.07	1.08	0.05	-6.95	-5.26	1.10	-0.17	-0.33	-0.28	-0.70	-0.24
Pulses	0.01	0.08	0.00	2.27	-0.04	0.06	-0.07	0.34	-0.02	-0.07	-0.02	0.37	-0.35
Fruits	-0.01	-0.05	0.01	-1.37	0.05	-2.04	-1.31	-2.25	-0.09	0.02	-0.06	-0.75	0.45
Oil&fats	0.02	0.01	0.00	0.29	-0.03	-0.26	-0.22	0.40	-1.00	-0.04	-0.10	0.30	-0.08
Beverages	-0.01	0.20	0.02	1.68	-1.76	-16.14	-14.36	12.86	0.01	-2.40	-0.78	-0.85	-4.09
Spices	0.00	0.00	0.00	-0.03	-0.03	-0.24	-0.23	0.22	0.05	0.09	-1.01	-0.12	-0.05
Other Cons	0.00	0.01	0.00	0.08	0.05	0.16	0.11	-0.25	0.02	0.01	0.02	-0.67	-0.03
PFoods&Drink	0.00	-0.04	0.02	-2.21	-1.19	-11.83	-10.13	10.00	-0.80	-1.20	-0.55	-1.55	-6.08
Price Elasticities for Middle Income Group (Model I)													
Commodities	**Cereals**	**Tuber**	**Fish**	**Meat**	**Egg&Milk**	**Vegetables**	**Pulses**	**Fruits**	**Oil&fats**	**Beverages**	**Spices**	**Other Cons**	**PFoods&Drink**
Cereals	- 2.22	0.02	0.00	- 0.04	0.01	0.37	- 0.31	0.00	- 0.02	- 0.07	0.00	- 0.22	0.02
Tuber	- 0.44	- 0.64	- 0.12	1.89	0.58	- 13.21	8.61	0.16	0.22	1.75	- 0.18	4.72	- 0.50
Fish	- 0.02	- 0.15	- 0.22	0.16	0.12	- 0.68	0.21	0.01	0.04	0.15	- 0.00	0.60	- 0.04
Meat	0.03	0.07	0.00	- 0.70	- 0.08	1.04	- 0.66	- 0.01	0.00	- 0.12	0.02	- 0.31	0.04
Egg&Milk	0.00	0.02	0.00	- 0.08	- 0.92	0.12	- 0.15	- 0.00	0.01	- 0.02	0.00	0.02	0.01
Vegetables	0.24	0.26	0.01	- 0.45	0.30	6.27	- 5.55	0.02	- 0.29	- 1.15	0.06	- 3.46	0.28
Pulses	0.14	0.20	- 0.00	- 0.37	0.04	5.74	- 3.18	- 0.03	0.07	- 0.35	0.06	- 0.31	0.11
Fruits	0.02	0.04	0.00	- 0.10	- 0.01	0.63	- 0.54	- 0.16	- 0.06	- 0.19	0.03	- 0.70	0.05
Oil&fats	0.02	0.03	0.00	- 0.05	0.03	0.64	- 0.08	- 0.02	- 1.05	- 0.15	- 0.00	- 0.16	0.04
Beverages	0.24	0.30	0.03	- 0.33	0.17	9.67	- 1.12	- 0.21	- 0.00	- 1.43	0.32	- 0.13	0.35
Spices	0.71	0.94	0.08	- 0.86	0.58	31.36	- 3.33	- 0.65	- 0.42	- 2.81	0.24	0.35	1.19
Other Cons	0.15	0.17	0.01	- 0.25	0.16	5.22	- 0.24	- 0.15	0.10	- 0.18	0.11	- 0.79	0.08
PFoods&Drink	- 0.01	- 0.02	- 0.00	0.02	- 0.00	- 0.48	0.15	0.01	- 0.00	0.04	- 0.01	0.06	- 1.10
Price Elasticities for High Income Group (Model I)													
Commodities	**Cereals**	**Tuber**	**Fish**	**Meat**	**Egg&Milk**	**Vegetables**	**Pulses**	**Fruits**	**Oil&fats**	**Beverages**	**Spices**	**Other Cons**	**PFoods&Drink**
Cereals	- 1.52	0.08	0.01	- 0.09	0.03	0.71	- 0.19	- 0.02	- 0.04	- 0.11	0.05	0.24	0.09
Tuber	- 0.81	0.79	0.09	- 0.79	1.36	17.96	- 3.70	- 0.10	- 1.14	- 2.62	1.73	4.38	2.36
Fish	- 0.88	2.15	0.27	- 2.97	0.94	23.86	- 6.20	- 0.49	- 1.19	- 3.47	1.96	7.17	3.01
Meat	0.28	- 0.69	- 0.14	0.51	- 0.46	- 8.28	2.18	0.13	0.51	1.31	- 0.74	- 2.37	- 1.15
Egg&Milk	0.30	- 0.62	- 0.10	0.75	- 0.83	- 9.55	2.28	0.09	0.64	1.57	- 0.92	- 2.13	- 1.35
Vegetables	0.32	- 1.07	- 0.14	1.25	- 0.47	- 11.63	2.95	0.18	0.60	1.67	- 0.95	- 3.19	- 1.46
Pulses	- 0.22	0.89	0.10	- 1.06	0.24	8.53	- 3.53	- 0.12	- 0.40	- 1.26	0.66	2.47	1.05
Fruits	0.51	- 1.60	- 0.26	1.97	- 0.92	- 17.31	5.12	0.21	1.08	2.83	- 1.57	- 4.65	- 2.46
Oil&fats	- 0.08	0.13	0.03	- 0.20	0.08	1.82	- 0.37	- 0.04	- 1.11	- 0.26	0.14	0.44	0.21
Beverages	- 4.81	12.46	2.02	- 15.88	4.79	140.84	- 31.62	- 2.94	- 6.23	- 19.03	10.92	42.98	16.31
Spices	- 5.37	13.75	2.21	- 17.43	5.27	155.88	- 35.01	- 3.24	- 7.16	- 21.05	11.17	48.15	18.03
Other Cons	- 1.47	4.36	0.65	- 5.41	2.04	48.83	- 12.07	- 0.85	- 2.49	- 7.01	4.08	12.60	6.08
PFoods&Drink	0.02	- 0.02	- 0.00	0.02	- 0.03	- 0.16	0.11	- 0.00	0.03	0.06	- 0.03	- 0.02	- 0.94

Table 5-13

Own – and – Cross Price Elasticities of 13 commodities observed in Indonesia according to areas derived from Model I

Price Elasticities for Indonesia_Urban (Model I)													
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cons	PFoods&Drink
Cereals	-2.13	0.01	0.00	-0.02	0.04	0.04	0.01	0.00	0.01	0.01	0.00	0.02	-0.01
Tuber	-0.33	-1.58	-0.85	9.15	-9.80	14.07	4.24	-0.29	-0.31	0.20	1.06	-0.50	0.44
Fish	-0.02	-0.86	0.03	1.23	-2.65	2.11	0.72	-0.52	-0.03	0.06	0.20	-0.06	0.08
Meat	0.03	0.52	0.06	-1.77	2.29	-3.14	-1.11	0.26	0.02	-0.12	-0.19	-0.05	-0.03
Egg&Milk	-0.04	-0.29	-0.08	1.24	-2.90	2.39	0.71	-0.17	-0.01	0.06	0.16	-0.02	0.03
Vegetables	0.00	-0.43	-0.07	1.73	-2.42	2.70	0.94	-0.28	-0.03	0.09	0.23	0.06	0.05
Pulses	0.00	0.10	0.01	-0.41	0.53	-0.69	-1.34	0.07	0.01	-0.02	-0.06	-0.03	-0.02
Fruits	-0.04	0.00	-0.11	0.65	-0.86	1.51	0.31	0.28	-0.10	-0.12	0.14	-0.17	0.14
Oil&fats	0.00	-0.06	-0.01	0.22	-0.34	0.50	0.18	-0.04	-1.01	-0.01	0.01	0.00	0.01
Beverages	0.11	1.10	0.25	-4.26	5.13	-7.42	-3.10	0.49	-0.33	-1.63	-0.22	-1.27	0.76
Spices	0.08	0.92	0.20	-3.56	4.50	-6.29	-2.50	0.40	-0.31	-1.09	-1.17	-0.40	0.54
Other Cons	0.00	0.00	0.01	-0.07	0.04	-0.20	-0.13	-0.01	-0.02	-0.05	0.00	-1.28	0.00
PFoods&Drink	-0.04	-0.09	-0.02	0.32	-0.37	0.54	0.25	-0.05	0.01	0.06	0.02	0.09	-1.42
Price Elasticities for Indonesia_Rural (Model I)													
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cons	PFoods&Drink
Cereals	- 3.70	0.00	0.00	0.00	- 0.00	0.00	- 0.00	0.00	0.00	- 0.00	0.00	- 0.02	0.02
Tuber	3.85	- 1.00	- 0.01	0.01	0.00	- 0.00	0.00	0.01	0.00	- 0.01	0.00	- 0.55	0.55
Fish	2.56	0.00	- 1.00	- 0.20	0.21	0.00	0.00	- 0.01	- 0.00	0.01	- 0.00	0.42	- 0.42
Meat	0.03	- 0.00	0.00	- 1.00	- 0.00	0.00	0.00	0.00	0.00	- 0.00	0.00	- 0.02	0.02
Egg&Milk	- 0.06	0.00	0.01	0.00	- 1.01	0.00	- 0.00	- 0.00	- 0.00	0.00	- 0.00	0.01	- 0.01
Vegetables	0.24	0.00	- 0.00	- 0.01	0.01	- 1.00	0.00	0.00	0.00	- 0.00	0.00	- 0.10	0.10
Pulses	- 0.05	0.00	0.00	- 0.00	- 0.00	0.00	- 1.00	- 0.00	- 0.00	0.00	0.00	- 0.00	0.00
Fruits	1.71	- 0.00	- 0.00	- 0.01	0.01	- 0.00	0.00	- 0.99	0.00	- 0.01	0.00	- 0.21	0.21
Oil&fats	- 0.23	0.00	0.00	0.00	- 0.00	0.00	- 0.00	- 0.00	- 1.00	0.00	- 0.00	- 0.02	0.02
Beverages	2.07	- 0.00	- 0.00	- 0.00	0.01	- 0.00	0.00	0.00	0.00	- 1.00	- 0.00	0.10	- 0.10
Spices	- 1.63	0.00	0.00	0.01	- 0.02	0.00	- 0.00	- 0.01	- 0.00	0.01	- 1.00	0.75	- 0.75
Other Cons	0.00	- 0.00	0.00	0.00	- 0.00	- 0.00	0.00	- 0.00	- 0.00	0.00	- 0.00	- 1.00	- 0.00
PFoods&Drink	0.58	- 0.00	- 0.00	- 0.00	0.00	- 0.00	- 0.00	- 0.00	- 0.00	0.00	- 0.00	0.40	- 1.39
Price Elasticities for Indonesia_All (Model I)													
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cons	PFoods&Drink
Cereals	-3.05	-0.01	-0.01	0.02	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tuber	-1.35	-1.83	-1.67	7.93	-7.60	-0.33	1.56	-1.10	-0.31	0.74	-0.15	0.00	-0.73
Fish	0.39	0.26	0.31	-2.87	2.72	0.15	-0.46	0.32	0.09	-0.21	0.04	0.00	0.21
Meat	-0.04	-0.04	-0.06	-0.47	-0.52	0.00	0.07	-0.06	-0.01	0.02	-0.01	0.00	-0.02
Egg&Milk	0.06	0.03	0.11	-0.67	-0.36	0.03	-0.07	0.05	0.01	-0.03	0.01	0.00	0.03
Vegetables	0.08	0.00	0.08	-0.36	0.34	-0.98	0.01	-0.02	0.01	-0.02	0.00	0.00	0.02
Pulses	0.03	0.02	0.04	-0.20	0.19	0.01	-1.06	0.05	0.01	-0.02	0.00	0.00	0.02
Fruits	-0.46	-0.23	-0.59	2.81	-2.63	-0.19	-0.16	-0.68	-0.10	0.26	-0.05	0.00	-0.25
Oil&fats	-0.08	-0.04	-0.11	0.50	-0.47	-0.03	0.19	-0.16	-1.02	0.05	-0.01	0.00	-0.05
Beverages	-0.06	-0.03	-0.07	0.35	-0.33	-0.02	0.12	-0.10	-0.02	-0.97	0.00	0.00	-0.03
Spices	-1.11	-0.55	-1.40	6.96	-6.54	-0.42	2.35	-1.98	-0.26	0.63	-1.10	0.00	-0.63
Other Cons	0.01	0.00	0.01	-0.04	0.04	0.00	0.02	-0.02	0.00	0.00	0.00	-1.00	0.00
PFoods&Drink	-0.20	-0.11	-0.25	1.31	-1.23	-0.08	0.37	-0.31	-0.05	0.11	-0.01	0.00	-1.11

Table 5-14

Own – and – Cross Price Elasticities of 13 commodities observed in Java according to areas derived from Model I

Price Elasticities for Java_Urban (Model I)												
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cor
Cereals	-2.48	-0.04	0.05	-0.09	0.01	0.03	0.01	-0.11	0.01	0.03	0.00	0.
Tuber	1.80	-24.32	22.65	-38.91	-3.62	-15.16	2.60	-37.85	0.50	7.36	-1.09	4.
Fish	-2.14	24.71	-23.41	43.25	3.15	15.50	-2.73	39.39	-0.75	-7.88	1.41	-5.
Meat	0.31	-3.84	3.84	-7.11	-0.34	-3.20	0.06	-6.32	0.12	1.24	-0.23	0.
Egg&Milk	-0.01	-0.29	0.25	-0.31	-1.22	-0.03	0.07	-0.54	0.02	0.08	0.00	0.
Vegetables	0.03	0.24	-0.23	0.64	-0.04	-0.51	-0.04	0.29	-0.01	-0.09	0.04	-0.01
Pulses	0.01	-0.07	0.07	-0.22	0.01	-0.05	-1.07	-0.11	0.01	0.03	-0.02	0.
Fruits	0.52	-6.76	6.41	-11.92	-1.30	-3.40	0.67	-9.29	0.04	1.84	-0.22	1.
Oil&fats	0.01	-0.02	0.01	0.00	-0.02	0.04	0.03	-0.06	-1.00	0.01	-0.01	0.
Beverages	-0.20	4.33	-3.95	6.39	0.59	2.66	-0.67	6.73	-0.36	-2.60	0.35	-1.
Spices	-0.08	1.70	-1.55	2.48	0.30	1.01	-0.26	2.57	-0.18	-1.01	-0.83	-0.
Other Cons	-0.02	0.36	-0.34	0.62	0.05	0.16	-0.07	0.55	-0.02	-0.13	0.01	-1.
PFoods&Drink	-0.08	-0.61	0.54	-0.84	-0.06	-0.45	0.12	-1.00	0.03	0.27	-0.06	0.
Price Elasticities for Java_Rural (Model I)												
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cor
Cereals	-4.44	0.05	-0.05	-0.18	-0.09	0.49	0.21	0.10	0.00	0.11	0.03	0.
Tuber	-0.12	-3.36	0.17	-9.38	-0.74	0.28	1.25	-4.89	-0.23	0.60	-0.03	-1.
Fish	-0.06	-0.02	0.75	7.50	0.74	-0.98	-1.94	-1.14	-0.14	-0.87	0.15	0.
Meat	0.00	0.01	-0.01	-0.94	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.
Egg&Milk	0.00	-0.03	0.01	-0.02	-1.02	0.02	-0.02	-0.06	-0.01	-0.01	0.00	-0.
Vegetables	0.11	0.02	0.02	0.13	0.00	-0.50	-0.08	-0.15	0.01	-0.08	-0.02	0.
Pulses	0.00	-0.01	0.01	0.03	0.01	-0.03	-0.89	0.05	-0.01	-0.02	0.00	-0.
Fruits	0.00	-0.13	0.00	-0.35	-0.02	0.15	-0.05	-1.59	0.01	0.06	0.00	-0.
Oil&fats	0.02	0.01	-0.01	0.02	0.01	-0.03	0.00	-0.01	-1.00	-0.01	-0.01	0.
Beverages	0.05	0.04	-0.10	-0.21	-0.16	0.20	0.39	0.43	0.12	-0.69	-0.01	0.
Spices	0.00	0.00	-0.04	-0.06	-0.08	0.17	0.18	0.13	-0.01	-0.05	-0.99	0.
Other Cons	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.
PFoods&Drink	-0.02	0.10	-0.09	-0.01	-0.11	0.24	0.37	0.57	0.04	0.28	0.02	0.
Price Elasticities for Java_All (Model I)												
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cor
Cereals	-2.96	0.00	-0.01	0.06	-0.06	0.22	0.05	-0.01	0.00	0.02	0.01	0.
Tuber	-0.14	-0.07	-0.30	3.48	-1.28	1.51	0.59	0.57	-0.32	-0.68	0.38	-0.
Fish	-0.06	-0.55	0.11	0.71	-0.99	0.62	0.26	0.06	-0.23	-0.18	0.22	-0.
Meat	0.02	0.18	0.01	-0.86	0.58	-0.75	-0.45	-0.05	0.08	0.09	-0.07	0.
Egg&Milk	-0.03	-0.08	-0.03	0.66	-1.82	0.91	0.25	-0.02	-0.06	-0.13	0.08	-0.
Vegetables	0.06	-0.05	0.00	0.45	-0.48	0.50	0.08	-0.03	-0.05	-0.14	0.09	-0.
Pulses	0.00	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	0.00	0.00	0.00	0.
Fruits	0.00	0.09	0.02	-0.43	0.04	0.01	-0.17	0.28	-0.04	-0.09	0.04	-0.
Oil&fats	0.01	-0.02	-0.01	0.07	-0.08	0.17	0.10	-0.02	-1.02	-0.03	-0.02	0.
Beverages	0.00	0.18	0.13	-1.46	1.03	-1.59	-1.06	0.09	-0.29	-1.33	0.02	-0.
Spices	-0.02	0.17	0.11	-1.31	1.04	-1.45	-0.97	0.08	-0.34	-0.85	-0.92	0.
Other Cons	0.01	-0.02	0.00	0.12	-0.14	0.06	0.04	-0.01	-0.03	-0.05	0.00	-1.
PFoods&Drink	-0.02	-0.06	-0.03	0.40	-0.27	0.34	0.29	-0.03	0.01	0.09	0.00	0.

5.3.3 Model I results compared to previous studies

In this sub-section, the current study compares its outcomes with previous studies as well as examines a shift of consumption patterns indicated from their own price elasticities from time to time for comparable commodities.

Table 5-15 and 5-16 briefly summarise own – price elasticities computed by the current study and the previous studies of different years for Java and Indonesian cases.

Table 5-15
Comparison study of price elasticities of commodities observed in Java between current study by Olivia (2002) and Deaton (1990)

Year				2002		1999		1981
Model				Model I: w = f(lnX, ln z)				
Author				Kodoatie		Olivia		Deaton
Code	Johanna	Olivia	Deaton	Urban	Rural	Urban	Rural	Rural
1	**Cereals**			-2.5	-4.4			
		Rice	Rice			-0.2	-0.4	-0.4
		Maize	Maize			-1.8	-4.0	-0.8
		Cereal Flours				-0.6	-3.3	
			Wheat					-0.7
2	**Tuber**	**Tuber**		-24.3	-3.4	-0.8	-0.6	
			Roots					-1.0
		Cassava	Cassava			-0.7	-0.8	-0.3
3	**Fish**			-23.4	0.8			
		Fresh Fish	Fresh Fish			-1.0	-1.3	-0.8
		Dried Fish	Dried Fish			-0.5	-0.5	-0.2
4	**Meat**	**Meat**	**Meat**	-7.1	-0.9	0	-0.6	-1.1
5	**Egg&Milk**	**Dairy&Eggs**		-1.2	-1.0	0.2	-0.8	
6	**Vegetables**	**Vegetables**	**Vegetables**	-0.5	-0.5	-0.5	-0.9	-1.1
7	**Pulses**	**Pulses**	**Legumes**	-1.1	-0.9	-0.8	-0.8	-1.0
8	**Fruits**	**Fruits**	**Fruits**	-9.3	-1.6	-0.7	-0.8	-1.0
9	**Oil&fats**	**Oil&fats**		-1.0	-1.0	-0.9	-1.0	
10	**Beverages**	**Beverages**		-2.6	-0.7	-0.9	-0.7	
		Sugar				-0.6	-0.8	
11	**Spices**	**Spices**		-0.8	-1.0	-0.5	-0.3	
12	**Other Cons**	**Other Cons**		-1.2	-1.0	-0.4	-0.5	
13	**PFoods&drinks**			-1.8	-2.2			
	15 comties	**17 comties**	**11 comties**					

There are 11 commodities from Olivia's (2002) study which can be compared to the current study, whereas only 4 commodities from Deaton (1990) can be compared. There are at least six commodities observed having similar own – price elasticities, namely Meat, Eggs and milk, Vegetables, Pulses, Oil and fats, Beverages (excluding sugar), and Spices. Interestingly, most of the commodities with the exception of spices are close to unitary, i.e. ranging from – 0.7 – 1.1.

Table 5.15 and Figure 5-6 suggest that demand for Fruits in rural Java, which derived from this study is more price elastic than other studies, whereas demand for Vegetables is more price inelastic.

The study employed slightly different techniques and used different commodity groups, so it is not strictly proper to compare. Nevertheless, by assuming that the previous studies' findings represent the time dimension, it is interesting to note that the price elasticity of demand for Meat in rural areas seems to have become less price elastic over time (since Deaton's era, 1990). However, Eggs and milk are the other way round, and have become more price elastic, i.e. – 0.8 in 1999 (Olivia's) become – 1 in 2002 (this study). The price elasticity of demand for Oil and fats do not seem to have changed much.

Figure 5-6
Comparison study of price elasticities of commodities observed in Java Between the current study and Olivia's (2002) and Deaton's (1990) studies

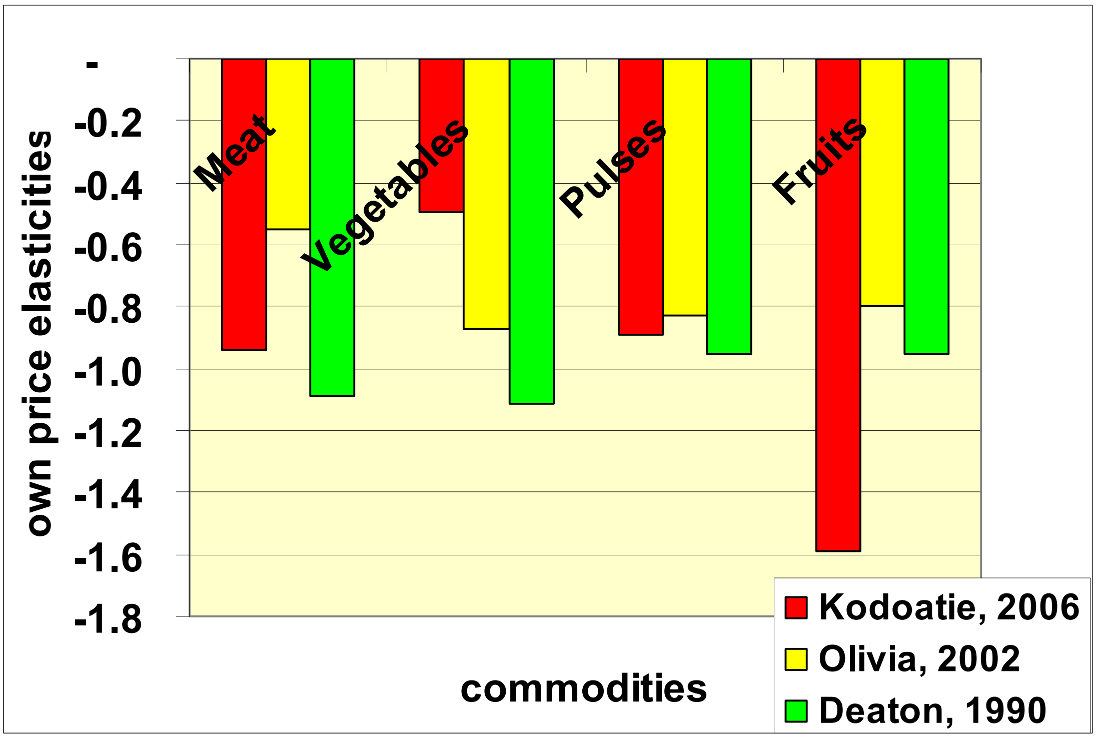
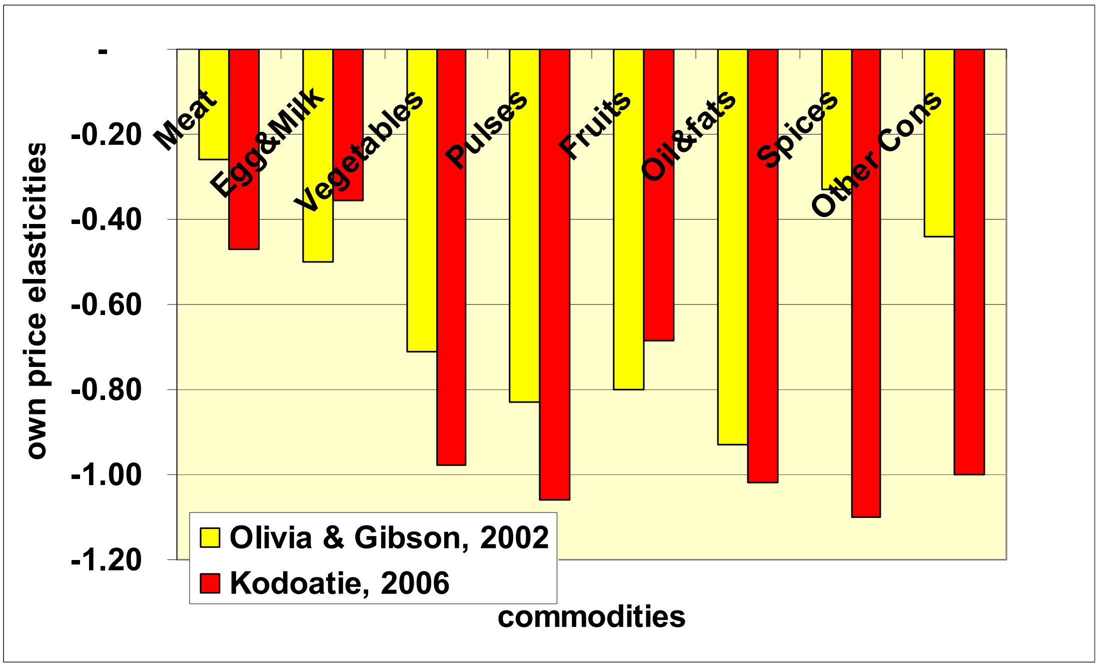


Table 5-16
Comparison study between current study with Olivia and Gibson's (2002) for Indonesia, 2002

Data used:			Indonesia	
Year:			1999	2002
Sources of Data:			SUSENAS	
Demand equations :			Deaton's procedure	
			w = f (lnX,z)	
Name of Authors:			O&G	Kodoatie
Code	Kodoatie	Olivia & Gibson		
1	**Cereals**			-3.05
		Rice	-0.29	
		Cereal Flours	-1.70	
		Maize	-2.01	
2	**Tuber**		-0.70	-1.83
		Cassava	-0.69	
3	**Fish**			0.31
		Fresh Fish	-1.32	
		Dried Fish	-0.58	
4	**Meat**	**Meat**	-0.26	-0.47
5	**Eggs&Milk**	**Dairy&Eggs**	-0.50	-0.36
6	**Vegetables**	**Vegetables**	-0.71	-0.98
7	**Pulses**	**Pulses**	-0.83	-1.06
8	**Fruits**	**Fruits**	-0.80	-0.68
9	**Oil&fats**	**Oil&fats**	-0.93	-1.02
10	**Beverages**	**Beverages**	-0.77	-0.97
		Sugar	-0.83	
11	**Spices**	**Spices**	-0.33	-1.10
12	**Other Cons**	**Other Cons**	-0.44	-1.00
13	**PFoods&Drink**			-1.11
	13 comties	**16 comties**		

Compared to Olivia and Gibson's (2002) study, the present study suggests that, with the exception of Eggs and milk and Fruits, the demands for the observed commodities are more price elastic than Olivia and Gibson's findings (and tend to be unitary elastic) for Indonesian cases (Model I).

Figure 5-7
Comparison study of price elasticities of commodities observed in Indonesia Between current study and Olivia (2002)



5.2 Model II

This section will concentrate on Model II in providing an alternative approach to compute price elasticities. Before presenting the size of the computed price elasticities, a justification for making use of the Model will be discussed in Sub–section 5.4.1. Income elasticities will be included in the discussion. A similar test for the significance(s) of parameters involved in Model I's first stage estimates will also be conducted here and presented in sub-section 5.4.2 whereas price responses resulting from second stage estimates will be reported in sub-section 5.4.3.

5.4.1 Empirical estimates of the 'income effect'

Theory suggests that Model I is an ideal model to be used for policy prescription for tax reform, since it allows the pure welfare / efficiency effects of change in price to be estimated. However, as discussed in Chapters 2 and 4, Model II will be able to provide welfare estimates which closely approximate to the compensating variations and / or equivalent variations if the income elasticities and the budget shares of the commodities observed are small.

In order to justify the formalisation of Model II, it is therefore important to compute income elasticity as one of the elements considered for the existence of the income effect. In computing income elasticities, three – stage procedure was carried out:

1. Running a regression for budget share equation, i.e. a ratio of expenditure of commodity *i* to total food expenditure (*wf*) as a function of log of total expenditure for food (LTEF), log of income (LIC) and family size (Z) to obtain estimated β_i and ρ_i.

   $$wf_{ih} = \hat{\beta}_i LTEF_h + \hat{\rho}_i LIC + \hat{\pi}_i Z \qquad \textbf{5-2}$$

2. Running a regression of log for expenditure (*LX*) as a function of log of income (*LIC*) to obtain estimated α:

   $$LX_h = \hat{\alpha} LIC_h \qquad \textbf{5-3}$$

   It is important to note that the λ can also be estimated by a simple computation of the ratio between Average of Household's Expenditure to Average of Household's Income (as computed in Table 3.10, see more detail in Chapter 3). This was also done so that these two estimations could be compared.

3. Computing income elasticity by making use of the following formula, in which the parameters such as β, α, and ρ have been earlier estimated in the previous stages:

   $$\eta_i = (\hat{\beta}_i / \overline{WF}_i * \hat{\alpha}) + (\hat{\rho}_i / \overline{WF}_i) \qquad \textbf{5-4}$$

   η_i = Income elasticity for commodity i

   $\overline{WF_i}$ = Average Budget share, a ratio of an expense for commodity *i* to total food expenditure.

   $\hat{\beta}_i, \hat{\rho}_i \hat{\alpha}$ = coefficient regressions derived from equation 5.1 and 5.2.

To make use of the estimated income elasticities in identifying types of goods, it is important to compute their t – ratios. The following formula is used:

$$\text{t ratio} = \frac{\hat{\eta}_i}{se_{(\eta_i)}} \qquad \textbf{5-5}$$

Where,

$$se_{(\eta_i)} = \sqrt{(\mathrm{var}(\hat{\eta}_i)} \text{ and} \qquad \textbf{5-6}$$

$$\operatorname{var}(\hat{\eta}_i) = \left[\frac{\hat{\alpha}}{WF_i}\right]^2 \times \operatorname{var}(\hat{\beta}_i) + \left[\frac{1}{WF_i}\right]^2 \times \operatorname{var}(\hat{\rho}_i) + \left[\frac{\hat{\alpha}}{WF_i}\right] \times \left[\frac{1}{WF_i}\right] \times \operatorname{cov}(\hat{\beta}_i, \hat{\rho}_i) \qquad \textbf{5-7}$$

It is important to note that by allowing the income variable to enter the analysis, types of the goods observed can be identified according to the demand responses to the change in income. The criteria categorizing the types of goods follow the following rule:

If $0 < \text{ICE}(\eta) < 1$ → normal goods

ICE (η) $= 0$ → necessities

ICE (η) > 1 → luxuries

ICE (η) < 0 → inferior *goods*

Table 5-17
Regression Coefficients of Budget Share Equation, Income Elasticity, Their t ratios, Average Budget Share, Types of Goods for Indonesian Households according to Commodity Groups, 2002

Commodities	WF = f(LTEF, LIC, Z)						Budget Share	α = 0.73*)		
	LTEF		LIC		Z			Income Elasticity		
	β	t ratio	ρ	t ratio	π	t ratio	WF	η	t-stat	Type of good
Cereals	-0.116	-97.24	-0.009	-12.30	0.034	146.61	0.24	-0.39	-131.87	inferior
Tuber	-0.003	-11.71	-0.001	-6.69	0.001	16.64	0.01	-0.30	-18.83	inferior
Fish	-0.013	-16.21	0.009	16.29	0.001	6.76	0.09	-0.01	-2.10	Necessities
Meat	0.028	30.08	0.012	19.46	-0.005	-32.68	0.04	0.86	63.17	Normal
Eggs&milk	0.013	15.31	0.008	13.24	-0.003	-19.72	0.05	0.38	33.75	Normal
Vegetables	-0.034	-55.19	0.001	3.39	0.004	39.62	0.08	-0.28	-64.41	inferior
Pulses	-0.012	-28.25	0.000	0.29	0.002	23.93	0.03	-0.27	-32.23	inferior
Fruits	0.009	14.92	0.009	23.02	-0.004	-34.98	0.04	0.39	43.58	Normal
Oils & fat	-0.017	-56.16	0.002	11.83	0.002	33.87	0.04	-0.26	-53.86	inferior
Beverages	-0.013	-32.58	0.001	4.03	0.001	16.22	0.05	-0.18	-34.90	inferior
Spices	-0.010	-45.05	0.002	14.93	0.000	13.55	0.02	-0.22	-37.61	inferior
Other Cons	0.001	3.37	0.002	8.67	-0.001	-9.13	0.02	0.17	13.26	Normal
Pfoods&drinks	0.043	18.48	0.000	0.21	-0.018	-43.14	0.15	0.21	23.90	Normal

Note: Coincidently, α which is estimated by two different approaches results in similar output, i.e. 0.73. T ratios were computed based on equation 5.4.

Table 5-17 illustrates not only the regression coefficients derived from equation 5-1, i.e. β and ρ and their statistic t ratio, but also a regression coefficient derived from equation 5-3, i.e. α and the statistic t ratio. Income elasticity is computed by utilising equation 5-4.

It is important to note that the estimated α equalising to 0.73 was, in fact, computed with two different approaches as outlined and explained with reference to equation 5-4. It is surprising that the approaches came up with a unique figure, i.e. 0.73.

Table 5-17 suggests that overall, income elasticities vary from -0.30 – 0.86. This study demonstrates that commodities aggregates which constitute the diet of poorer households have lower income elasticities (even with negative income elasticities). In particular, food products which were earlier “flagged” as necessities (because of their expenditure elasticity such as cereals, oils and fats, beverages and spices) are here shown to be inferior goods. Interestingly, only the commodity group of Fish is identified as a necessity. Other consumptions, fruits, meat, eggs and milk and prepared foods and drinks are categorized as normal goods as the higher the households’ income, the higher the households’ expense on the commodity; in particular, meat is the one commodity group that is close to being categorised as a luxury.

Theoretically, within one dataset, if some commodity groups were categorised as inferior goods, as a consequence, they will follow with some other groups were likely to be classified as luxury goods or superior goods. Unfortunately, this is not the case for the present study. Apart from the reason discussed in the previous paragraph, it seems that Non – food commodity groups seem to be responsible for the reason why many commodity groups in this present study are likely to be categorised as inferior goods. This means that some non – food commodity groups such as durables might fill in the gap of the absence of superior goods in this study. Unfortunately, unit value for some non food commodity groups cannot be computed in this study because of an absence of quantity data. Accordingly, it is important to consider the non food analysis for further research to complete the demand systems.

The findings suggest that Prepared foods and drinks and Other consumptions are likely to be responsible for a reason of the inferiority of those identified commodity goods discussed in the previous paragraph. Both Prepared foods and drinks, and Other consumptions might be a substitute for the inferior goods identified by the current study. Prepared foods and drinks include foods and drinks served and sold in “warung” (kiosks / stalls) by street vendors and in small restaurants, whereas Other consumptions includes instant noodles, which are popular fast – foods both in urban and rural areas. Households, in particular those in urban areas, tend to have their meals and beverages (breakfast and lunch) in “warung” or small restaurants; it is a part of their lifestyle. The cost of rice (cereals) spice ingredients (spices), of various vegetable courses (vegetables), and of cooking oil (oils and fats) can be saved as all can be consumed as their meal in a restaurant or “warung”. In other words, saving time and money seems to be the reason. At the same time, the availability of instant foods and drinks such as instant noodles and “three in one” drinks (milk, coffee and sugar) also contributes to the inferiority of rice (cereals) and beverages. Therefore, it is not surprising that most Indonesian households will leave out the inferior goods when they become more affluent. Most of the inferior goods are consumed by the poor and the villagers. Unfortunately, the study focuses on relatively large commodity groups; accordingly, little more can be said until or unless the data are analysed using smaller commodity groups as well as smaller spatial category (for detailed smaller commodity groups can be found in Appendix B).

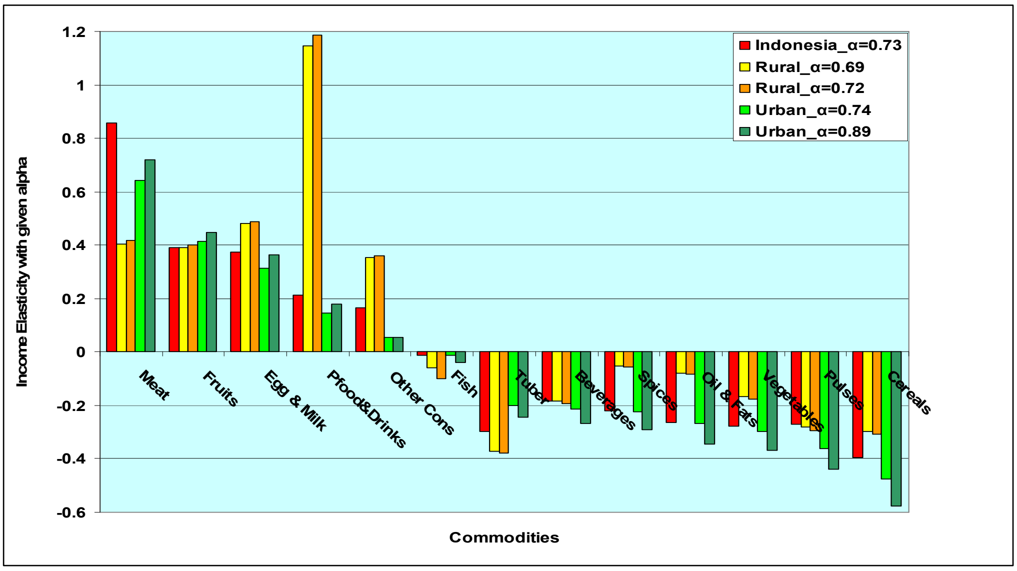
Similar income elasticity calculations have been carried out when considering urban and rural areas. Table 5-18 provides the figures with given αs according to commodity groups. Estimated αs were obtained by utilising equation 5.2 as well as a simple calculation of a ratio of average of total expenditure to average of total income (See chapter 3 for more detail). Accordingly, various values of α are presented.

In general, types of the goods observed in urban and rural areas according to the size of their income elasticities are similar to the one observed for all Indonesian households, with the exception of Fish for urban areas and prepared foods and drinks for rural areas. A different magnitude of the estimated α, which resulted from different approaches of computation, will lead a particular commodity to be classified into different types of goods. The larger the estimated α is, the more likely the good is perceived as inferior goods. For example, Fish can be categorised as necessities or inferior goods dependent on the degree of α.

Table 5-18
Income Elasticities (η) with given α According to Commodity Groups and Areas, 2002

Commodities	Income Elasticity (η) with given α											
	Urban						Rural					
	α = 0.74	t-stat	type	α = 0.89	t-stat	type	α = 0.72	t-stat	type	α = 0.69	t-stat	type
Cereals	-0.47	-92.15	Inferior	-0.58	-93.53	Inferior	-0.31	-96.15	Inferior	-0.30	-95.34	Inferior
Tuber	-0.20	-9.33	Inferior	-0.25	-9.66	Inferior	-0.38	-16.47	Inferior	-0.37	-16.58	Inferior
Fish	-0.01	-1.32	Necessities	-0.04	-3.78	Inferior	-0.10	-1.22	Necessities	-0.06	-0.73	Necessities
Meat	0.64	44.64	Normal	0.72	42.62	Normal	0.42	44.81	Normal	0.40	44.33	Normal
Egg & Milk	0.31	22.30	Normal	0.36	21.81	Normal	0.49	27.57	Normal	0.48	27.76	Normal
Vegetables	-0.30	-43.86	Inferior	-0.37	-45.50	Inferior	-0.18	-47.17	Inferior	-0.17	-46.61	Inferior
Pulses	-0.36	-29.97	Inferior	-0.44	-30.39	Inferior	-0.29	-15.44	Inferior	-0.28	-15.17	Inferior
Fruits	0.41	35.84	Normal	0.45	32.85	Normal	0.40	25.24	Normal	0.39	25.29	Normal
Oil & Fats	-0.27	-34.92	Inferior	-0.34	-37.36	Inferior	-0.08	-40.99	Inferior	-0.08	-40.17	Inferior
Beverages	-0.21	-25.84	Inferior	-0.27	-27.00	Inferior	-0.19	-23.44	Inferior	-0.18	-23.10	Inferior
Spices	-0.22	-25.02	Inferior	-0.29	-27.33	Inferior	-0.06	-27.90	Inferior	-0.05	-27.11	Inferior
Other Cons	0.06	3.50	Normal	0.05	2.86	Normal	0.36	16.35	Normal	0.35	16.46	Normal
Pfood&Drinks	0.15	14.42	Normal	0.18	14.95	Normal	1.19	20.28	Luxury	1.15	20.13	Luxury

Figure 5-8
Income Elasticities of 13 commodities observed across income groups, areas and regions derived from Model II, 2002



In brief, as suggested by Figure 5-8, demands for Fruits and Eggs and milk are income elastic, if considering only urban households, whereas demand for Eggs and milk and Meat are indicated as income elastic, if rural households are the focus of the analysis. In general, demands for Meat, Fruits, and Eggs and milk have significant income elasticities (the three highest) but are not sufficient to be classified as luxuries (indicated in chapter 3) as the values are less than 1.

After computing and presenting the income elasticities, the study begins to provide rationale for the use of the Marshallian model to analyse the welfare effect of tax reform. Table 5-19 below provides a complete description of estimated compensated own price elasticities (Estimated CPE), Uncompensated Own Price Elasticities (OPE), Budget share as a percentage of either Total Expenditure or Total Food Expenditure (W or WF), income elasticities (ICE, which is computed by making use of equation 5-4), including a product of budget share and income elasticity (W x ICE) and types of goods identified based on the computed income elasticities. Table 5-19 also presents the estimated compensated price elasticities (Estimated CPE) referring to Vives (1987) definition which considers a expenditure share either as a % of total expenditure or a % of total expenditure for food. These two different budget shares are considered to allow minimum and maximum errors to be made as a result of the difference between the estimation of Compensated Price Elasticities (Est. CPE) and the Uncompensated Price Elasticities (OPE).

$$Est.CPE_i = OPE_i + (\overline{W_i} \times ICE_i)$$ - Minimum error and

$$Est.CPE_i = OPE_i + (\overline{WF_i} \times ICE_i)$$ - Maximum error

Table 5-19 demonstrates the fact that in general, Indonesian households have not only small income elasticities but also a small expenditure share average of the good. It is undeniable that some of commodities observed such as meat, fruit, and eggs and milk have relatively significant income elasticities (38 - 86%), but the product of these (income elasticities and the average of expenditure share of the good) are relatively small (in absolute figures less than or equal to 0.1, see Table 5.3 for details).

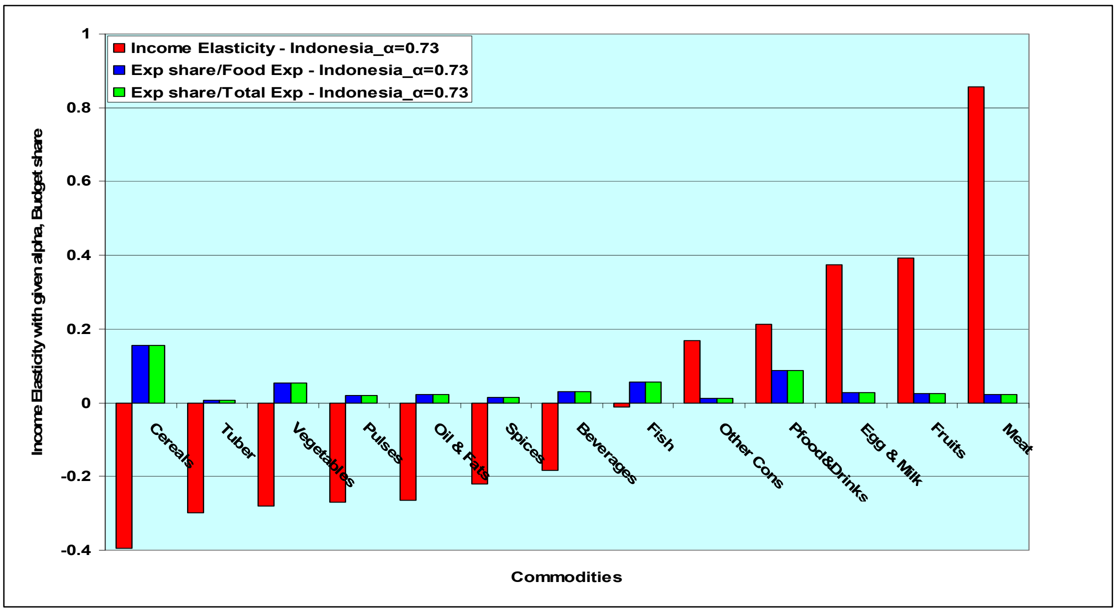
Table 5-19
Estimated Compensated Price Elasticities (Est. CPE), Uncompensated Own Price elasticities (OPE), Budget share (W or WF), Income elasticities (ICE), a product of budget share times its income elasticities (W x ICE), and % Error Estimation for 13 commodities observed in Indonesia, 2002

INDONESIA													
Commodities	Est. CPE		OPE	ICE	Budget share		ICE x W		(Est.CPE/OPE) x 100		Error (%)	
	W	WF			W	WF	W	WF	W	WF	W	WF
Cereals	-4.65	-4.68	-4.58	-0.39	0.16	0.24	-0.06	-0.09	101.3	102.0	1.3	2.0
Tuber	-1.00	-1.00	-1.00	-0.30	0.01	0.01	0.00	0.00	100.2	100.3	0.2	0.3
Fish	-0.99	-0.99	-0.99	-0.01	0.06	0.09	0.00	0.00	100.1	100.1	0.1	0.1
Meat	-1.27	-1.26	-1.29	0.86	0.02	0.04	0.02	0.03	98.5	97.5	-1.5	-2.6
Egg & Milk	-2.03	-2.02	-2.04	0.38	0.03	0.05	0.01	0.02	99.5	99.2	-0.5	-0.9
Vegetables	-1.01	-1.02	-1.00	-0.28	0.05	0.08	-0.01	-0.02	101.5	102.4	1.4	2.3
Pulses	-1.00	-1.01	-1.00	-0.27	0.02	0.03	-0.01	-0.01	100.5	100.9	0.5	0.9
Fruits	-0.99	-0.98	-1.00	0.39	0.02	0.04	0.01	0.02	99.0	98.4	-1.0	-1.6
Oil & Fats	-1.01	-1.01	-1.00	-0.26	0.02	0.04	-0.01	-0.01	100.6	101.0	0.6	1.0
Beverages	-1.00	-1.01	-1.00	-0.18	0.03	0.05	-0.01	-0.01	100.5	100.9	0.5	0.9
Spices	-1.00	-1.00	-1.00	-0.22	0.01	0.02	0.00	-0.01	100.3	100.5	0.3	0.5
Other Cons	-1.00	-1.00	-1.00	0.17	0.01	0.02	0.00	0.00	99.8	99.7	-0.2	-0.3
Pfood&Drinks	-0.97	-0.96	-0.99	0.21	0.09	0.15	0.02	0.03	98.1	96.8	-1.9	-3.3

Note: W and WF in the third row show the computation consideration of the identified budget share.

Table 5-19 and Figure 5-9 also confirms the closeness of the uncompensated own price elasticities (OPE) to compensated own price elasticities (Est. CPE). Across Indonesian data, percentage errors of the difference are negligible, i.e. they are, in absolute, approximately between 0.1 – 3.3%. This infers that Marshallian price elasticities can be validly entered in lambda computation for evaluating the welfare effects of tax reforms, as is the aim of the current study.

Figure 5-9
Income elasticities and Expenditure share for 13 commodities observed in Indonesia, 2002



Similar analyses have been carried out for urban and rural areas and similar conclusions have been reached, that is, across Indonesian urban and rural, percentage errors of the difference are negligible, i.e. they are, in absolute, approximately between 0 – 3.5% (see Figures 5-10, 5-11 and Table 5-20).

Figure 5-10
Income elasticities and Expenditure share for 13 commodities observed in Urban Area, 2002

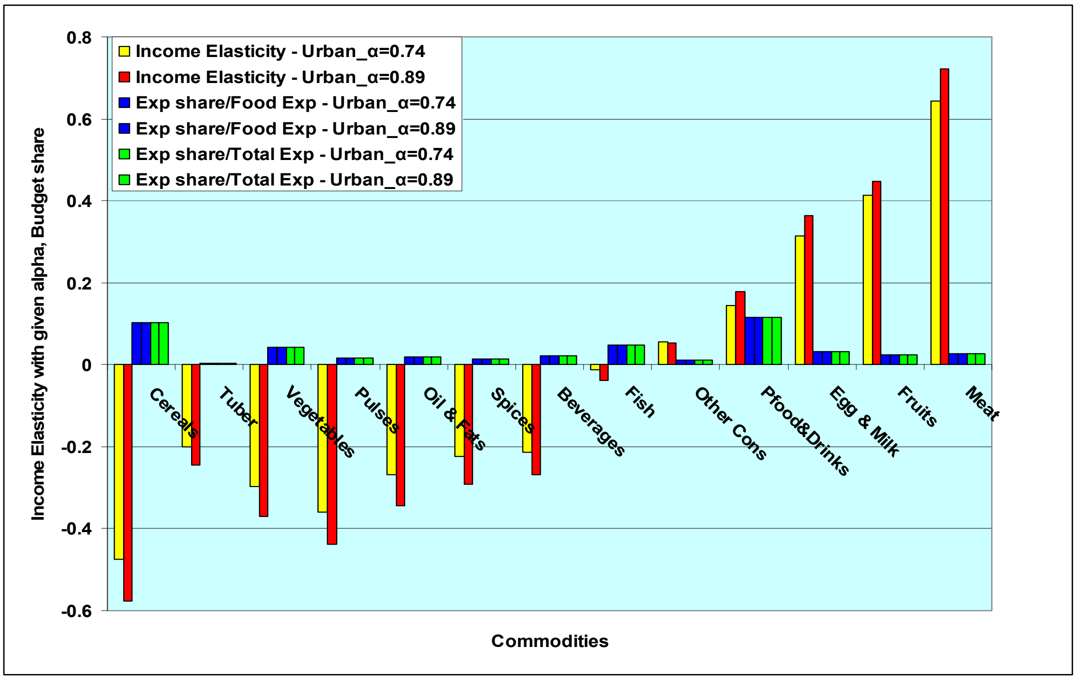


Figure 5-11
Income elasticities and Expenditure share for 13 commodities observed in Rural Area, 2002

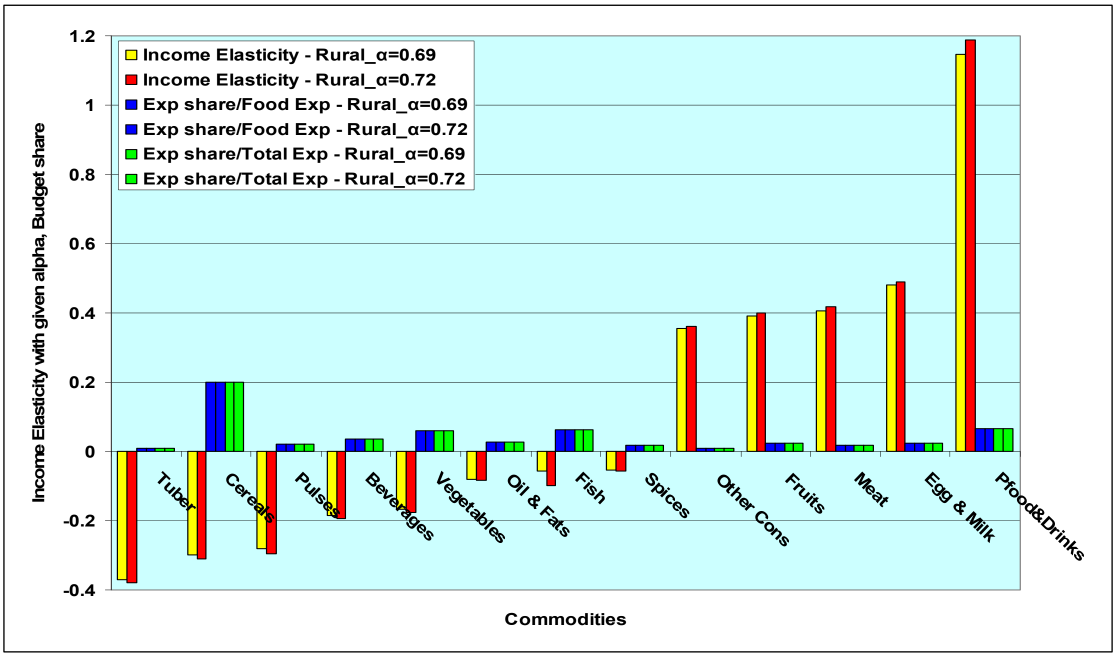


Table 5-20

Evidence for utilising Model II as an alternative to Model I as small income elasticities (ICE) and small budget share (W or WF) or the product of these (ICE x W) is small according to areas, 2002

Commodities	Est. CPE		OPE	ICE	Budget share		ICE x W		(Est.CPE/OPE) x 100		Error (%)	
URBAN												
	W	WF			W	WF	W	WF	W	WF	W	WF
Cereals	-4.41	-4.45	-4.36	-0.47	0.10	0.18	-0.05	-0.08	101.1	101.9	1.1	1.9
Tuber	-0.51	-0.51	-0.51	-0.20	0.00	0.01	0.00	0.00	100.2	100.3	0.2	0.3
Fish	-1.04	-1.04	-1.04	-0.01	0.05	0.08	0.00	0.00	100.0	100.1	0.0	0.1
Meat	-0.96	-0.95	-0.98	0.64	0.03	0.05	0.02	0.03	98.2	96.6	-1.8	-3.5
Egg & Milk	-1.18	-1.17	-1.19	0.31	0.03	0.06	0.01	0.02	99.2	98.4	-0.8	-1.6
Vegetables	-1.03	-1.05	-1.02	-0.30	0.04	0.08	-0.01	-0.02	101.3	102.3	1.2	2.2
Pulses	-0.98	-0.98	-0.97	-0.36	0.02	0.03	-0.01	-0.01	100.6	101.2	0.6	1.1
Fruits	-0.85	-0.84	-0.86	0.41	0.02	0.05	0.01	0.02	98.8	97.8	-1.2	-2.3
Oil & Fats	-1.01	-1.01	-1.00	-0.27	0.02	0.03	0.00	-0.01	100.5	100.9	0.5	0.9
Beverages	-0.99	-0.99	-0.98	-0.21	0.02	0.04	0.00	-0.01	100.5	100.9	0.5	0.9
Spices	-1.00	-1.00	-0.99	-0.22	0.01	0.02	0.00	-0.01	100.3	100.5	0.3	0.5
Other Cons	-0.96	-0.96	-0.96	0.06	0.01	0.02	0.00	0.00	99.9	99.9	-0.1	-0.1
Pfood&Drinks	-3.12	-3.11	-3.14	0.15	0.12	0.21	0.02	0.03	99.5	99.0	-0.5	-1.0
RURAL												
Commodities	**Est. CPE**		**OPE**	**ICE**	**Budget share**		**ICE x W**		(Est.CPE/OPE) x 100		**Error (%)**	
	W	WF			W	WF	W	WF	W	WF	W	WF
Cereals	-5.86	-5.88	-5.79	-0.31	0.20	0.29	-0.06	-0.09	101.1	101.5	1.1	1.5
Tuber	-1.00	-1.00	-1.00	-0.38	0.01	0.01	0.00	-0.01	100.4	100.5	0.4	0.5
Fish	-1.03	-1.04	-1.03	-0.10	0.06	0.09	-0.01	-0.01	100.6	100.9	0.6	0.9
Meat	-0.97	-0.96	-0.97	0.42	0.02	0.03	0.01	0.01	99.2	98.8	-0.8	-1.2
Egg & Milk	-0.50	-0.49	-0.51	0.49	0.02	0.04	0.01	0.02	97.8	96.6	-2.3	-3.5
Vegetables	-1.01	-1.01	-1.00	-0.18	0.06	0.09	-0.01	-0.02	101.1	101.6	1.0	1.6
Pulses	-0.86	-0.86	-0.85	-0.29	0.02	0.03	-0.01	-0.01	100.7	101.1	0.7	1.1
Fruits	-1.48	-1.48	-1.49	0.40	0.02	0.04	0.01	0.01	99.4	99.0	-0.6	-1.0
Oil & Fats	-1.00	-1.00	-1.00	-0.08	0.03	0.04	0.00	0.00	100.2	100.4	0.2	0.4
Beverages	-1.01	-1.01	-1.00	-0.19	0.04	0.05	-0.01	-0.01	100.7	101.0	0.7	1.0
Spices	-1.00	-1.00	-1.00	-0.06	0.02	0.03	0.00	0.00	100.1	100.1	0.1	0.1
Other Cons	-1.20	-1.20	-1.20	0.36	0.01	0.02	0.00	0.01	99.7	99.5	-0.3	-0.5
Pfood&Drinks	-4.39	-4.35	-4.46	1.19	0.06	0.10	0.08	0.12	98.3	97.4	-1.8	-2.7

5.4.2 First stage estimates

After realising that Model II is reliable for the facilitation of price elasticities computation for further tax policy reform recommendation, as discussed in Sub – section 5.2.3, it is also important to examine the significance of the variables involved in the model. This investigation is similar to the one for Model I (see subsection 5.3.1).

Tables 5-21 and 5-22 demonstrate the significance of the parameters in urban and rural areas, including total food expenditure elasticities, which are computed from EE = $((1-\beta_i^1)+\beta_i^0/\overline{wf_i})$ plus coefficient of LTEF (β_i^1) from unit value equation (quality elasticities). In fact, these total food expenditure elasticities derived from Model II are analogous to those derived from Model I. The only difference is in the data of budget share used (*wf* = expense for commodity *i* as a share of total food expenses versus *w* = expense for commodity *i* as a share of total expenditure).

Table 5-21 suggests that for urban areas in general, the coefficients of parameters derived from budget share equation (as discussed in Chapter 4) are significant, except for Tuber, Pulses, Other consumptions and Prepared foods and drinks. They are similar to those derived from unit value equation, except for Eggs and milk, Vegetables, Pulses and Oil and fats. Specifically, it can be inferred that budget share for Other consumptions is not determined by the size of total expense for food.

Table 5-21
Budget share and UV equations for 13 commodities observed In Urban Indonesia, 2002 (Derived from Model II)

URBAN																
	Budget share Equation							Unit Value Equation								
Commodities	LTEF	t stat	LIC	t stat	Z	t stat	R2	LTEF	t stat	LIC	t stat	Z	t stat	R2	WF	EE
Cereals	-0.11	-71.25	0.00	-4.41	0.03	104.01	0.38	0.04	14.05	0.02	8.04	-0.01	-17.59	0.03	0.18	0.34
Tuber	0.00	-8.27	0.00	0.26	0.00	14.42	0.01	0.08	10.18	0.07	12.71	-0.02	-14.39	0.03	0.01	0.64
Fish	-0.01	-11.43	0.01	11.94	0.00	13.55	0.01	0.13	14.74	0.07	12.28	-0.03	-18.33	0.04	0.08	0.71
Meat	0.02	18.49	0.02	17.02	0.00	-16.45	0.09	0.04	9.07	0.02	5.99	-0.01	-8.81	0.01	0.05	1.43
Egg & Milk	0.02	12.67	0.01	5.93	0.00	-9.21	0.03	0.03	3.99	0.01	1.22	0.00	-0.95	0.00	0.06	1.27
Vegetables	-0.03	-38.32	0.00	3.88	0.01	36.56	0.11	0.02	7.36	0.00	-1.25	0.00	-1.84	0.00	0.08	0.54
Pulses	-0.01	-25.33	0.00	-1.51	0.00	27.77	0.06	0.03	7.27	0.00	1.61	0.00	-5.17	0.00	0.03	0.50
Fruits	0.01	10.14	0.01	20.35	0.00	-27.59	0.07	0.05	10.61	0.04	11.86	-0.02	-15.93	0.03	0.05	1.15
Oil & Fats	-0.01	-36.81	0.00	8.87	0.00	31.74	0.09	-0.02	-4.54	0.00	2.14	0.00	0.73	0.00	0.03	0.56
Beverages	-0.01	-24.52	0.00	4.10	0.00	17.08	0.05	0.06	11.36	0.02	5.11	-0.01	-11.44	0.02	0.04	0.60
Spices	-0.01	-29.34	0.00	9.54	0.00	15.30	0.06	0.07	11.96	0.02	5.58	-0.01	-8.74	0.01	0.02	0.51
Other Cons	0.00	-0.48	0.00	3.85	0.00	-2.62	0.00	0.03	6.94	0.01	2.46	0.00	-5.53	0.00	0.02	0.96
Pfood&Drink	0.04	11.52	0.00	-0.51	-0.03	-37.72	0.06	0.06	12.68	0.03	9.40	-0.02	-15.94	0.03	0.21	1.14

Note: shaded cells are those having insignificant t ratio.

In addition, the consumption of Tubers, Pulses, Prepared foods and drinks are not dependent on their income. From unit value equation, it can be inferred that quality selection for Eggs and milk, and Vegetables are not influenced by either income or the number of family members within the households. Interestingly, Oil and fats quality selection is not dictated by the number of family members in the households.

Table 5-22 below suggests that in rural areas, only the log of income (LIC) associated with Vegetables and Pulses is not statistically significant across the variables involved. This means that their food expenditure shares are not determined by their incomes, or by quality selection. The latter includes Eggs and milk, Oil and fats and Other consumptions (see under heading unit value equation). Likewise, family size (Z) does not significantly contribute to the quality selection of the following goods: Eggs and milk, Vegetables, and Oil and fats.

Meanwhile, in urban areas, income elasticities across commodities derived from budget share equation are also small, but most of the elasticities are statistically significant, with the exception of Tubers, Pulses and Prepared foods and drinks, whereas Eggs and milk, Vegetables and Pulses do not seem to be dictated by quality selection. This would seem to imply that an increase in income does not affect an increase in unit value.

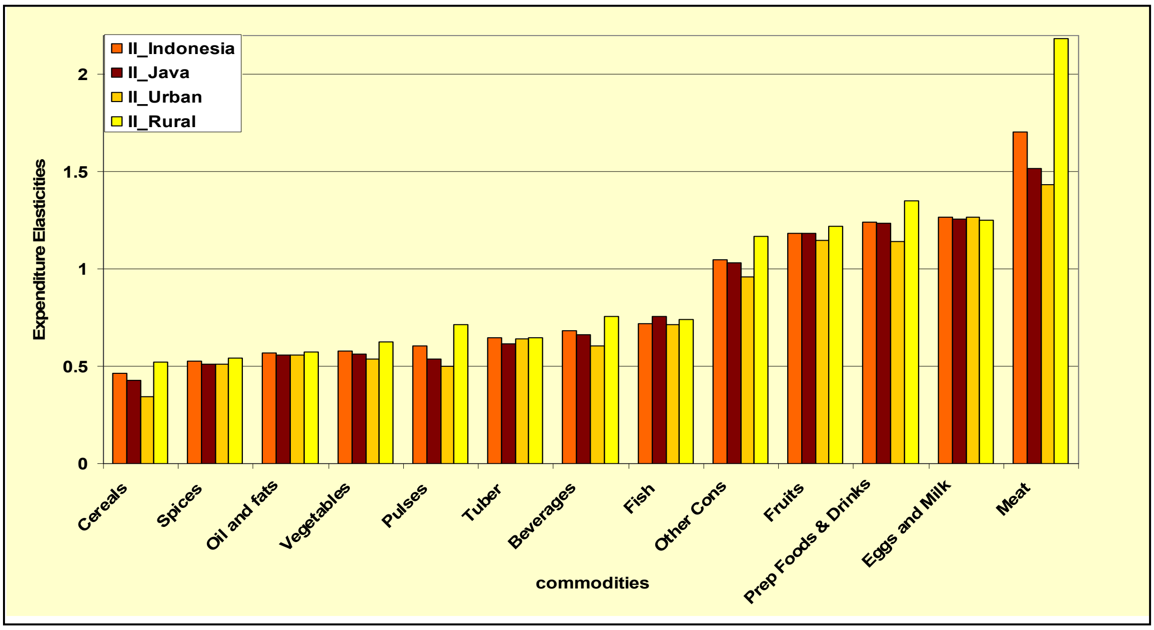
Table 5-22
Budget share and UV equations for 13 commodities observed In Rural Indonesia, 2002 (Derived from Model II)

RURAL																
	Budget share Equation								Unit Value Equation							
Commodities	LTEF	t stat	LIC	t stat	Z	t stat	R2	LTEF	t stat	LIC	t stat	Z	t stat	R2	WF	EE
Cereals	-0.12	-67.39	-0.01	-12.10	0.04	105.05	0.33	0.05	15.19	0.01	2.62	-0.01	-17.20	0.02	0.29	0.52
Tuber	0.00	-8.50	0.00	-8.25	0.00	11.95	0.01	0.06	7.97	0.04	8.30	-0.02	-10.36	0.01	0.01	0.64
Fish	-0.01	-10.31	0.01	10.21	0.00	-3.89	0.01	0.13	13.61	0.05	8.20	-0.03	-16.24	0.02	0.09	0.74
Meat	0.03	24.92	0.01	9.71	-0.01	-29.85	0.08	0.01	2.95	0.01	3.49	0.00	-4.41	0.00	0.03	2.19
Egg & Milk	0.01	9.43	0.01	14.13	0.00	-20.66	0.03	0.02	2.35	0.01	2.19	0.00	-0.73	0.00	0.04	1.25
Vegetables	-0.03	-38.65	0.00	-0.38	0.00	19.30	0.13	0.01	3.76	0.00	0.61	0.00	-1.53	0.00	0.09	0.63
Pulses	-0.01	-14.34	0.00	1.45	0.00	6.18	0.02	0.01	4.79	0.00	1.85	0.00	-5.69	0.00	0.03	0.71
Fruits	0.01	11.19	0.01	11.60	0.00	-21.69	0.03	0.03	7.45	0.01	5.30	-0.01	-10.37	0.01	0.04	1.22
Oil & Fats	-0.02	-41.62	0.00	6.80	0.00	17.66	0.14	0.00	1.39	0.00	-0.22	0.00	-2.06	0.00	0.04	0.57
Beverages	-0.01	-20.99	0.00	1.18	0.00	6.42	0.05	0.00	1.59	0.01	4.37	0.00	-3.62	0.00	0.05	0.76
Spices	-0.01	-33.76	0.00	11.09	0.00	4.10	0.10	0.04	8.65	0.02	4.57	-0.01	-7.66	0.01	0.03	0.54
Other Cons	0.00	5.70	0.00	9.06	0.00	-11.78	0.01	0.01	3.69	0.00	1.11	0.00	-3.01	0.00	0.02	1.17
Pfood&Drink	0.04	13.73	0.00	2.88	-0.01	-22.24	0.03	0.03	8.00	0.02	6.28	-0.01	-9.07	0.01	0.10	1.35

Note: shaded cells are those having insignificant t ratio.

Similar conclusions are attributed for urban and rural households derived from Model II; i.e., there is a negative relationship between total food expenditure (LTEF) and family size (Z), with the exception of Other consumptions in urban areas and Fish in rural areas (see budget share equations of Tables 5.21 and 5.22). However, income and family size move in opposite directions, whereas income moves in a similar direction to total food expenditure in terms of quality selection.

Figure 5-12
Expenditure Elasticities across areas derived from Model II, 2002



5.4.3 Second stage estimates: Quantity and quality price-elasiticities

Sub-section 5.4.3.1 reports the own- and cross- price elasticities for 13 commodities derived from this model, whereas Sub-section 5.4.3.2 reports these for the Java case.

5.4.3.1 Indonesia

Table 5.24 and Figure 5.13 suggest that in general, own price elasticities across commodities, disregarding the areas they belong to, are as expected, i.e. negative with Cereals and Prepared foods and drinks commodities have a larger own price elasticity compared to other foods (i.e. – 4.36 to – 5.79 for Cereals and – 3.14 to – 4.46 for Prepared foods and drinks). In fact, they are more price elastic in rural areas than in urban areas. Other than this, most commodity groups have own – price elasticities which are close to unitary. This may indicate that rural people buy according to a budget: if the price rises then the quantity demanded falls in the same proportion with constant amount spent on each commodity group. This seems plausible, particularly in a rural context where food sources can be supplemented by own production.

Figure 5-13
Own Price Elasticities of 13 commodities observed across areas derived from Model II, 2002

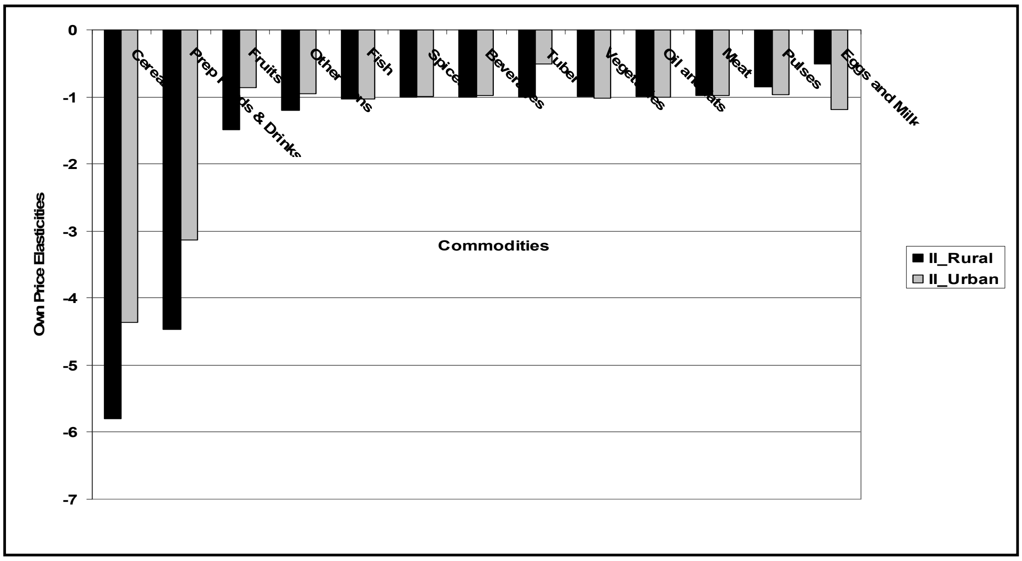


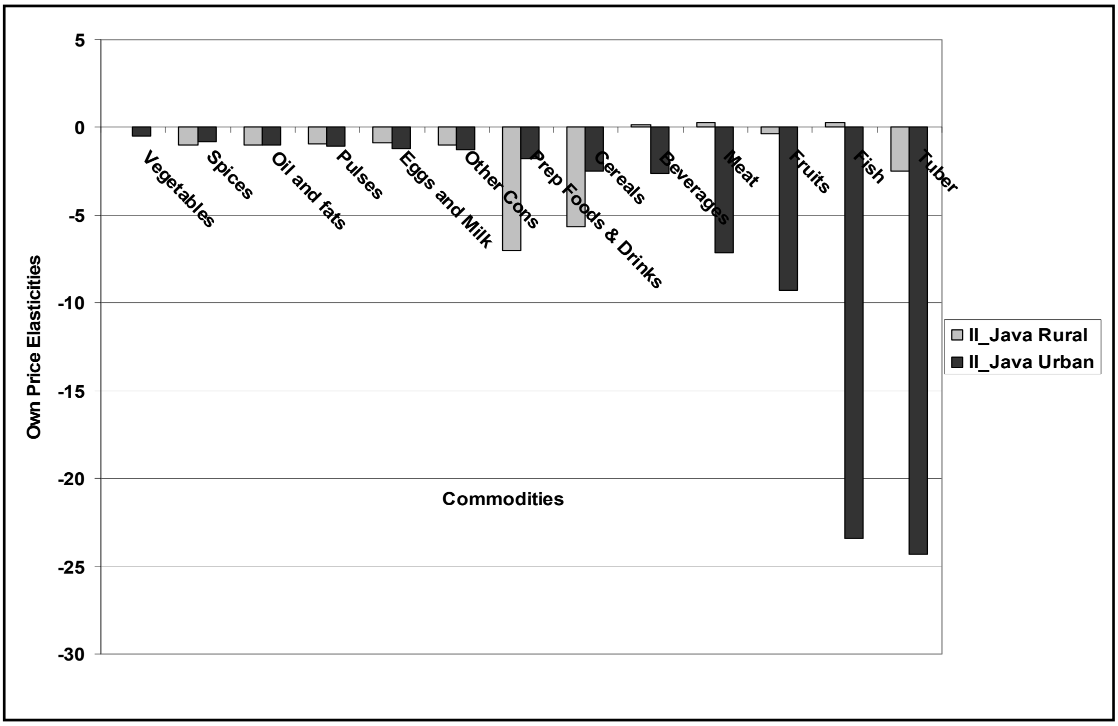
Table 5-23
Own- and Cross- Elasticities of 13 commodities observed in Indonesia (Model II)

	Indo_All												
Commodities	**Cereals**	**Tuber**	**Fish**	**Meat**	**Egg&Milk**	**Vegetables**	**Pulses**	**Fruits**	**Oil&fats**	**Beverages**	**Spices**	**Other Cons**	**PFoods&Drink**
Cereals	-4.58	0.00	0.00	-0.02	0.02	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	-0.00
Tuber	4.01	-1.00	-0.00	-0.10	0.10	-0.00	0.00	-0.00	0.00	0.00	0.00	0.00	-0.00
Fish	3.46	0.00	-0.99	0.15	-0.15	0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	-0.00
Meat	0.21	-0.00	-0.00	-1.29	0.29	-0.00	0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00
Egg&Milk	-0.04	-0.00	0.00	1.04	-2.04	0.00	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00
Vegetables	0.08	0.00	-0.00	-0.13	0.13	-1.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00
Pulses	-0.07	0.00	0.00	0.00	-0.00	0.00	-1.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00
Fruits	-0.60	0.00	0.00	0.02	-0.02	0.00	-0.00	-1.00	-0.00	-0.00	-0.00	-0.00	0.00
Oil&fats	-1.00	0.00	-0.00	-0.03	0.03	-0.00	-0.00	0.00	-1.00	-0.00	-0.00	-0.00	0.00
Beverages	0.41	-0.00	-0.00	-0.02	0.02	-0.00	0.00	-0.00	0.00	-1.00	-0.00	0.00	-0.00
Spices	-5.10	0.00	0.00	0.17	-0.17	0.00	-0.00	0.00	-0.00	-0.00	-1.00	-0.00	0.00
Other Cons	-0.02	0.00	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-1.00	0.00
PFoods&Drink	-13.70	0.00	0.00	0.51	-0.51	0.00	-0.00	-0.02	-0.01	-0.00	0.03	0.00	-0.99
	Indo_Urban												
Commodities	**Cereals**	**Tuber**	**Fish**	**Meat**	**Egg&Milk**	**Vegetables**	**Pulses**	**Fruits**	**Oil&fats**	**Beverages**	**Spices**	**Other Cons**	**PFoods&Drink**
Cereals	-4.36	0.01	-0.00	0.00	-0.02	0.01	0.01	0.00	-0.00	0.01	-0.00	-0.02	0.01
Tuber	-16.19	-0.51	-0.09	-0.00	-1.66	-0.12	2.35	-0.55	-0.01	0.38	-0.00	-1.42	1.03
Fish	-8.11	0.33	-1.04	-0.14	-1.50	-0.09	1.87	-0.14	-0.01	0.22	-0.00	-0.75	0.52
Meat	-0.28	-0.01	0.02	-0.98	0.02	0.03	-0.06	-0.02	-0.00	0.00	-0.00	-0.02	0.01
Egg&Milk	10.59	-0.28	0.00	-0.04	-1.19	-0.07	-0.21	0.50	0.01	-0.27	0.00	0.95	-0.68
Vegetables	-4.64	0.17	-0.01	-0.02	-0.39	-1.02	0.70	-0.26	-0.00	0.10	0.00	-0.41	0.30
Pulses	-0.13	0.00	-0.00	-0.00	-0.02	-0.00	-0.97	-0.01	-0.00	0.00	0.00	-0.01	0.01
Fruits	-1.04	0.03	0.00	0.00	-0.20	-0.01	0.06	-0.86	-0.00	0.03	0.00	-0.09	0.07
Oil&fats	-0.90	0.06	0.01	0.00	-0.29	-0.02	0.56	-0.25	-1.00	0.04	0.00	-0.10	0.06
Beverages	-4.85	0.09	-0.01	-0.01	-0.47	-0.01	0.40	0.10	-0.00	-0.98	0.00	-0.29	0.27
Spices	-1.15	0.18	0.05	-0.02	-1.23	-0.14	2.32	-0.93	-0.00	0.07	-0.99	-0.16	0.09
Other Cons	0.55	-0.01	0.00	-0.00	0.05	-0.00	-0.04	-0.01	0.00	-0.01	-0.00	-0.96	-0.03
PFoods&Drink	37.67	-0.33	0.21	-0.06	1.85	-0.07	0.60	-2.35	0.01	-0.14	0.02	2.32	-3.14
	Indo_Rural												
Commodities	**Cereals**	**Tuber**	**Fish**	**Meat**	**Egg&Milk**	**Vegetables**	**Pulses**	**Fruits**	**Oil&fats**	**Beverages**	**Spices**	**Other Cons**	**PFoods&Drink**
Cereals	-5.79	0.00	0.00	0.00	-0.06	0.00	0.01	0.03	-0.00	-0.00	0.00	-0.12	0.12
Tuber	-8.17	-1.00	-0.02	-0.04	-0.97	-0.00	0.20	0.53	-0.01	-0.00	0.01	-1.89	1.88
Fish	2.29	-0.00	-1.03	-0.25	-0.50	-0.00	0.85	-0.06	0.00	0.00	-0.00	0.16	-0.16
Meat	-1.34	0.00	0.02	-0.97	-0.08	0.00	-0.09	0.09	-0.00	-0.00	0.00	-0.30	0.30
Egg&Milk	-7.91	0.00	0.00	0.02	-0.51	0.00	-1.06	0.37	-0.01	-0.00	0.01	-1.28	1.27
Vegetables	-7.48	0.00	0.01	-0.03	-0.32	-1.00	-0.24	0.40	-0.01	-0.00	0.01	-1.39	1.38
Pulses	1.31	-0.00	-0.01	-0.01	-0.05	-0.00	-0.85	-0.05	0.00	0.00	-0.00	0.18	-0.18
Fruits	9.49	-0.00	-0.02	-0.00	0.34	-0.00	0.40	-1.49	0.01	0.00	-0.01	1.69	-1.69
Oil&fats	1.70	-0.00	-0.00	-0.00	0.03	-0.00	0.08	-0.07	-1.00	0.00	-0.00	0.24	-0.24
Beverages	-13.82	0.00	0.03	0.02	-0.58	0.00	-0.38	0.63	-0.01	-1.00	0.01	-2.18	2.17
Spices	3.44	-0.00	-0.00	0.01	0.12	-0.00	0.25	-0.26	0.00	0.00	-1.00	0.89	-0.89
Other Cons	-1.45	0.00	0.00	0.00	-0.04	0.00	-0.05	0.06	-0.00	-0.00	0.00	-1.20	0.20
PFoods&Drink	11.47	-0.00	-0.02	-0.02	0.80	-0.00	0.72	-1.01	0.01	0.00	-0.00	3.48	-4.46

5.4.3.2 Java

Some important findings can be derived from Model II. Demands for beverages, meat and Fish have inconsistent own-price responses between urban and rural Java. For example, demands for beverages, Fish and meat are price – elastic in urban areas but are giffen goods in rural areas However, demands for prepared foods and drink and cereals are the most price – elastic in rural areas.

Figure 5-14
Own Price Elasticities of 13 commodities observed in Java across areas derived from Model II, 2002



Due to inconsistent outcomes in both areas, it is wise to take into account the model which produces the least number of giffen goods, i.e. the model applied in all Javanese households. In fact, cereals have a similar pattern of own- price elasticities to that across households, both according to areas and income groups. Meat, eggs and milk and prepared foods and drinks are elastic goods which are similar to the types of goods consumed by all Indonesian households.

Figure 5-15
Own Price Elasticities of 13 commodities observed in Java and in Indonesia derived from Model I and II, 2002

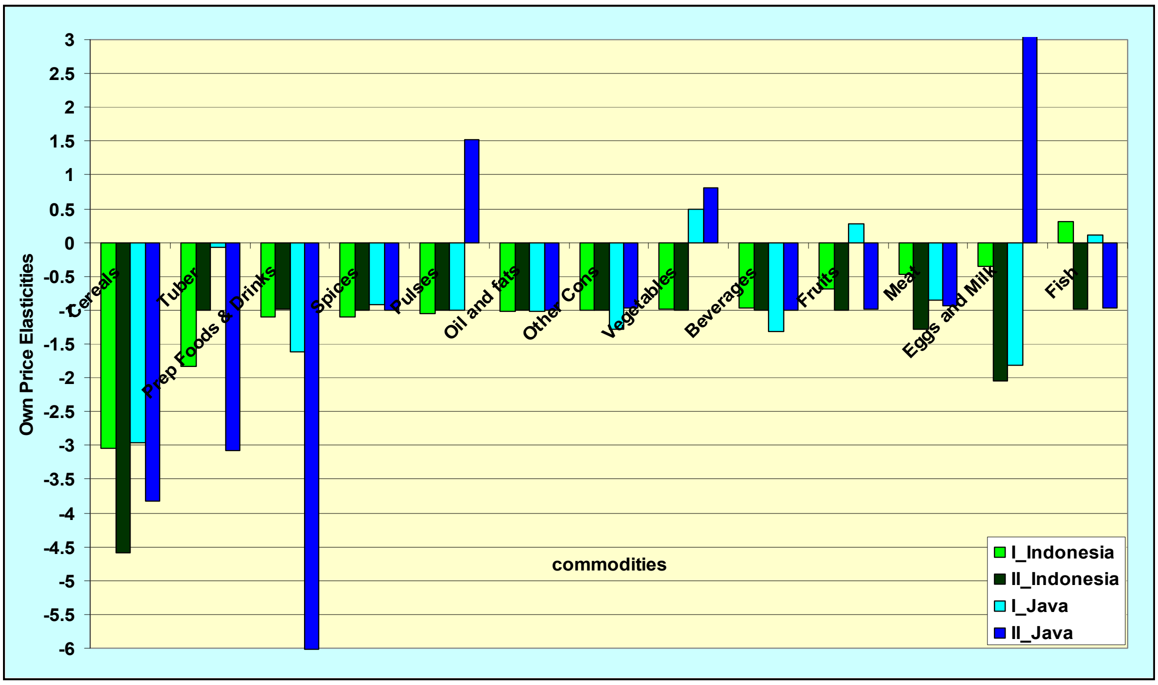


Table 5-24
Own- and Cross- Elasticities of 13 commodities observed in Java (Model II)

Price Elasticities for Java_Urban (Model II)													
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cons	PFoods&Drink
Cereals	-4.89	0.28	0.43	-2.30	0.75	-3.50	-2.78	0.38	-0.78	-1.74	0.44	-1.80	1.78
Tuber	1.21	-1.52	-2.99	16.77	-5.27	23.40	16.12	-1.45	4.13	9.59	-2.05	9.91	-9.74
Fish	0.05	-0.88	-0.04	0.82	-0.87	2.41	2.08	-1.41	0.66	1.53	-0.33	1.74	-1.45
Meat	0.07	-0.21	-0.06	-0.69	-0.41	1.43	0.89	-0.26	0.20	0.48	-0.10	0.56	-0.46
Egg&Milk	-0.81	1.61	1.88	-12.78	6.35	-22.28	-12.89	2.93	-3.28	-7.26	1.42	-7.94	7.34
Vegetables	0.77	-0.83	-1.01	6.88	-2.79	11.50	7.32	-1.65	2.05	4.58	-0.98	4.93	-4.59
Pulses	0.03	-0.04	-0.05	0.30	-0.11	0.49	-0.62	-0.06	0.10	0.22	-0.05	0.23	-0.22
Fruits	0.17	-0.15	-0.33	1.74	-0.58	2.95	1.95	-0.96	0.54	1.23	-0.28	1.29	-1.26
Oil&fats	-0.04	0.06	0.13	-0.63	0.10	-0.95	-0.73	0.04	-1.29	-0.58	0.12	-0.49	0.57
Beverages	1.55	-1.82	-2.82	15.94	-5.01	26.83	19.19	-3.39	5.27	11.27	-2.83	12.49	-12.27
Spices	1.26	-1.52	-2.39	13.49	-4.15	22.58	16.16	-2.83	4.34	9.82	-3.30	10.96	-10.31
Other Cons	-0.12	0.16	0.27	-1.53	0.48	-2.54	-1.83	0.27	-0.52	-1.16	0.25	-2.35	1.14
PFoods&Drink	-3.10	3.20	5.07	-28.71	9.23	-48.71	-34.20	5.72	-9.75	-21.78	5.05	-22.82	17.56
Positive signs	3												

Price Elasticities for Java_Rural (Model II)													
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cons	PFoods&Drink
Cereals	-5.64	0.13	-0.06	0.13	-0.09	0.87	0.64	0.44	-0.02	0.23	0.03	0.09	-0.47
Tuber	-0.07	-2.49	-0.16	-6.86	-0.85	0.74	2.98	-2.40	-0.29	1.19	-0.06	-1.34	-1.85
Fish	-0.06	-0.38	0.28	2.80	0.47	-1.47	-2.77	-2.06	0.01	-1.04	0.20	-0.16	1.95
Meat	0.00	0.19	-0.04	0.32	0.03	-0.01	-0.13	0.16	0.03	-0.08	-0.01	0.12	0.09
Egg&Milk	0.01	0.13	-0.02	0.17	-0.85	-0.06	0.06	0.18	0.03	0.02	0.00	0.24	-0.07
Vegetables	0.18	-0.01	0.09	0.17	0.05	0.04	-0.67	-0.62	0.01	-0.35	-0.02	0.11	0.61
Pulses	0.00	-0.11	0.07	-0.13	0.05	-0.24	-0.95	-0.18	-0.04	-0.19	0.01	-0.17	0.39
Fruits	0.00	0.12	0.05	0.40	0.05	-0.31	-0.29	-0.36	0.00	-0.22	0.00	0.08	0.40
Oil&fats	0.04	0.03	-0.03	0.00	0.00	-0.01	0.06	0.00	-0.99	0.02	-0.04	0.09	-0.04
Beverages	0.17	0.33	-0.26	0.33	-0.30	0.90	2.10	2.15	0.40	0.18	-0.11	1.33	-2.10
Spices	0.01	0.02	-0.02	0.04	-0.02	0.09	0.16	0.13	0.00	0.02	-1.00	0.08	-0.16
Other Cons	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-1.00	0.00
PFoods&Drink	0.02	0.72	-0.34	1.29	-0.25	1.44	2.90	3.70	0.13	1.57	-0.01	0.58	-7.02
Positive signs	4												

Price Elasticities for Java_All (Model II)													
Commodities	Cereals	Tuber	Fish	Meat	Egg&Milk	Vegetables	Pulses	Fruits	Oil&fats	Beverages	Spices	Other Cons	PFoods&Drink
Cereals	-4.78	0.05	-0.02	-0.10	0.60	0.52	0.91	-0.07	0.30	0.57	-0.08	1.18	-0.32
Tuber	0.00	-0.14	-0.18	0.79	3.00	-4.08	2.01	0.44	0.48	1.24	-0.22	2.33	-0.69
Fish	-0.07	-0.19	-0.23	-0.26	-0.10	-1.07	-0.84	0.04	-0.21	-0.33	0.08	-0.72	0.21
Meat	0.04	-0.05	-0.01	-1.88	0.87	-0.54	0.95	0.02	0.26	0.55	-0.11	1.13	-0.30
Egg&Milk	-0.78	-1.02	0.45	4.05	-14.71	5.52	-15.10	0.91	-5.56	-10.47	2.14	-21.15	5.97
Vegetables	0.04	0.46	0.20	-1.13	-0.66	0.72	-5.25	0.09	-1.12	-2.44	0.39	-4.12	1.37
Pulses	-0.12	-0.02	0.08	0.07	-1.00	-0.82	-2.67	0.15	-0.70	-1.27	0.29	-2.53	0.76
Fruits	0.01	-0.01	0.00	0.01	0.09	0.00	0.17	-1.08	0.05	0.10	-0.02	0.20	-0.05
Oil&fats	0.04	0.03	-0.01	-0.16	0.30	-0.07	0.38	-0.07	-1.01	0.06	-0.07	0.47	-0.05
Beverages	0.15	0.01	-0.08	-0.08	1.56	0.20	2.73	-0.13	0.90	0.64	-0.31	3.41	-0.93
Spices	-0.62	-0.08	0.35	0.45	-6.56	-0.51	-11.32	0.57	-3.86	-7.38	0.37	-13.45	3.90
Other Cons	0.10	0.01	-0.06	-0.11	1.11	-0.04	1.78	-0.11	0.55	1.08	-0.22	0.91	-0.64
PFoods&Drink	1.03	0.01	-0.66	-0.49	12.46	0.43	21.58	-1.13	6.65	12.98	-2.35	25.56	-11.56
Positive signs	0												

5.3 Concluding Remarks

This chapter estimated price, expenditure and income elasticities for different consumer groups using two different models. The consumer groups include income groups (low, middle and high income), areas (urban and rural), and regions (Indonesia and Java).

In terms of price elasticities, the overall results suggest that demand for Cereals and Prepared foods and drinks are the two most price – elastic across categories and models, with the exception of the high income group. For the high income group in Model I, demand for Vegetables and Beverages is the most price elastic, whereas demand for Vegetables and Prepared foods and drinks is the most price – elastic for the low income group.

Across areas, Model I suggests that demand for Eggs and milk is the most price – elastic for urban areas, whereas demand for Cereals is the most price – elastic for rural areas. Model II suggests that demand for Cereals is the most price elastic both for rural and urban areas.

In general, in the case of for Java, it seems that price elasticities computed from Model II are more robust than those computed from Model I in terms of expected negative signs for own price elasticities. However, Model II has more ‘giffen’ goods including Pulses, Vegetables, Eggs and milk. Across Java, except in the case of Fruits, Vegetables, and Fish, the negative expected signs of own price elasticities have been confirmed in Model I.

The present study suggests that demand for Fruits in rural Java is more price elastic than as suggested in the previous studies by Olivia (2002) and Deaton (1990), whereas demand for Vegetables is more price – inelastic.

In the case of Indonesia, the present study suggests that with the exception of Eggs and milk and Fruits, the demands for the observed commodities are more price – elastic than in the findings of Olivia and Gibson (2002) and are also more likely to be unitary elastic. Only Oil and fats seems to be less sensitive, both to time variable and model selection, due to the fact that Oil and fats would seem to be an important commodity, from generation to generation, for Indonesian households. In brief, it seems that model II produces more elastic own price elasticities for the goods observed than those derived from Model I, which utilised either 1999 data (Olivia and Gibson study) or 2002 data (the present study).

Both expenditure elasticities (derived from Model I) and income elasticities (derived from Model II) tell a similar story that, in general, Meat, Eggs and milk and Fruits, are the top three commodities having the highest expenditure elasticities as well as the highest income elasticities.

Model II suggests that Meat, Eggs and milk, Other consumptions, and Fruits are considered normal goods in both urban and rural areas. These include Prepared foods and drinks in urban areas whereas in rural areas, this commodity group is perceived as a luxury, as its income elasticity is larger than unity (about 1.2).

It is important to note that the above computed price elasticities, derived from the present study, will be further used as one of the inputs for the tax reform analysis of λ along with the proposed unique inequality aversion parameter that will be presented later in Chapter 6, as well as in considering the existing tax rate regimes.

Chapter 6
Empirical Results II:
Tax reform analysis and policy prescriptions

6.1 Introduction

As almost all taxes cause some economic efficiency losses, the challenge for a tax policy, is to minimize the extent of the losses and at the same time to provide a fair tax system that treats people in similar situations indiscriminately, and treats people of different economic means differently (Stiglitz, 2000; Sandmo, 1976). As mentioned in Chapter 1, the Indonesian tax system has undergone a series of reforms since 1983. Accordingly, the major challenge facing Indonesia's tax reformers is to determine how best to collect revenue in an efficient and equitable manner.

To address the challenge, the current study examines whether the trade – off between efficiency and equity occurs in the tax reforms in Indonesia. More specifically, the study seeks to determine if *Indonesia's commodity tax system can be reformed in a way that maintains revenue while improving social welfare and to see which commodity taxes should be altered so as to increase overall tax revenues at (the) least social cost?*

As the present study deals with aggregate commodities, a selection for commodity tax rates should be carefully carried out. To accommodate this, the present study comes up with different tax rate scenarios. First, the study conducts the tax simulation of 10% uniform tax rates across commodity groups, except for Cereals, Beverages and Prepared foods and drinks (hereafter referred to as the MIX tax rates regime). This is similar to the regime expressed by Olivia (2002) study and by Olivia and Gibson's (2002). This was done for reasons of comparison. The scenario is also aligned with the first Ikhsan's recommendation which was discussed in Chapter 2. Secondly, the study assumes that within the timeframe of the present study, some commodities are also subject to other taxes such as excise tax and sales tax on luxury goods (a detailed discussion can be found in Chapter 3). Accordingly, the present study also conducts a tax simulation using these higher tax rates (hereafter referred to as the MAX tax rates regime). This tax rates regime allows for more variation in the tax rates applied in the Indonesian tax system.

This chapter, which is a continuation of the previous chapter, presents empirical results for Indonesian data analysis according to the methodology discussed in Chapter 4. The chapter is structured as follows. Section 6.1 will be followed by Section 6.2, which presents a calculation for a unique inequality aversion parameter as proposed by the present study. Section 6.3 presents tax reform analysis: lambdas which are computed from Model I and Model II using Indonesian data[6]. The discussion includes a justification of why Model II is selected for tax reform policy prescriptions. Section 6.4 provides the policy prescriptions based on Model II. Finally, Section 6.5 presents the conclusions.

This study employs the marginal tax reform approach, taking the existing tax system and identifying directions of reform at the margin.

Since the methodology reflects that of Deaton (1997), a brief recap this methodology (which was outlined in more detailed in Chapter 4) will be given here. The appendix C also contains a detailed discussion.

Deaton (1997) suggests that taxes affect social welfare through two channels: first, a movement in the tax rate of a particular good *i* will cause a change in welfare ($\partial W_i/\partial t_i$); and secondly, a change in government revenues ($\partial R_i/\partial t_i$). The ratio of those two measures, known as the "Lambda" Pigovian ratio:

$$\lambda_i = \frac{\partial W / \partial t_i}{\partial R / \partial t_i}$$

The lambda gives the marginal social cost (λ_i) of raising one unit of revenue from an increase in the tax of good *i*. If λ_i is larger than one (i.e. the cost of the tax is higher than its benefit) then social welfare would be improved via a decrease in the tax. The opposite is true when λ_i is smaller than one.

When the households are valued differently, e.g. giving more weight to poor households, then it is possible to estimate the effect of the tax reform with respect to

[6] As recognised in Chapter 5, Model I produces less robust own price elasticities than those from Model II. However, the present study still keeps Model I when discussing tax reform analysis, because it is used for a comparison between its computed lambdas and that computed according to Model II in reaching a conclusion of model selection in favour of Model II for prescribing policy prescriptions.

the poor instead of to the average household. More precisely, the weight given to particular households depends on the degree of inequality aversion that society is willing to put in the calculation. Accordingly, higher weight for poorer households will identify a tax reform that is inequality reducing. To this extent, by using Atkinson's social welfare function, the numerator of equation λ can be written as:

$$\frac{\partial W}{\partial t_i} = -\sum_{h=1}^{H} \eta_h q_{ih} = -\frac{1}{H}\sum_{h=1}^{H}\left(\frac{x_h}{n_h}\right)^{-\varepsilon} q_{ih}$$

Where, the term x_h/n_h is the per capita expenditure of household h. The higher the inequality aversion parameter ε, the higher is the weight given, the lower per capita expenditure of households in the computation of λ_i. In the case that ε is zero, all households have the same weights; therefore the effect of tax reform will consider only the average household.

To see how price elasticities enter the computation of changes in social welfare, the denominator of λ can be written as:

$$\partial R/\partial t_i = 1 + \frac{t_i}{1+t_i}\left(\frac{\theta_{ii}}{\tilde{w}_i} - 1\right) + \sum_{k \neq i} \frac{t_i}{1+t_i}\left(\frac{\theta_{ki}}{\tilde{w}_i}\right)$$

Where θ_{ii} is the own price and θ_{ki} is the cross price elasticity and $\tilde{w}_i$ is the budget share for the average households.

$$\lambda_i = \frac{-\dfrac{1}{\dfrac{1}{H}\sum_{h=1}^{H}\left[\dfrac{x_h}{n_h}\right]^{-\varepsilon}} q_{ih}}{1 + \dfrac{t_i}{1+t_i}\left(\dfrac{\theta_{ii}}{\tilde{w}_i} - 1\right) + \sum_{k \neq i} \dfrac{t_k}{1+t_k}\left(\dfrac{\theta_{ki}}{\tilde{w}_i}\right)} \qquad \textbf{6-1}$$

For practical reason, the numerator is re-written, giving the following:

$$\lambda_i = \frac{w_{\varepsilon i} / \tilde{w}_i}{1 + \dfrac{t_i}{1+t_i}\left(\dfrac{\theta_{ii}}{\tilde{w}_i} - 1\right) + \sum_{k \neq i} \dfrac{t_k}{1+t_k}\left(\dfrac{\theta_{ki}}{\tilde{w}_i}\right)} \qquad \textbf{6-2}$$

Where $w_{\varepsilon i}$ and $\widetilde{w}_i$ are defined according to Olivia (2002) and Nicita (2004), as:

$$w_{\varepsilon i} = \left(\sum_{h=1}^{H} \left(\frac{x_h}{z_h} \right)^{-\varepsilon} x_h w_{ih} \right) \Bigg/ \sum_{h=1}^{H} x_h \quad \text{and} \quad \widetilde{w}_i = \left(\sum_{h=1}^{H} x_h w_{ih} \right) \Bigg/ \sum_{h=1}^{H} x_h$$

Where,

x_h = total expenditure of household, *h*

w_i = budget share for good *i*

ε = inequality aversion parameters are deliberately chosen, i.e. ε = 0 (as a reflection of efficiency only) and ε = 1.5 (the unique value of ε which is computed by a new and modified method of Atkinson Index utilisation, discussed in subsection 4.2.3 – as an expression both efficiency and equity aspects)

ti and tk = tax rates for good i and k

θii and θik = own – and cross – price elasticities

i = commodity 1, …, 13

k = other commodity 2, …, 13, (k ≠ i)

zh = number of family members in household *h*

As suggested by equation 6-2, the numerator of the equation for λ is in fact, the equity aspect of a tax reform analysis, whereas the denominator of the equation represents the efficiency aspect of the tax reform analysis. Accordingly, equation 4.3 can be re – written:

$$\lambda_i = \frac{w_{\varepsilon i} / \widetilde{w}_i}{1 + \frac{t_i}{1+t_i}\left(\frac{\theta_{ii}}{\widetilde{w}_i} - 1 \right) + \sum_{k \neq i} \frac{t_k}{1+t_k} \left(\frac{\theta_{ki}}{\widetilde{w}_i} \right)} = \frac{\textit{equity aspect}}{\textit{efficiency aspect}}$$

To explain the equity aspect, the $w_{\varepsilon i} / \widetilde{w}$ shows the share of total budget spent on good *i* by a poor person relative to that spent by an average person. The higher is ε, the poorer is the ‘poor person”. If ε = 0 then, $w_{\varepsilon i} = \widetilde{w}_i$, so that $w_{\varepsilon i} / \widetilde{w} = 1$. It means that there is no distributional concern. In this case the result will be optimal in efficiency rather than in equity.

The denominator of the equation for λ measures the efficiency of the tax. The first term comprises $\frac{t_i}{1+t_i}$ which are the tax factors, and ($\frac{\theta_i}{\tilde{w}_i} - 1$) which are the own – commodity contributions to the tax distortion, i.e. the own price elasticities of quality and quantity together. The product of these two measures its own – price effect, that is, the effect that gives the contribution of the own – price effects to the measure of the distortion that would be caused by a marginal increase in the price of good *i*. The second term of the λ denominator captures the cross – price effect, which combine the effect on other goods (*k*) of the change in tax on good *i*. In sum, the denominator of λ shows the efficiency effects of raising taxes on each of the commodities in which nothing has yet been said about distributional issues ($\varepsilon = 0$). It is important to note that if this term is large (and negative) then it would be costly to further increase revenue through taxes on this commodity.

The usual practice is to analyse the results of the various cost-benefit ratios of lambda (λ_i) calculated for a range of values of ε.

6.2 Inequality Aversion

Before prescribing tax reform policy based on Model II, it is important to estimate a unique inequality aversion parameter to reflect a concern for the poor. The following section provides the estimation of the parameter.

As discussed in Chapter 2, several studies have observed that the choice of model and the degree of inequality aversion are of importance in evaluating the marginal costs of taxation evaluation (Olivia, 2002, Van de Gaer et al, 1997 and Kroll and Davidovitz, 1999). The degree of inequality aversion is measured by the amount society is willing to surrender in order to achieve a more egalitarian distribution of income, that is, the more convex the overall *social* indifference curve, the more averse the society is to inequality (Kroll & Davidovitz, 1999). Olivia and Gibson (2002) point out that the different values of ε reflect different judgments about the desirability of making transfers to reduce income inequality. Accordingly, a range of values of ε is commonly employed to ascertain whether recommendations of tax reform are consistent with particular ethical judgments.

The present study proposes a new approach in order to provide a unique value of ε, by utilising the Atkinson Index approach and an existing income distribution available in Indonesia. The procedure is as follows.

1. By recalling the formula of the equity-sensitive average income (a part of the Atkinson Index approach) used for a calculation of a unique ε is as follows:

   $$y_e = \left(\sum_i^n (y_i).y_i^{1-\varepsilon} \right)^{1/1-\varepsilon}$$

2. By making use of a series of ε values, where most of the literature suggest that the likely values of ε are between 0 and 2, y_e can be estimated from the above y_e equation in which y_i is the existing income distribution available in SUSENAS. However, the present study uses a series of ε values between 0 – 3.45, the values chosen arbitrarily.

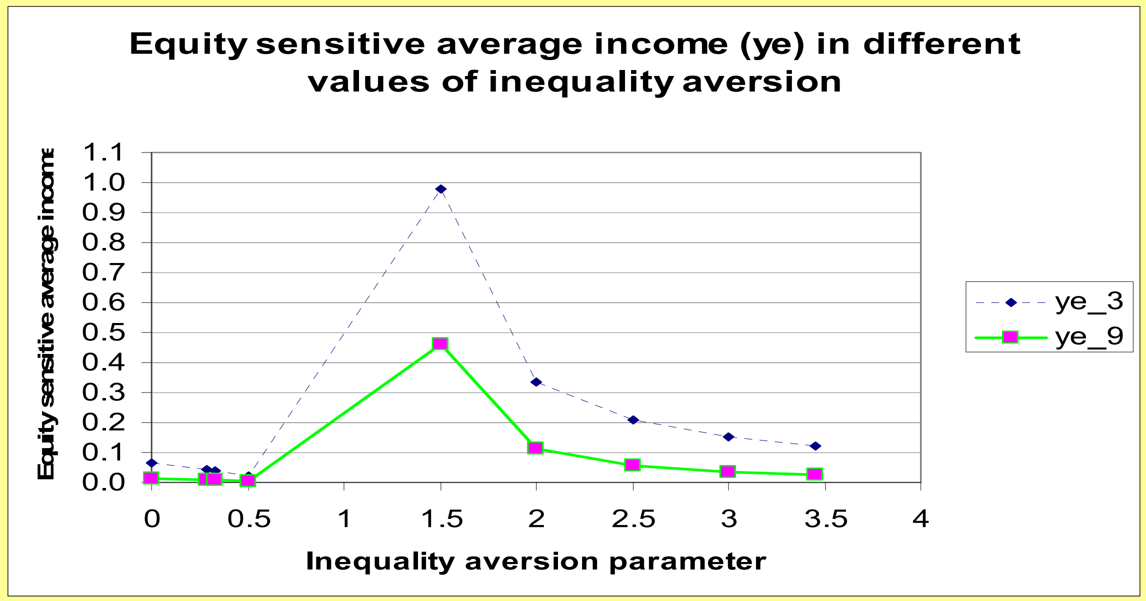
3. By using a maximum principle theory, the ε will be obtained where the max value of y_e is reached and subsequently this unique ε will be used in computing lambda, λ to accompany the computed λ with ε = 0.

4. By looking at the results of calculation of y_e both in terms of three income groups (y_e_3) and of nine income groups (y_e_9). Figure 6.1 illustrates the calculation of y_e according to various inequality aversion parameters.

Figure 6-1 illustrates various values of inequality aversion parameter which are computed by utilising a modified Atkinson index approach and the existing income distribution available in Indonesia (see Appendix E).

Figure 6-1 suggests that at level ε equals 1.5, y_e reaches maximum value both applied in the three and nine income groups considered (the detailed income group categorisation can be found in Chapter 3).

Figure 6-1
Various values of equity sensitivity average incomes (y_e) and various values of inequality aversion parameter by utilising Atkinson index approach and three and nine groups of existing income distribution, 2002



Source: Appendix E

In brief, the study has succeeded in providing a unique estimate for inequality aversion (ε) for Indonesia, namely 1.5. This figure infers that the existing Indonesian tax system is already relatively progressive. This unique figure will be used for policy prescription when considering the poor (instead of using a series "trial and error" numbers as previous studies have mostly done).

6.3 Tax Reform Analysis

In this Sub – section, this thesis examines the existence of a trade off between efficiency and equity aspects in the Indonesian tax system by considering the ranking lambdas derived from Model I and Model II. The lambdas have first been computed by considering the estimated inequality aversion parameters, the estimated price elasticities which were presented in Chapter 5, as well as the existing tax rate regimes: MIX and MAX tax rates.

Just for a convenience, the lambda formula has been recalled.

$$\lambda_i = \frac{w_{\varepsilon i} / \widetilde{w}_i}{1 + \frac{t_i}{1+t_i}\left(\frac{\theta_{ii}}{\widetilde{w}_i} - 1\right) + \sum_{k \neq i} \frac{t_k}{1+t_k}\left(\frac{\theta_{ki}}{\widetilde{w}_i}\right)}$$

Later, the computed lambdas will be ranked from the lowest to the highest lambdas (as commodities observed for policy prescription); but only considering the positive values of lambdas. An increase in tax on commodities with lambdas less than 1 would be recommended, accompanied by a reduction in tax on commodities with lambdas larger than 1 according to the rankings provided.

Table 6-1 lists of computed lambdas for 13 commodity groups, which are not only derived from Model I and Model II but also take into consideration the MIX and MAX tax rate scenarios and various inequality aversion parameters. Two unique inequality aversion parameters were selected, i.e. ε = 0, expressing only the efficiency aspect of tax reform consideration, and ε = 1.5, as estimated by the present study.

The table suggests that Model II produces more robust lambdas than Model I. This is demonstrated by the fact that there are more positive lambdas in Model II than in Model I, regardless of the proposed scenarios corresponding to the tax rate regimes (69.23% versus 43.6%). One generally expects to find positive lambdas since it indicates that there is a MSC of raising taxes (a negative lambda implies that one can raise social welfare by raising tax which is counterintuitive). This infers that Model II identifies more opportunity for reforming the existing tax regime. For example, except for Cereals, Eggs and milk (for all Indonesian households, both urban and rural), Fruits (for Indonesians in urban areas with ε = 1.5) and Other consumptions (for rural Indonesians with ε = 1.5), the computed lambdas are positive.

Table 6-1
Various lambdas for 13 commodities observed which derived from Model I and II according to a MIX tax rate scenario

Commodities	Model I_Indonesia						Model II_Indonesia					
	λ_ε = 0_Mix			λ_ε =1.5_Mix			λ_ε = 0_Mix			λ_ε =1.5_Mix		
	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All
Cereals	3.65	1.76	- 0.49	1.02	0.01	- 2.04	0.09	- 0.09	- 0.13	0.03	- 0.05	- 0.06
Tuber	0.01	- 0.14	- 0.07	0.00	- 0.42	- 0.25	0.24	2.05	3.32	0.05	1.14	1.24
Fish	1.32	1.89	- 0.15	0.27	0.08	- 0.46	0.97	1.23	1.28	0.20	0.63	0.39
Meat	- 0.12	0.01	0.02	- 0.02	0.61	0.03	2.86	7.87	0.25	0.40	2.73	0.04
Eggs and Milk	0.05	- 0.04	- 0.02	0.01	0.03	- 0.04	- 0.20	- 0.21	8.60	- 0.04	- 0.10	1.95
Vegetables	- 0.03	- 5.45	- 0.81	- 0.01	0.07	- 3.13	4.61	1.11	1.12	1.21	0.70	0.43
Pulses	- 0.02	0.03	0.04	- 0.01	0.08	0.16	0.03	0.66	1.18	0.01	0.45	0.51
Fruits	0.24	0.74	- 0.08	0.05	0.06	- 0.20	- 0.13	0.21	1.32	- 0.03	0.10	0.33
Oil and fats	- 0.10	0.15	- 0.39	- 0.03	0.07	- 1.65	1.08	1.19	1.12	0.30	0.81	0.48
Beverages	- 0.20	- 7.20	0.15	- 0.06	0.10	0.63	0.80	1.45	2.00	0.24	0.92	0.84
Spices	0.13	- 1.59	- 1.02	0.03	- 0.34	- 4.14	1.30	1.11	1.15	0.35	0.73	0.47
Other Cons	- 0.03	- 0.07	1.41	- 0.01	0.00	3.89	0.48	- 0.05	1.23	0.11	- 0.02	0.34
PFoods & Drinks	0.27	- 0.62	- 1.40	0.08	1.37	- 4.55	0.60	0.11	1.21	0.19	0.07	0.39

Note: blue shaded cells show negative lambdas

For the Max scenario, Model II suggests that Fruits (for urban Indonesia) and Pulses (rural Indonesia) are added to the list of negative lambdas. However, Max tax rate regime seems to improve the findings derived from Model I, in particular for urban and rural areas. Oil and fats and Other consumptions for urban Indonesia, whereas Eggs and milk, Vegetables, Beverages and Other consumptions for rural Indonesia are added to the list of positive lambdas. Table 6-2 provides the detailed lambdas based on MAX tax rate regime.

Table 6-2
Various lambdas for 13 commodities observed which derived from Model I and II according to a MAX tax rate scenario

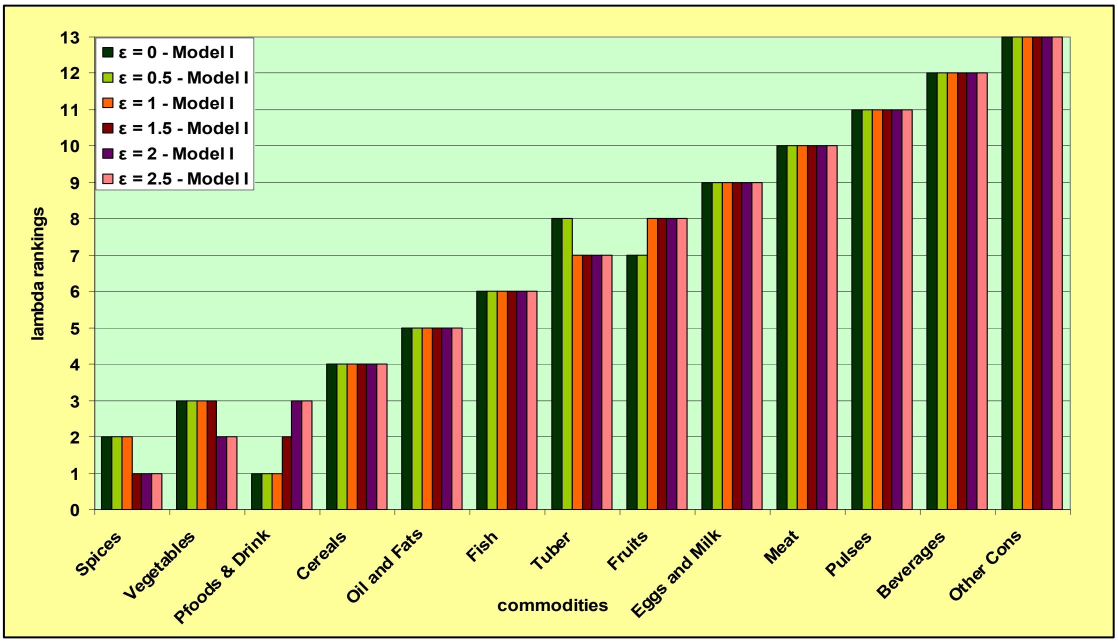
Commodities	Model I_Indonesia						Model II_Indonesia					
	λ_ε = 0_Max			λ_ε =1.5_Max			λ_ε = 0_Max			λ_ε =1.5_Max		
	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All
Cereals	0.09	0.12	- 0.40	0.02	0.01	- 1.66	0.1	-0.05	- 0.12	0.02	-0.03	-0.05
Tuber	- 1.07	- 7.62	- 0.06	- 0.22	- 0.42	- 0.23	0.3	2.05	3.33	0.06	1.14	1.24
Fish	0.85	1.55	- 0.15	0.18	0.08	- 0.45	1.0	1.18	1.28	0.20	0.60	0.39
Meat	29.88	15.68	0.02	4.17	0.54	0.03	3.5	4.34	0.18	0.48	1.51	0.03
Eggs and Milk	- 0.15	0.69	- 0.02	- 0.03	0.03	- 0.04	-0.2	-0.15	10.72	-0.03	-0.07	2.43
Vegetables	4.34	1.12	- 0.76	1.14	0.07	- 2.93	8.0	1.11	1.12	2.09	0.70	0.43
Pulses	0.03	1.19	0.03	0.01	0.08	0.15	0.0	-0.40	1.18	0.01	-0.28	0.51
Fruits	- 0.15	1.29	- 0.07	- 0.03	0.06	- 0.19	-0.1	0.14	1.32	-0.03	0.06	0.33
Oil and fats	1.16	1.18	- 0.37	0.32	0.08	- 1.57	1.1	1.41	1.19	0.31	0.95	0.51
Beverages	- 1.11	2.23	0.16	- 0.33	0.14	0.65	1.9	1.76	3.23	0.56	1.11	1.35
Spices	2.54	- 1.48	- 0.94	0.68	- 0.10	- 3.84	1.3	1.05	1.16	0.34	0.68	0.47
Other Cons	0.33	0.10	1.41	0.07	0.00	3.89	0.3	-0.02	1.23	0.07	-0.01	0.34
PFoods & Drinks	0.62	- 19.76	- 1.30	0.19	- 1.21	- 4.21	0.6	0.08	1.21	0.19	0.05	0.39

Note: blue shaded area show negative lambda

In brief, Model II is more plausible than Model I as it produces more robust lambdas, i.e. produces more positive lambdas (69.23% versus 43.6%).

Before using the estimated parameters to answer the thesis question, it is interesting to note that Models I and II appear to give quite different messages in relation to the existence of equity – efficiency trade off.

Figure 6-2
Various lambda rankings for 13 commodities observed with various inequality aversion parameters derived from Model I

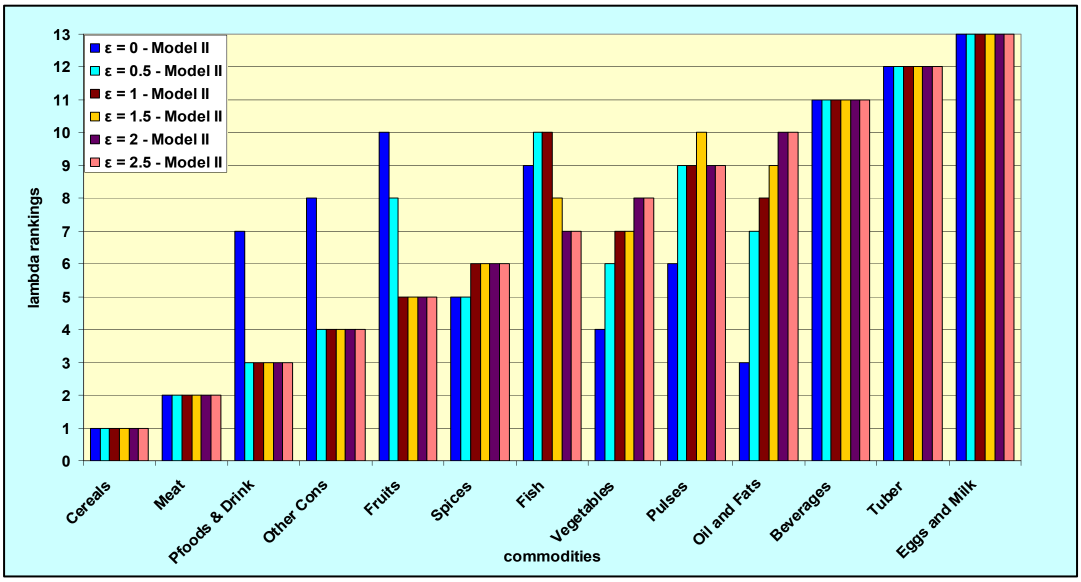


Source: Table 6.1. The figure includes negative lambdas for the rankings.

Firstly, Figure 6-2 suggests that there is no – trade off between efficiency and equity in Model I because it always tells us to lower taxes on Other consumptions, Beverages and Pulses (the commodities with λ larger than 1) and to raise taxes on Spices and Vegetables (the commodities with λ less than 1). In fact, changing ε makes no difference to the λ rankings.

In contrast, Figure 6-3 suggests that there is a trade off if using Model II since changing ε changes λ too. For example, if the policy makers should increase taxes on Cereals and Meat and should lower Eggs and milk, and Tubers. Inequality is irrelevant in these cases. However, if the policy makers do care about the poor, then taxes on Prepared foods and drinks, Other consumption and Fruit should be increased.

Figure 6-3
Various lambda rankings for 13 commodities observed with various inequality aversion parameters derived from Model II



Source: Table 6.2. The figure includes negative lambdas for the rankings.

In brief, the findings derived from Model I by using Indonesian data, suggest that there is no significant trade – off between efficiency (ε = 0) and equity (ε = 1.5) aspects in the tax reform. This fact can be seen from Figure 6-3 illustrating that lambda rankings with ε = 0 move in the same direction as those having ε = 1.5. However, when the analysis is derived from Model II, a trade – off between the efficiency and equity seems to occur. In particular, this has been demonstrated by the ranked commodities based on the computed lambdas with ranged values of ε between 0 and 1.5.

6.3.1 Addressing the Key – research questions

(a) *Can Indonesia's commodity tax system be reformed in a way that maintains revenue while improving social welfare?*

(b) *Which commodity taxes should be altered so as to increase overall tax revenues at (the) least social cost?*

In order to answer these questions, a key element of the tax reform analysis should take into consideration, i.e. lambda – the Pigovian Ratio. As is evident from the preceding discussion, lambda is computed from several variables: the inequality aversion parameters; the existing tax rate regimes; the own – and cross – price elasticities of the commodity groups; and equity.= 0 and 1.5 (see Figure 6 - 3 above).

To prescribe tax reform policy, the present study considers only two unique inequality aversion parameters. ε = 0 demonstrates the efficiency aspect and ε = 1.5 shows how the government and society care for the poor (equity aspect). Considering that policy prescription follows the rule of ***one policy for all*** the present study only takes into account Indonesian data. However, similar analysis has been undertaken of Indonesian urban and rural areas to complement the Indonesian data analysis.

In order to provide answers to the research questions one must consider the following:

1. To maintain the tax revenues, it is important to reform tax rates by increasing tax on commodities which have the highest λ rankings and at the same time reducing tax on commodities having the lowest λ rankings
2. To increase the overall tax revenues at least social cost, it is useful to prescribe a tax change policy by increasing the tax on commodities which have positive values of λ (that is less than one). The smallest positive lambdas can raise revenue at least cost.

To prescribe a rational policy, there will be two scenarios: First, the Scenario under MIX TAX RATE REGIME and secondly, the Scenario under MAX TAX RATE REGIME. They are introduced in order to accommodate a difference between fairly uniform tax rates and more varied tax rates applied in the Indonesian tax system. The scenarios can be illustrated in Table 6-3 below.

Table 6-3
Policy Prescriptions according to Commodity Groups based on Model II utilising Indonesian Data, 2002

Indonesia										
Commodities	Mix Tax Rate Regime (Fairly Uniform Tax Rates)					Max Tax Rate Regime (Various Tax Rates)				
	Tax Rates	λ		Tax reform policy prescription		Tax Rates	λ		Tax reform policy prescription	
		ε = 0	ε = 1.5	Efficiency	Efficiency + Equity		ε = 0	ε = 1.5	Efficiency	Efficiency + Equity
Cereals	0.23	-0.13	-0.06			1.17	-0.12	-0.05		
Tuber	0.10	3.32	1.24		reduce tax	0.10	3.33	1.24		reduce tax
Fish	0.10	1.28	0.39			0.10	1.28	0.39		
Meat	0.10	0.25	0.04	increase tax	increase tax	0.10	0.18	0.03	increase tax	increase tax
Eggs and Milk	0.10	8.60	1.95	reduce tax	reduce tax	0.20	10.72	2.43	reduce tax	reduce tax
Vegetables	0.10	1.12	0.43			0.10	1.12	0.43		
Pulses	0.10	1.18	0.51			0.10	1.18	0.51		
Fruits	0.10	1.32	0.33		increase tax	0.10	1.32	0.33		increase tax
Oil and fats	0.10	1.12	0.48			0.20	1.19	0.51		
Beverages	0.10	2.00	0.84			0.67	3.23	1.35		reduce tax
Spices	0.10	1.15	0.47			0.10	1.16	0.47		
Other Cons	0.10	1.23	0.34			0.10	1.23	0.34		increase tax
Prep Foods & Drinks	0.15	1.21	0.39			0.15	1.21	0.39		

To address the first research question, it is important to understand that the effect of a small change in the tax rate that can be inferred from the analysis of the cost benefit ratio λ. Table 6 – 3 suggests that in the case of no aversion to inequality (ε = 0), the most efficient way to increase social welfare would be to decrease the tax on Eggs and milk (λ >1) and conversely, raise the tax on Meat (λ <1). However, an increase in the tax on Meat does not seem to be an efficient way to collect funds for the government as demand for Meat is price elastic; therefore if an increase in the price of Meat resulted from an increase in tax, households would tend to shift their demand to non – meat commodities including Eggs and milk. Whereas an increased tax on Fruits and a lower tax on Tubers are complementary to an increase in tax on Meat and a lower tax on Eggs and milk in order to promote equity or to reduce inequality. Fruits also have a high own price elasticity.

The answer (all but trivial) to the second research question which logically follows from this, is that governments who wish to raise revenues at least social cost should increase the tax on Meat since it has the highest lambda.

In brief, in the scenario of MIX TAX RATES Regime, Model II suggests that the policy maker should raise the tax on Meat and reduce the tax on Eggs and Milk if only interested in efficiency. But there is more scope for government to improve welfare when considering the poor (distributional concerns), i.e. by increasing tax on

Meat and Fruits but reducing tax on Eggs and milk and Tubers. Likewise, if the goal of policymakers is to raise tax (rather than just lower social cost) then they should raise the tax on both Meat and Fruits.

Based on the scenario of MAX TAX RATE REGIME, more room is available for the Indonesian government to undertake tax reform. Under this regime, the policy maker adds recommendations made under MIX TAX RATE REGIME which prescribes that the policy maker should increase tax on Other consumptions and lower tax on Beverages if wishing to maintain revenue while increasing social welfare.

It is important to note that the policy recommendations are likely to differ when analysing different regions (urban or rural areas). Similar simulations derived from Model II for urban and rural areas only are also repeated in this study (see Table 6.4 below). The tax reform simulation for Indonesian urban areas suggests that policymakers should raise taxes on Cereals and on Pulses and reduce taxes on Meat and on Vegetables when only the efficiency aspect is concerned, whereas if the government has more concern for the poor, policy makers should raise the tax on Pulses and lower the tax on Vegetables. This simulation is not sensitive to tax rate regime. In the mean time, the tax reform simulation for Indonesian rural areas suggests that policy makers should raise taxes on Fruits and on Prepared foods and drinks and reduce taxes on Tubers and on Meat when considering both efficiency and equity aspects. This means that under the MIX tax rate regime, the recommendations are not sensitive to the choice of inequality aversion parameters. However, under MAX tax rate regime, more scope is provided for tax reform as more commodity groups are subject to the tax reforms. For example, when considering the efficiency aspect only, similar tax reforms to MIX tax rate regime recommendation are prescribed. However, when the government shows more concerns for the poor, policy makers should raise tax on the commodity group of Fish and lower the tax on Beverages in addition to the recommendation for the efficiency aspect only.

Table 6-4

Policy Prescriptions according to Commodity Groups based on Model II utilising Urban and Rural Indonesian Data, 2002

Urban										
Commodities	Mix Tax Rate Regime (Uniform Tax Rates)					Max Tax Rate Regime (Various Tax Rates)				
	Tax Rates	λ		Tax reform policy prescription		Tax Rates	λ		Tax reform policy prescription	
		ε = 0	ε = 1.5	Efficiency	Efficiency + Equity		ε = 0	ε = 1.5	Efficiency	Efficiency + Equity
Cereals	0.10	0.09	0.03	increase cereals		1.17	0.09	0.02	increase cereals	
Tuber	0.10	0.24	0.05			0.10	0.29	0.06		
Fish	0.10	0.97	0.20			0.10	0.98	0.20		
Meat	0.10	2.86	0.40	reduce meat		0.10	3.45	0.48	reduce meat	
Eggs and Milk	0.10	-0.20	-0.04			0.20	-0.16	-0.03		
Vegetables	0.10	4.61	1.21	reduce vegetables	reduce vegetables	0.10	7.97	2.09	reduce vegetables	reduce vegetables
Pulses	0.10	0.03	0.01	increase pulses	increase pulses	0.10	0.03	0.01	increase pulses	increase pulses
Fruits	0.10	-0.13	-0.03			0.10	-0.14	-0.03		
Oil and fats	0.10	1.08	0.30			0.20	1.13	0.31		
Beverages	0.10	0.80	0.24			0.67	1.89	0.56		
Spices	0.10	1.30	0.35			0.10	1.28	0.34		
Other Cons	0.10	0.48	0.11			0.10	0.31	0.07		
Prep Foods & Drinks	0.10	0.60	0.19			0.15	0.62	0.19		
Rural										
Commodities	Mix Tax Rate Regime (Uniform Tax Rates)					Max Tax Rate Regime (Various Tax Rates)				
	Tax Rates	λ		Tax reform policy prescription		Tax Rates	λ		Tax reform policy prescription	
		ε = 0	ε = 1.5	Efficiency	Efficiency + Equity		ε = 0	ε = 1.5	Efficiency	Efficiency + Equity
Cereals	0.10	-0.09	-0.05			1.17	-0.05	-0.03		
Tuber	0.10	2.05	1.14	reduce tuber	reduce tuber	0.10	2.05	1.14	reduce tuber	reduce tuber
Fish	0.10	1.23	0.63			0.10	1.18	0.60		increase fish
Meat	0.10	7.87	2.73	reduce meat	reduce meat	0.10	4.34	1.51	reduce meat	reduce meat
Eggs and Milk	0.10	-0.21	-0.10			0.20	-0.15	-0.07		
Vegetables	0.10	1.11	0.70			0.10	1.11	0.70		
Pulses	0.10	0.66	0.45			0.10	-0.40	-0.28		
Fruits	0.10	0.21	0.10	increase fruits	increase fruits	0.10	0.14	0.06	increase fruits	increase fruits
Oil and fats	0.10	1.19	0.81			0.20	1.41	0.95		
Beverages	0.10	1.45	0.92			0.67	1.76	1.11		reduce beverages
Spices	0.10	1.11	0.73			0.10	1.05	0.68		
Other Cons	0.10	-0.05	-0.02			0.10	-0.02	-0.01		
Prep Foods & Drinks	0.10	0.11	0.07	increase pfoods&drinks	increase pfoods&drinks	0.15	0.08	0.05	increase pfoods&drinks	increase pfoods&drinks

6.4 Conclusions

The study examines whether the trade – off between efficiency and equity occurs in the tax reforms in Indonesia. More specifically, the study aims to answer the following research questions: (1) *Can Indonesia's commodity tax system be reformed in a way that maintains revenue while improving social welfare? (2) Which commodity taxes should be altered so as to increase overall tax revenues at (the) least social cost?*

To address those research questions, Deaton (1997) suggests a way for this, i.e. by looking at how taxes affect social welfare. He suggests that there are two channels: first, a movement in the tax rate of a particular good *i* will cause a change in welfare; and secondly, a change in government revenues. The ratio of those two measures is known as the "Lambda" Pigovian ratio.

It is evident that the lambda is computed from several variables: the inequality aversion parameters; the existing tax rate regimes; the own – and cross – price elasticities of the commodity groups; and the equity aspect of the lambdas (i.e. the relative shares of the market-representative individual and the socially-representative individual whose income is lower, the higher the inequality aversion parameter ε).

A unique inequality aversion (ε) of 1.5, as an expression of how society cares about the poor (equity aspect of lambda), has been proposed by the study by utilising the modified Atkinson Index and the existing income distribution. This figure will be compared with $\varepsilon = 0$ represents efficiency aspect of lambda only. At the mean time, this study adopts two different tax rate regimes. First, The MIX tax rate regime is introduced to accommodate a fairly uniform tax rates whereas the MAX tax rate regime allows more varied tax rates applied in the Indonesian tax system.

In order to prescribe tax reform policy, the computed lambdas will be ranked from the lowest to the highest lambdas (as commodities observed for policy prescription); but only considering the positive values of lambdas. The policy makers should increase tax on commodities with small positive lambdas and should reduce tax on commodities with lambdas larger than 1 if wishing to keep maintain government revenues. In other word, to maintain revenues while improving income distribution and incentives for efficiency, it is important to identify cases where one can (a) raise some taxes which are efficient and / or fair; and (b) lower taxes which are inefficient and / or unfair, thereby keeping the government revenue neutral

The findings of the present study suggest that Model II produces more robust lambdas than Model I, i.e. Model II produces 69.23% of positive lambdas whereas Model I produces 43.6% of positive lambdas.

Model II suggests that, under the scenario of MIX tax rate Regime, the policy maker should raise the tax on Meat and reduce the tax on Eggs and Milk (efficiency only) but provide more scope for government to raise revenue when considering the poor (distributional concerns), i.e. by increasing the tax on Meat and Fruits but reducing the tax on Eggs and milk and Tubers. Whereas, based on the scenario of MAX tax rate regime, more room is made available for the Indonesian government to undertake tax reform. Under this regime, policy makers add recommendations made under MIX regime by prescribing that policy makers should increase tax on Other consumptions and lower tax on Beverages, to meet distributional concerns.

Recommendations derived from Model II using (a) only urban areas; (b) only rural areas are also considered in this study. The simulation for Indonesian urban areas is not sensitive to the tax rate regime whereas for Indonesian rural areas, the recommendations under MIX tax rate regime are not sensitive to the choice of inequality aversion parameters. Under MAX tax rate regime, more scope is provided for tax reform since more commodity groups are subject to the tax reforms.

When the analysis focuses only on urban areas, then policymakers should increase tax on Cereals and Pulses and lower tax on Meat and Vegetables if considering only efficiency aspect. However, the policymakers should raise tax on pulses and reduce tax on vegetables if equity considerations are important.

When rural areas are the focus for the tax reform policy, then the analysis suggests that policy makers should increase tax on Fruits and Prepared foods and drinks and lower tax on Tubers and Meat. More commodity groups are subject to the reform when allowing for more variation in the tax rates applied in the tax system. This regime suggests that apart from the former recommendation, the policymakers should also raise tax on Fish and reduce tax on Beverages when equity aspect is also considered.

Chapter 7
Conclusions, Policy Prescriptions, Contribution to Existing Knowledge, Limitations and Future Research Directions

As mentioned in the previous chapters, this study examines whether the trade off between efficiency and equity exists in the tax reform in Indonesia. More specifically, the study is set out to answer the following research questions: (1) *Can Indonesia's tax system be reformed in a way that maintains revenue while improving social welfare? (2) Which commodity taxes should be altered so as to increase overall tax revenues at (the) least social cost?*

The general approach of the study was: (a) To determine the way in which demand for different commodities change in response to changes both in price and in income; (b) To obtain a unique estimate of inequality aversion in Indonesia (using Atkinson Index); (c) To investigate a direction for indirect tax reform by employing the estimated demand elasticities and the inequality aversion parameter combined with information on existing tax rates for future tax policy recommendations.

In order to achieve the objectives of the study, Preparatory and Tax Reform "Lambda" Analyses have been carried out. **The Preparatory analysis** involved estimates of the two proposed models: a compensated Hicksian demand model (Model I) and an uncompensated Marshallian demand model (Model II). The David Mackinnon variable specification test for family size (Z) was conducted and Heteroscedasticity was controlled for.

The Tax reform 'Lambda' Analysis comprised two initial analyses and one comprehensive analysis. First, Price elasticities were estimated using two different models both of which used Deaton's three stage procedure to circumvent the unobservable price and zero – consumption problems. Next, a unique inequality aversion parameter was estimated (by employing the Atkinson Index and the existing income distribution). Finally, directions for future taxes change were analysed by using the computed price elasticity estimates; the estimated inequality aversion index; and the existing tax rates adopted by the Indonesian economy. Here, Ahmad and Stern's approach of lambda computation for tax reform analysis were adopted.

This chapter presents key findings of the above analyses and consists of four sections. Conclusions are presented in Section 7.1 whereas Policy Recommendation will be prescribed in Section 7.2. Contributions of the present study to existing knowledge will be presented in Section 7.3. Finally, Limitations of the study as an inspiration for future research direction will be discussed in Section 7.4.

7.1 Conclusions

1. The findings of the present study demonstrate that
   a. Model II produces more plausible outcomes compared to Model I for the following reasons:
      (1) It has more plausible (negative) own price elasticities as expected, except for Java case;
      (2) It has more positive 'Lambdas' (69.23% versus 43.6%);
      (3) It generates estimates of income elasticities for policy decision purposes.
   b. The non nested 'Davidson and MacKinnon' test was carried out to determine whether it was better to use Z or that of log Z as regressor in the model. This test was inclusive and the present study selected the model with Z since it offers more plausible own price elasticities for Model I and Model II.
   c. Model I is most often used for policy prescription. However, Model II can be alternatively used to Model I since its uncompensated estimates of own price elasticities closely approximate compensated elasticities. Accordingly, Model II can be used as an alternative to Model I to estimate welfare effect of tax reform analysis.
   d. For Indonesia as a whole, Model I indicates that there may not be a trade off between the efficiency ($\varepsilon = 0$) and equity ($\varepsilon = 1.5$) aspects of tax reforms, whereas the trade off seems to occur when employing Model II. Also, policy prescriptions derived from Model I are not sensitive to a choice of tax rate regimes and inequality aversion parameters, whereas Model II seems to be sensitive to the choice of inequality aversion parameters, but not to differences in tax rate regimes.

2. In terms of price elasticities, the present study suggests that (see Table 7-1 for more detailed)
    a. Demand for Cereals and Prepared foods and drinks are the two most price – elastic commodity groups across categories and models, except for high income consumers. For them, Model I suggests that demand for Vegetables and for Beverages are the most price elastic, whereas the demand for Vegetables and for Prepared foods and drinks are the most price – elastic for low income consumers.
    b. Model I suggests that demand for Eggs and milk is the most price – elastic for urban areas whereas demand for Cereals is the most price – elastic for rural areas. Model II suggests that Cereals is the most price elastic commodity group both in rural and urban areas.
    c. In Java, it seems that price elasticities computed from Model II are more robust than those computed from Model I in terms of expected negative signs for own price elasticities. However, Model II has more 'giffen' goods including pulses, vegetables, eggs and milk. In Java, except in the case of fruits, vegetables, and fish, the negative expected signs of own price elasticities have been confirmed in Model I.
    d. In Java, demand for Fruits in rural areas is more price elastic than that suggested by the previous studies, whereas demand for Vegetables is more price inelastic, compared to Olivia's (2002) study and Deaton's (1990) study.
    e. In Indonesia, except Eggs and milk and Fruits, the demands for the observed commodities are more price elastic than Olivia and Gibson's findings (2002) and many are unitary elastic.
    f. The study suggests that demand systems in Java are not a representative of Indonesian demand systems. As a consequence, the present study did not take into consideration the Java data for the tax reform policy prescription

Table 7-1
Types of commodities according to their price elasticity, areas and regions, 2002

Price Elasticity according to commodity observed and areas, 2002												
Commodities	Model I						Model II					
	Indonesia			Java			Indonesia			Java		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
Cereals	elastic	elastic	elastic	elastic	elastic	elastic	elastic	elastic	elastic	elastic	elastic	elastic
Tuber	elastic	elastic	unitary	inelastic	elastic	elastic	unitary	inelastic	unitary	elastic	elastic	elastic
Fish	giffen	giffen	unitary	giffen	elastic	giffen	inelastic	inelastic	inelastic	inelastic	elastic	giffen
Meat	inelastic	elastic	unitary	inelastic	elastic	inelastic	inelastic	inelastic	inelastic	inelastic	elastic	giffen
Eggs and Milk	inelastic	elastic	inelastic	elastic	elastic	elastic	elastic	elastic	inelastic	giffen	elastic	inelastic
Vegetables	inelastic	giffen	unitary	giffen	inelastic	inelastic	unitary	inelastic	unitary	giffen	inelastic	giffen
Pulses	inelastic	elastic	unitary	unitary	elastic	inelastic	unitary	inelastic	inelastic	giffen	elastic	inelastic
Fruits	inelastic	giffen	unitary	giffen	elastic	elastic	unitary	inelastic	elastic	inelastic	elastic	inelastic
Oil and fats	inelastic	elastic	unitary	inelastic	unitary	unitary	unitary	unitary	unitary	unitary	unitary	inelastic
Beverages	inelastic	elastic	unitary	elastic	elastic	inelastic	unitary	inelastic	unitary	unitary	elastic	giffen
Spices	elastic	elastic	unitary	inelastic	inelastic	inelastic	unitary	inelastic	unitary	unitary	inelastic	unitary
Other Cons	unitary	elastic	unitary	elastic	elastic	inelastic	unitary	inelastic	elastic	inelastic	elastic	unitary
Prep Foods & Drinks	elastic	elastic	elastic	elastic	elastic	elastic	inelastic	elastic	elastic	elastic	elastic	elastic

3. In terms of expenditure and income elasticities, the study suggests that both expenditure elasticities (derived from both Models I and II) and income elasticities (derived from Model II) come to similar conclusions: that in general Meat, Eggs and milk and Fruits, have the highest expenditure elasticities and also the highest income elasticities.

4. This study has succeeded in providing a unique estimate for inequality aversion (ε) for Indonesia, namely 1.5. This figure infers that the existing Indonesian tax system is already relatively progressive.

5. The descriptive analysis of Chapter 3 also found some interesting and noteworthy facts:
   a. The average income of rich households is significantly larger than average expenditure, whereas the average income for urban households is close to expenditure. However, rural households have both higher income and expenditure than urban households. As a consequence, the rural savings ratio was also larger than the urban. In addition, the average budget share for food is generally relatively large compared to that for non-food. Only in Jakarta - the richest region – does the average budget share for non-food exceed that for food.
   b. Expenses for Cereals, Prepared foods and drinks, Spices, Beverages flavour for food categories, and Housing and household facilities and

Goods and services for non food categories are the largest contributors to household budget expenditure.

c. In general, expenditures for Clothes, Durables and Goods and services are high for urban areas, with Jakarta being the highest. Bali has the highest expenditure on Festivities because of their traditions. Furthermore, urban rich regions spend most of their income on Housing and household facility expenses – the highest being in Jakarta. Clothes tend to be categorised as normal goods as their budget share seems constant across income groups.
d. Although the highest spending was in the richest regions such as Jakarta and Bali, expenses for Taxes and insurance were still low, even lower than the expenses for Tobacco and betel across all regions and income groups.
e. Alcohol consumption was relatively high in urban areas compared to rural areas. It was found that in poor urban regions, such as Gorontalo and East Nusa Tenggara where the majority of the people are Christian, more alcohol is consumed.

7.2 7.2 Policy Prescriptions

The following tax reform policy prescriptions are proposed based on the positive computed lambdas which comprise important elements such as estimates of price elasticities which must first be determined, the degree of inequality aversion parameter and assumptions about the existing tax rate regimes. In this study there are 6 different simulations have been carried out: three different regions and two different tax rates regimes (MIX and MAX tax rate regimes). It is important to note that the present study focused primarily on the prescription derived from Model II although that for Model I are presented in Appendix F.

Table 7-2
Tax reform policy prescriptions suggested by Model II according to areas, 2002

Model	Tax reform policy prescription			
	Mix Tax Rate Regime		Max Tax Rate Regime	
	Efficiency	Efficiency + Equity	Efficiency	Efficiency + Equity
Indonesia				
Model II		reduce tuber		reduce tuber
	increase meat	increase meat	increase meat	increase meat
	reduce Eggs&milk	reduce Eggs&milk	reduce Eggs&milk	reduce Eggs&milk
		increase fruits		increase fruits
				reduce beverages
				increase other cons
Urban				
Model II	increase cereals		increase cereals	
	reduce meat		reduce meat	
	reduce vegetables	reduce vegetables	reduce vegetables	reduce vegetables
	increase pulses	increase pulses	increase pulses	increase pulses
Rural				
Model II	reduce tuber	reduce tuber	reduce tuber	reduce tuber
	reduce meat	reduce meat	reduce meat	reduce meat
	increase fruits	increase fruits	increase fruits	increase fruits
	increase pfoods&drinks	increase pfoods&drinks	increase pfoods&drinks	increase pfoods&drinks
				increase fish
				reduce beverages

1. Under the scenario of MIX TAX RATES Regime, Model II suggests that policy makers could maintain revenues while increase social welfare if they raise the tax on Meat and reduce the tax on Eggs and Milk (if only interested in efficiency). But there is more room for change when considering the poor (distributional concerns). In this case, governments could improve social welfare by increasing tax on Meat and Fruits while reducing tax on Eggs and milk, and Tubers.

2. The MAX TAX RATE REGIME suggests that the tax rate on more commodities should be changed if wishing to improve social welfare while maintaining revenues. Under this regime, the policy makers should make the changes in under MIX scenario (point 1) and should also increase the tax on Other consumption while lowering the tax on Beverages to meet distributional concerns.

3. The proposed recommendation for Meat by the present study matches those of Olivia and Gibson‘s study – but the reasons for this differ. Olivia and Gibson's study found that, *inter alia*, the demand for Meat was price inelastic. They also found that Meat had the highest expenditure elasticity. So while this study suggests that raising the tax on Meat would be inefficient but equitable; their study concluded that raising tax on Meat would be both efficient and equitable.

4. The simulation for Indonesian urban is not sensitive to the tax rate regime but is sensitive to the choice of inequality aversion parameters. However, for Rural Indonesia, the recommendations under MIX tax rate regime are not sensitive to the choice of inequality aversion parameters, whereas under MAX tax rate regime, there is more room for tax reform as more commodity groups are subject to tax reform.
5. Indonesian Urban data analysis suggests that under both the MIX and the MAX TAX RATES Regimes, policy makers should increase taxes on Cereals and Pulses and lower taxes on Meat and Vegetables if aiming to improve efficiency. If they believe that equity is an important part of social welfare, then they should tax on pulses and reduce tax on vegetables.
6. Indonesian Rural data analysis suggests that under a scenario of MIX TAX RATES Regime, policy makers should increase taxes on Fruits and Prepared foods and drinks while lowering taxes on Tubers and Meat. Under MAX TAX RATES regime, more commodity groups are subject to the reforms: policymakers should raise taxes on Fish and reduce taxes on Beverages.

7.3 Contributions to existing knowledge

The most interesting feature of this study in terms of its contributions to existing knowledge is threefold. First, this study proposes a different variable specification of family size (Z) using Z instead of log Z in the equations adopted from Deaton's three stage procedure.

Second, this study also introduces uncompensated 'Marshallian' demand Model as an alternative to compensated 'Hicksian' demand Model (which is mostly utilised by previous studies) to be used for estimating the welfare effect of tax reform. Based on Indonesian data, the Marshallian welfare estimates associated with Model II are likely to be reasonable approximation to compensating and / or equivalent variation as the income effects estimated were negligible.

Finally, this study introduces the modified Atkinson Index approach to estimate a unique inequality aversion parameter as an alternative to a series "trial and error" numbers as previous studies have mostly done.

7.4 Limitations and Future Research Directions

Analysing different commodity groups and / or different regions are likely to result in different policy recommendations. Accordingly, it may be important to conduct further research using smaller commodity groups as well as analysing regional taste variations, in order to capture not only the magnitude of cross – price elasticities but also different consumption and taste patterns among households.

Further, the Ordinary Least Square (OLS) employed in this study may suffer from inefficient estimation in cases where the errors of different demand functions are correlated. Accordingly, Seemingly Unrelated Regression (SUR) is recommended to correct the inefficiency of the OLS estimators for future research agenda; provided of course one is able to collect data on the entire system of demand. This study was unable to include non-food commodity groups within its analysis (due to an absence of quantity data; that would allow for the calculation of unit values). Further research should aim to include these commodity groups to ensure that the analysis relates to a complete demand system.

The study recognizes that the majority of the Indonesian people living in coastal area tend to be high consumers of fish, so that fish is a potential substitute for meat for majority of the households, disregarding regional and income variations. At the meantime, Indonesian households generally spend more on tobacco and betel than meat. Unfortunately, tobacco and betel are excluded in the econometric analysis due to low participation rates. Accordingly, a study on meat in relation to fish as a potential substitute for it, and on betel and tobacco might be worthy of further investigation.

In addition, the unit values used in this study may not accurately represent true prices Although unit values have been used in many studies, some researcher believe that the use of unit values may give biased results (Deaton, 1997). The problem with unit values is that, as Gibson and Rozelle (2001) observed, in contrast to market prices, the unit values reflect household – specific quality and reporting error effects, and are subject to sample selection effects, because they are unavailable for non – purchasing households. Even procedures developed by Deaton (1990) to correct these biases have been shown to produce inaccurate and imprecise results (Gibson and

Rozelle, 2001). Accordingly, further research could usefully test the techniques used to estimate unit values by comparing estimates with market prices that have been collected 'in the field'.

Nevertheless, this study highlights the fact that the Indonesian tax system can, indeed, be reformed. If the only goal is to maintain taxes while improving social welfare then policy makers should raise taxes on Meat, Fruits, and Other consumption and lower taxes on Tubers, Eggs and milk, and Beverages according to the existing tax rate regimes. On the other hand, if the goal of policy makers is to raise revenue at least social cost, this analysis suggests that policy makers should raise tax on Meat, Fruits and Other consumptions.

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Appendix A: Key points of relevant economic issues

There are some relevant economic issues which should be acknowledged to be familiar with for preliminary knowledge for tax reform analysis.

Tax and the principles

Tax imposes a cost on the taxpayer in terms of opportunity to consume, produce, and enjoy goods and services. Most public finance and tax policy experts agree that taxes should have a minimal, or neutral, effect on the behaviour of consumers, thereby satisfying economic efficiency principle. As almost all taxes result in some loss of economic efficiency, the challenge for economic policy, in particular tax policy, is to limit the extent of the efficiency losses and simultaneously provide a fair tax system that treats people in similar situations similarly, and treats people of different economic means differently (Stiglitz, 2000; Sandmo, 1976). Accordingly, it is important to understand these basic tax principles to produce a rational tax policy accepted by the majority of society.

Efficiency: Excess burden, Ramsey rule and inverse elasticity rule

'**Excess burden'** of taxation represents an efficiency loss which must be compared with any perceived gains arising either from income redistribution or from the non-transfer expenditure carried out by the government (Creedy, 2003).

To minimise total excess burden, tax rates should be set so that the percentage reduction in the quantity demanded of each commodity is the same, as observed by Rosen (2005), this is called the **Ramsey rule**. However, in terms of government revenue generation and efficiency consideration, the Ramsey rule does not necessarily suggest all rates have to be set uniformly.

The tax rate set should be dependent on the demand elasticities of the taxable goods which are clearly expressed in **Inverse elasticity rule**. The Inverse elasticity rule suggests that the tax rates should be inversely proportional to elasticities as long as commodities are unrelated in consumption (Rosen, 2005). By assuming that two goods involved, x and y, the higher is η_x (demand elasticity of good x) relative to η_y (demand elasticity of good y), the lower should be t_x (tax rate on good x) relative to t_y

(tax rate on good *y*). The intuition behind the rule is that an efficient tax distorts economic decisions in particular in consuming the taxable goods as little as possible, as, the more elastic the demand for a commodity, the greater the potential for distortion.

Equity: Welfare and Social Welfare (SWF)

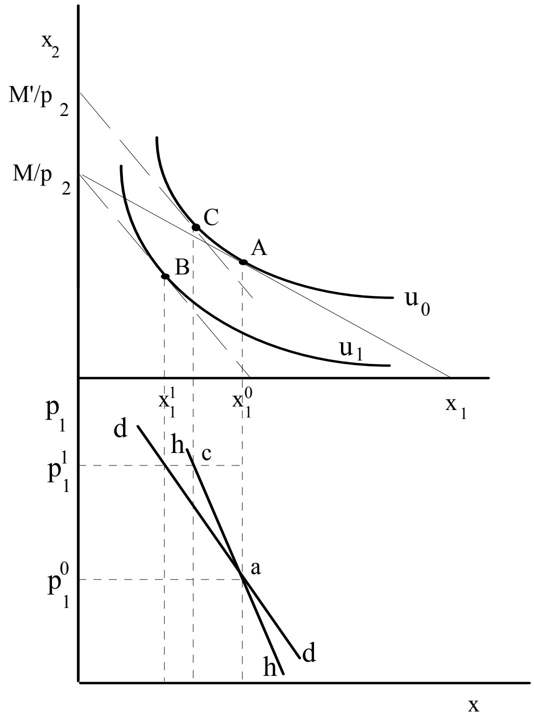
Welfare in economic terms means utility or happiness or satisfaction. Unfortunately, welfare is unmeasurable, but the change in welfare is measurable. **Social welfare** is determined positively by the welfare of individuals whereas **welfare of individuals** is determined by the goods and services they consume (Gans, King & Mankiw, 2003; Morton, 2003).

Price change: substitution and income effects

A tax imposition makes the individual worse off by leaving him /her with less money to spend. Normally, when an individual is worse off, the individual consumes less of all goods. In economic perspective, this will result in **two effects**: income and substitution effects. The amount by which his/her consumption of the taxed good is reduced due to the fact that there has been a fall in income (his/her real income has fallen), is called **the income effect** of the tax. Second, the tax makes one good relatively more expensive than other goods. When the good becomes relatively more expensive, individuals find a substitute. The extent to which consumption of the taxed good is reduced because of the increased relative price is **the substitution effect.**

Compensated Hicksian demand versus Uncompensated Marshallian demand

The relationship between Marshallian demand curve and Hicksian demand curve can be shown in the figure below.



From points A and B the uncompensated or *money* income constant demand curve, *dd* can be derived. This is also called a **Marshallian demand curve,** whereas from points A and C the compensated or constant *real* income demand curve, *hh* can be constructed. This is also known as a **Hicksian demand curve**. The figure implies that the Marshallian demand curve is known as uncompensated demand curve as it reflects both substitution and income effects whereas the Hicksian demand curve is referred to compensated demand curve as it reflects only substitution effects. In other words, the Marshallian demand curve and the Hicksian demand curve will coincide if the income effect is zero (Vives, 1987, Hausman, 1981, Willig, 1976). This means that the areas of compensating variation equals the equivalent variation and subsequently is equal to consumer surplus as well.

Tax reform and its fundamental elements

As Deaton (1997) pointed out, the fundamental elements in tax reform analysis are **the principles of equity and efficiency**. The efficiency effects are determined by how demand reacts to price changes. In other words, as argued by Deaton and Grimard (1992), whether tax reform benefits or hurts people is determined by how much people make a purchase or a sale of the goods in question Meanwhile, the effects on equity depend not only on demand patterns and the extent to which government is concerned to make use of taxes as a welfare policy instrument (Deaton and Grimard, 1992, Olivia 2002), but also depend on the extent to which changes in tax lead to changes in income distribution.

Appendix B: Glossary of the Observed Commodity Groups

No	Commodity Groups	Selected single commodity within the groups
1	Cereals	Rice, corn, sticky rice, rice flour, wheat flour and corn flour
2	Tubers	Cassava, sweet potato, sago, taro, potato, cassava flour
3	Fish	Fresh Fish, shrimp and other fresh sea foods, preserved fish (dried fish), shrimp and other preserved sea foods
4	Meat	Fresh meat including beef, ham, chicken; preserved meats including dried and canned meat; other meat including liver and entrails
5	Eggs and milk	Eggs, pure milk, dairy milk, powdered milk, sweetened condensed milk, baby powder milk, cheese
6	Vegetables	Spinach, cabbage, mushroom, carrot, cucumber, baby corn, raw jack fruit, garlic, chilly, shallot, canned vegetables
7	Pulses	Peanut with and without skin, soybean, cashew nut, mungbean, tofu, fermented soybean cake and sauce
8	Fruits	A variety of fruits: orange, mango, durian, pineapple, apple, avocado, canned fruits
9	Oil and fats	Coconut oil, corn oil, other cooking oil, coconut, margarine / butter
10	Beverages	Granulated sugar, palm sugar, tea, coffee (ground, beans, instant), instant cocoa, powdered cocoa, syrup
11	Spices	Salt, candle nuts, coriander, pepper, tamarind, fish paste, chilly sauce, tomato sauce, soy sauce, prepared spices, other cooking spices
12	Other consumption	Crisp, crisp chip, wet noodles, instant noodles, wheat and rice noodle, macaroni, jelly, baby food (packaging)
13	Prepared foods and drinks	White bread, sweet bread, dry cake, fried food, ice cream, snack for kids, foods and drinks prepared in restaurants and kiosk: satay, baked fish and meat, beverages without CO2: packaging water, packaging tea, health drink, coffee, coffee milk, tea, chocolate milk
14	Alcohol	Beer, wine
15	Betel and tobacco	Filtered clove cigarette, unfiltered clove cigarette, menthol cigarette, tobacco, betel leaves / areca nut

Appendix C: Marginal tariff reform and the poor

The purpose of this appendix is to illustrate how tax reform (small departures from the existing tax structure) affects household welfare. In doing so, the analysis follows Deaton (1997) and as outlined by Nicita (2004).

In the simplest form, social welfare can be written as:

$$W = V(u_1, u_2, \ldots, u_N) \quad \textbf{(1)}$$

Where N is the number of people (households) in the economy for each of which the welfare levels are given by the indirect utility function:

$$u_h = \psi(x_h, p) \quad \textbf{(2)}$$

Where x_h is total expenditures and p is a vector of prices.

The effect of the tax reform on social welfare W through the movement in the prices of goods can be obtained by differentiating (1) with respect to the tax change, with the chain rule:

$$\frac{\partial W}{\partial t_i} = \sum_{h=1}^{H} \frac{\partial V}{\partial u_h} \frac{\partial u_h}{\partial p_i} \quad \textbf{(3)}$$

This can be written by using Roy's identity: $\partial u_h / \partial p_i \,/\, \partial u_h / \partial x_h = -q_{ih}$ as:

$$\frac{\partial W}{\partial t_i} = -\sum_{h=1}^{H} \eta_h q_{ih} \quad \textbf{(4)}$$

Equation 4 represents the social cost of the tax increase as represented by the increase in the cost of the expenditure baskets of the household, where η_h is the social marginal utility of money in the hands of household h:

$$\eta_h = \frac{\partial V}{\partial u_i} \frac{\partial \psi_h}{\partial x_h} = \frac{\partial W}{\partial x_i} \quad \textbf{(5)}$$

Apart from by changes in the cost of the expenditure basket, social welfare is also determined by government public expenditures, which in turn, are a function of taxes. Government revenues are determined by the sum, over all goods, of the tax payments and subsidy costs. Hence:

$$R = \sum_{i=1}^{M} \sum_{h=1}^{N} t_i q_{ih} \quad \textbf{(6)}$$

Where M is the set of goods i. The effect of a small change in the tax or subsidy will have an effect on government revenue R and thereafter on the level of individual welfare.
Taking the derivative of the revenue with respect to the tax change leads to:

$$\frac{\partial R}{\partial t_i} = \sum_{h=1}^{H} q_{ih} + \sum_{h=1}^{H} \sum_{i=1}^{M} \frac{\partial q_{ih}}{\partial p_i} \quad \textbf{(7)}$$

This represents the outcome of the tax reform through its retributive effects.

Equation 7) can be further simplified. Assuming that consumer prices are determined by world prices ((p_i^0) and tax or subsidies, (t_i) $p_i = p_i^0 + t_i$ the household' budget constraint can be written as:

$$x_h = \sum_{i=1}^{M} (p_i^0 + t_i) q_{ih} \quad \textbf{(8)}$$

Where q_{ih} is quantity consumed.

Since the total expenditure of each household is unaffected by the tax increase, differentiating equation 6 with respect to tax and holding world prices constant gives:

$$\sum_{h=1}^{H} q_{ih} + \sum_{h=1}^{H} \sum_{i=1}^{M} t_i \frac{\partial q_{ih}}{\partial p_i} = -\sum_{i=1}^{M} p_i^0 \frac{\partial q_{ih}}{\partial p_i} \quad \textbf{(9)}$$

In this setup, the two equations (4) and (9) represent the social benefits and social costs of a tax increase. The costs are born by the individual who purchases the goods, and the benefit is represented by the additional government revenue.

A measure of the effects of the tax reform can be given by the ratio of (negative) costs to benefits which is:

$$\lambda_i = \frac{Costs}{beneits} = \frac{\sum_{h=1}^{H} \eta_h q_{ih}}{\sum_{h=1}^{H} q_{ih} + \sum_{h=1}^{H} \sum_{j=1}^{M} t_j \frac{\partial q_{jh}}{\partial p_i}} \tag{10}$$

The equation (10) represents the social cost of raising one unit of revenue by increasing the tax on good *i*. Hence, if λ_i is large, social welfare would be improved by reducing the tax (either because the tax is taxing those with higher weights in the social welfare function, or because the tax is distortionary, or both).

On the other hand, goods with low λ_i are those that are candidates for an increase in tax. When all the ratios are the same, taxes are optimally set and there is no scope for beneficial reform.

Appendix D: Commodity groups, sample size and budget share by areas, income groups and Java

	Urban					Rural					All				
Commodities	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share
Cereals	28,123	3.43	0.05	1,731	0.10	34,948	3.34	0.06	2,243	0.20	63,071	3.38	0.06	3,974	0.16
Tuber	14,665	2.82	0.26	1,632	0.00	18,768	2.28	0.32	2,085	0.01	33,433	2.52	0.31	3,716	0.01
Fish	13,651	4.08	0.17	1,612	0.05	16,918	3.54	0.24	2,045	0.06	30,569	3.78	0.22	3,656	0.06
Meat	9,340	5.03	0.08	1,478	0.03	5,065	5.00	0.08	1,377	0.02	14,405	5.02	0.08	2,855	0.02
Eggs&Milk	9,046	4.10	0.19	1,460	0.03	4,430	3.68	0.27	1,268	0.02	13,476	3.96	0.22	2,728	0.03
Vegetables	9,042	2.58	0.14	1,459	0.04	4,426	2.49	0.16	1,267	0.06	13,468	2.55	0.15	2,726	0.05
Pulses	8,707	3.44	0.12	1,440	0.02	3,915	3.46	0.13	1,179	0.02	12,622	3.45	0.13	2,619	0.02
Fruits	8,351	3.55	0.14	1,419	0.02	3,653	3.15	0.16	1,136	0.02	12,004	3.43	0.16	2,554	0.02
Oils&Fats	8,333	3.54	0.09	1,417	0.02	3,646	3.41	0.11	1,136	0.03	11,979	3.50	0.10	2,552	0.02
Beverages	8,304	2.02	0.25	1,415	0.02	3,618	1.82	0.20	1,132	0.04	11,922	1.96	0.25	2,546	0.03
Spices	8,279	1.98	0.29	1,413	0.01	3,613	1.70	0.39	1,132	0.02	11,892	1.90	0.32	2,544	0.01
Other Cons	7,184	2.31	0.19	1,327	0.01	2,875	2.17	0.21	1,002	0.01	10,059	2.27	0.20	2,329	0.01
Pfood&Drinks	7,108	2.67	0.21	1,320	0.12	2,757	2.13	0.30	979	0.06	9,865	2.52	0.25	2,299	0.09

	IC1 (LOW INCOME)					IC2 (MIDDLE INCOME)					IC3 (HIGH INCOME)				
Commodities	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share
Cereals	31,081	3.34	0.06	3,665	0.20	23,814	3.41	0.05	3,675	0.13	8,176	3.47	0.05	2,231	0.06
Tuber	15,761	2.21	0.32	3,423	0.01	12,758	2.67	0.27	3,453	0.01	4,914	3.10	0.21	2,135	0.00
Fish	13,744	3.45	0.25	3,363	0.06	12,098	3.94	0.18	3,405	0.06	4,727	4.31	0.14	2,104	0.04
Meat	3,326	4.94	0.08	2,572	0.01	6,998	5.00	0.08	2,722	0.03	4,081	5.12	0.08	1,848	0.03
Eggs&Milk	2,844	3.66	0.27	2,445	0.02	6,629	3.95	0.21	2,617	0.03	4,003	4.19	0.19	1,806	0.03
Vegetables	2,839	2.42	0.15	2,443	0.06	6,627	2.55	0.15	2,616	0.05	4,002	2.64	0.13	1,805	0.03
Pulses	2,559	3.37	0.13	2,341	0.02	6,237	3.45	0.13	2,512	0.02	3,826	3.49	0.13	1,757	0.01
Fruits	2,303	3.11	0.16	2,276	0.02	5,942	3.39	0.15	2,452	0.03	3,759	3.69	0.14	1,731	0.03
Oils&Fats	2,297	3.45	0.10	2,274	0.03	5,931	3.50	0.10	2,450	0.02	3,751	3.54	0.10	1,729	0.01
Beverages	2,274	1.79	0.20	2,268	0.04	5,908	1.90	0.22	2,445	0.03	3,740	2.16	0.27	1,728	0.02
Spices	2,272	1.62	0.40	2,267	0.02	5,888	1.87	0.32	2,443	0.01	3,732	2.10	0.26	1,726	0.01
Other Cons	1,747	2.13	0.21	2,055	0.01	4,960	2.25	0.20	2,234	0.01	3,352	2.37	0.18	1,625	0.01
Pfood&Drinks	1,667	2.04	0.31	2,025	0.08	4,878	2.46	0.24	2,205	0.10	3,320	2.86	0.18	1,617	0.10

	Java_Urban					Java_Rural					Java_All				
Commodities	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share	No of HH with UVI	Mean of UVI	CV of UVI	No of clusters with UVI	Mean of budget share
Cereals	17,846	3.45	0.05	1,056	0.10	14,656	3.35	0.05	941	0.19	32,502	3.41	0.05	1997	0.13
Tuber	9,307	2.80	0.27	999	0.00	7,716	2.01	0.35	887	0.01	17,023	2.44	0.34	1888	0.01
Fish	8,409	4.03	0.19	984	0.03	6,351	3.18	0.30	861	0.03	14,760	3.66	0.26	1846	0.03
Meat	6,236	5.03	0.08	907	0.03	2,100	4.95	0.07	611	0.02	8,336	5.01	0.08	1518	0.02
Eggs&Milk	6,069	4.10	0.19	897	0.03	1,906	3.72	0.26	577	0.02	7,975	4.01	0.21	1474	0.03
Vegetables	6,066	2.53	0.13	896	0.04	1,902	2.34	0.14	576	0.06	7,968	2.49	0.13	1472	0.05
Pulses	5,965	3.38	0.12	892	0.02	1,853	3.33	0.12	570	0.03	7,818	3.37	0.12	1462	0.03
Fruits	5,729	3.59	0.14	879	0.02	1,702	3.11	0.15	548	0.02	7,431	3.48	0.15	1427	0.02
Oils&Fats	5,715	3.55	0.09	877	0.02	1,698	3.44	0.09	548	0.03	7,413	3.53	0.09	1425	0.02
Beverages	5,694	2.04	0.26	876	0.02	1,686	1.80	0.20	545	0.03	7,380	1.98	0.25	1421	0.03
Spices	5,679	2.05	0.25	874	0.01	1,686	1.72	0.37	545	0.02	7,365	1.98	0.28	1419	0.01
Other Cons	5,025	2.31	0.19	834	0.01	1,407	2.10	0.20	495	0.01	6,432	2.26	0.19	1328	0.01
Pfood&Drinks	4,989	2.70	0.20	831	0.13	1,385	2.09	0.29	491	0.09	6,374	2.56	0.24	1320	0.11

Appendix E: A unique Inequality Aversion making use of Atkinson Index (including the program)

ε	0	0.29	0.33	0.5	1.5	2	2.5	3	3.45
ye_3	0.065	0.043	0.039	0.024	0.979	0.333	0.209	0.152	0.121
ye_9	0.015	0.008	0.008	0.004	0.459	0.111	0.058	0.036	0.026

Note:

ε = various figures of inequality aversion and

Ye_3 = various figures of equity-sensitive average income with various inequality aversion for three different income distribution

Ye_9 = various figures of equity-sensitive average income with various inequality aversion for nine different income distribution

Appendix F: Policy Prescription derived from Model I

Model	Tax reform policy prescription			
	Mix Tax Rate Regime		Max Tax Rate Regime	
	Efficiency	Efficiency + Equity	Efficiency	Efficiency + Equity
Indonesia				
Model I	increase meat	increase meat	increase meat	increase meat
	reduce other cons	reduce other cons	reduce other cons	reduce other cons
Urban				
Model I	increase tubers	increase tubers	increase pulses	reduce meat
	increase eggs&milk	reduce cereals	increase cereals	reduce vegetables
	reduce cereals		increase other cons	reduce spices
	reduce fish		increase pfoods&drinks	reduce oil&fats
Rural				
Model I	increase meat	increase other cons	increase other cons	
	increase pulses	increase cereals	increase cereals	
	reduce fish	reduce pfoods&drinks	increase eggs&milk	
	reduce cereals	reduce meat	reduce meat	
			reduce beverages	
			reduce fish	

Appendix F suggests that policy prescriptions derived from Model I are not sensitive to a choice of both tax rate regimes and inequality aversion parameters (see under heading Indonesia). Model I suggests that the tax on Meat, should be increased whereas the tax on Other consumption goods should be lowered. If urban and rural areas are analysed separately then different policy prescriptions are obtained.

Appendix G: SHAZAM Programs for Model II

*Master Program: Prog Master for shazam_23Oct_All_13X13_ICWF Olivia.txt

Set nocolor

*INDONESIA All

sample 1 64422
Par 300000
Size 600000
Set Skipmiss
read (C:\Data August\Indonesia\Table INDO 22 Oct.txt) Island Region Area Regency SubDist Village NKS NUS TEF WTEF LTEF D_LTEF &
X LX D_LX IC LIC D_LIC Z D_Z LZ D_LZ E1 WF1 D_WF1 W1 D_W1 LV1 LnV1 D_LnV1 DlnV1 E2 WF2 D_WF2 W2 D_W2 LV2 LnV2 D_LnV2 DlnV2 E3 WF3 D_WF3 W3 D_W3 LV3 LnV3 D_LnV3 DlnV3 &
E4 WF4 D_WF4 W4 D_W4 LV4 LnV4 D_LnV4 DlnV4 E5 WF5 D_WF5 W5 D_W5 LV5 LnV5 D_LnV5 DlnV5 E6 WF6 D_WF6 W6 D_W6 LV6 LnV6 D_LnV6 DlnV6 E7 WF7 D_WF7 W7 D_W7 LV7 LnV7 D_LnV7 DlnV7 &
E8 WF8 D_WF8 W8 D_W8 LV8 LnV8 D_LnV8 DlnV8 E9 WF9 D_WF9 W9 D_W9 LV9 LnV9 D_LnV9 DlnV9 E10 WF10 D_WF10 W10 D_W10 LV10 LnV10 D_LnV10 DlnV10 E11 WF11 D_WF11 W11 D_W11 LV11 LnV11 D_LnV11 DlnV11 &
E12 WF12 D_WF12 W12 D_W12 LV12 LnV12 D_LnV12 DlnV12 E13 WF13 D_WF13 W13 D_W13 LV13 LnV13 D_LnV13 DlnV13 E14 WF14 D_WF14 W14 D_W14 LV14 LnV14 D_LnV14 DlnV14 E15 WF15 D_WF15 W15 D_W15 LV15 LnV15 D_LnV15 DlnV15 &
E18_M WNF18 D_WNF18 W18 E19_M WNF19 D_WNF19 W19 E20_M WNF20 D_WNF20 W20 E21_M WNF21 D_WNF21 W21 E22_M WNF22 D_WNF22 W22 E23_M WNF23 D_WNF23 W23 TENF WTENF/skiplines=1

*Note: LV is unit value With missing value cells Whereas LnV is unit value in Which missing value replaced by cluster average
Stat E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15 TEF E18_M E19_M E20_M E21_M E22_M E23_M TENF/mean=Ebar

Stat W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 W14 W15 W18 W19 W20 W21 W22 W23 WTEF WTENF/mean=Wbar

Stat WF1 WF2 WF3 WF4 WF5 WF6 WF7 WF8 WF9 WF10 WF11 WF12 WF13 WF14 WF15 WNF18 WNF19 WNF20 WNF21 WNF22 WNF23 WTEF WTENF/mean=WFbar

Stat lv1 lv2 lv3 lv4 lv5 lv6 lv7 lv8 lv9 lv10 lv11 lv12 lv13 lv14 lv15/mean=lvbar

Stat LnV1 LnV2 LnV3 LnV4 LnV5 LnV6 LnV7 LnV8 LnV9 LnV10 LnV11 LnV12 LnV13 LnV14 LnV15/mean=LnVbar

```
Matrix TWFbar=WFbar'

Print TWFbar

Matrix WFb1=TWFbar(1,1)
Matrix WFb2=TWFbar(1,2)
Matrix WFb3=TWFbar(1,3)
Matrix WFb4=TWFbar(1,4)
Matrix WFb5=TWFbar(1,5)
Matrix WFb6=TWFbar(1,6)
Matrix WFb7=TWFbar(1,7)
Matrix WFb8=TWFbar(1,8)
Matrix WFb9=TWFbar(1,9)
Matrix WFb10=TWFbar(1,10)
Matrix WFb11=TWFbar(1,11)
Matrix WFb12=TWFbar(1,12)
Matrix WFb13=TWFbar(1,13)

*Concenate WFb1-WFb13
Matrix
WFb=(WFb1|WFb2|WFb3|WFb4|WFb5|WFb6|WFb7|WFb8|WFb9|WFb10|WFb11|W
Fb12|WFb13)
Print WFb
Matrix DTWFb=DIAG(WFb')
Print DTWFb
Matrix IWFb=INV(DTWFb)
Print IWFb

*Running regressions for equation 5.76a and 5.77b and to keep the coefficients for
calculating cluster averages

?OLS d_WF1 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_1 coef=b1
Tratio=T01
Gen1 R01=$R2
?OLS DLnV1 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_1 coef=c1
Tratio=T11
Gen1 R11=$R2
?OLS d_WF2 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_2 coef=b2
Tratio=T02
Gen1 R02=$R2
?OLS DLnV2 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_2 coef=c2
Tratio=T12
Gen1 R12=$R2
?OLS d_WF3 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_3 coef=b3
Tratio=T03
Gen1 R03=$R2
?OLS DLnV3 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_3 coef=c3
Tratio=T13
Gen1 R13=$R2
```

```
?OLS d_WF4 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_4 coef=b4
Tratio=T04
Gen1 R04=$R2
?OLS DLnV4 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_4 coef=c4
Tratio=T14
Gen1 R14=$R2
?OLS d_WF5 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_5 coef=b5
Tratio=T05
Gen1 R05=$R2
?OLS DLnV5 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_5 coef=c5
Tratio=T15
Gen1 R15=$R2
?OLS d_WF6 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_6 coef=b6
Tratio=T06
Gen1 R06=$R2
?OLS DLnV6 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_6 coef=c6
Tratio=T16
Gen1 R16=$R2
?OLS d_WF7 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_7 coef=b7
Tratio=T07
Gen1 R07=$R2
?OLS DLnV7 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_7 coef=c7
Tratio=T17
Gen1 R17=$R2
?OLS d_WF8 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_8 coef=b8
Tratio=T08
Gen1 R08=$R2
?OLS DLnV8 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_8 coef=c8
Tratio=T18
Gen1 R18=$R2
?OLS d_WF9 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_9 coef=b9
Tratio=T09
Gen1 R09=$R2
?OLS DLnV9 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_9 coef=c9
Tratio=T19
Gen1 R19=$R2
?OLS d_WF10 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_10 coef=b10
Tratio=T010
Gen1 R010=$R2
?OLS DLnV10 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_10 coef=c10
Tratio=T110
Gen1 R110=$R2
?OLS d_WF11 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_11 coef=b11
Tratio=T011
Gen1 R011=$R2
?OLS DLnV11 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_11 coef=c11
Tratio=T111
Gen1 R111=$R2
?OLS d_WF12 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_12 coef=b12
Tratio=T012
```

```
Gen1 R012=$R2
?OLS DLnV12 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_12 coef=c12
Tratio=T112
Gen1 R112=$R2
?OLS d_WF13 d_LTEF d_lIC d_z/HETCOV noconstant resid=e0_13 coef=b13
Tratio=T013
Gen1 R013=$R2
?OLS DLnV13 d_LTEF d_lIC d_z/HETCOV noconstant resid=e1_13 coef=c13
Tratio=T113
Gen1 R113=$R2

Matrix R2_W=(R01|R02|R03|R04|R05|R06|R07|R08|R09|R010|R011|R012|R013)
Matrix R2_lnV=(R11|R12|R13|R14|R15|R16|R17|R18|R19|R110|R111|R112|R113)

Print R2_W R2_LnV

Matrix Tbe1=T01(1,1)
Matrix Tbe2=T02(1,1)
Matrix Tbe3=T03(1,1)
Matrix Tbe4=T04(1,1)
Matrix Tbe5=T05(1,1)
Matrix Tbe6=T06(1,1)
Matrix Tbe7=T07(1,1)
Matrix Tbe8=T08(1,1)
Matrix Tbe9=T09(1,1)
Matrix Tbe10=T010(1,1)
Matrix Tbe11=T011(1,1)
Matrix Tbe12=T012(1,1)
Matrix Tbe13=T013(1,1)

Matrix TbI1=T01(2,1)
Matrix TbI2=T02(2,1)
Matrix TbI3=T03(2,1)
Matrix TbI4=T04(2,1)
Matrix TbI5=T05(2,1)
Matrix TbI6=T06(2,1)
Matrix TbI7=T07(2,1)
Matrix TbI8=T08(2,1)
Matrix TbI9=T09(2,1)
Matrix TbI10=T010(2,1)
Matrix TbI11=T011(2,1)
Matrix TbI12=T012(2,1)
Matrix TbI13=T013(2,1)

Matrix Tz1=T01(3,1)
Matrix Tz2=T02(3,1)
Matrix Tz3=T03(3,1)
Matrix Tz4=T04(3,1)
Matrix Tz5=T05(3,1)
Matrix Tz6=T06(3,1)
```

Matrix Tz7=T07(3,1)
Matrix Tz8=T08(3,1)
Matrix Tz9=T09(3,1)
Matrix Tz10=T010(3,1)
Matrix Tz11=T011(3,1)
Matrix Tz12=T012(3,1)
Matrix Tz13=T013(3,1)

Matrix TC1=T11(1,1)
Matrix TC2=T12(1,1)
Matrix TC3=T13(1,1)
Matrix TC4=T14(1,1)
Matrix TC5=T15(1,1)
Matrix TC6=T16(1,1)
Matrix TC7=T17(1,1)
Matrix TC8=T18(1,1)
Matrix TC9=T19(1,1)
Matrix TC10=T110(1,1)
Matrix TC11=T111(1,1)
Matrix TC12=T112(1,1)
Matrix TC13=T113(1,1)

Matrix TCI1=T11(2,1)
Matrix TCI2=T12(2,1)
Matrix TCI3=T13(2,1)
Matrix TCI4=T14(2,1)
Matrix TCI5=T15(2,1)
Matrix TCI6=T16(2,1)
Matrix TCI7=T17(2,1)
Matrix TCI8=T18(2,1)
Matrix TCI9=T19(2,1)
Matrix TCI10=T110(2,1)
Matrix TCI11=T111(2,1)
Matrix TCI12=T112(2,1)
Matrix TCI13=T113(2,1)

Matrix T1Z1=T11(3,1)
Matrix T1Z2=T12(3,1)
Matrix T1Z3=T13(3,1)
Matrix T1Z4=T14(3,1)
Matrix T1Z5=T15(3,1)
Matrix T1Z6=T16(3,1)
Matrix T1Z7=T17(3,1)
Matrix T1Z8=T18(3,1)
Matrix T1Z9=T19(3,1)
Matrix T1Z10=T110(3,1)
Matrix T1Z11=T111(3,1)
Matrix T1Z12=T112(3,1)
Matrix T1Z13=T113(3,1)

```
*Concenate Tbe1-Tbe13
Matrix
Tbe=(Tbe1|Tbe2|Tbe3|Tbe4|Tbe5|Tbe6|Tbe7|Tbe8|Tbe9|Tbe10|Tbe11|Tbe12|Tbe13)
Print Tbe
Matrix DTTbe=DIAG(Tbe')
Print DTTbe

*Concenate TbI1-TbI13
Matrix
TbI=(TbI1|TbI2|TbI3|TbI4|TbI5|TbI6|TbI7|TbI8|TbI9|TbI10|TbI11|TbI12|TbI13)
Print TbI
Matrix DTTbI=DIAG(TbI')
Print DTTbI

*Concenate Tz1-Tz13
Matrix Tz=(Tz1|Tz2|Tz3|Tz4|Tz5|Tz6|Tz7|Tz8|Tz9|Tz10|Tz11|Tz12|Tz13)
Print Tz
Matrix DTTz=DIAG(Tz')
Print DTTz

*Concenate TC1-TC13
Matrix TC=(TC1|TC2|TC3|TC4|TC5|TC6|TC7|TC8|TC9|TC10|TC11|TC12|TC13)
Print TC
Matrix DTTC=DIAG(TC')
Print DTTC

*Concenate TCI1-TCI13
Matrix
TCI=(TCI1|TCI2|TCI3|TCI4|TCI5|TCI6|TCI7|TCI8|TCI9|TCI10|TCI11|TCI12|TCI13
)
Print TCI
Matrix DTTCI=DIAG(TCI')
Print DTTCI

*Concenate T1z1-T1z13
Matrix
T1z=(T1z1|T1z2|T1z3|T1z4|T1z5|T1z6|T1z7|T1z8|T1z9|T1z10|T1z11|T1z12|T1z13)
Print T1z
Matrix DTT1z=DIAG(T1z')
Print DTT1z

*computing first stage of cluster averages by using the estimates (the coefficients)
Genr y01=(WF1-((b1:1)*LTEF)-((b1:2)*LIC)-((b1:3)*lz))
Genr y11=(LnV1-((c1:1)*LTEF)-((c1:2)*LIC)-((c1:3)*lz))
Genr y02=(WF2-((b2:1)*LTEF)-((b2:2)*LIC)-((b2:3)*lz))
Genr y12=(LnV2-((c2:1)*LTEF)-((c2:2)*LIC)-((c2:3)*lz))
Genr y03=(WF3-((b3:1)*LTEF)-((b3:2)*LIC)-((b3:3)*lz))
Genr y13=(LnV3-((c3:1)*LTEF)-((c3:2)*LIC)-((c3:3)*lz))
Genr y04=(WF4-((b4:1)*LTEF)-((b4:2)*LIC)-((b4:3)*lz))
Genr y14=(LnV4-((c4:1)*LTEF)-((c4:2)*LIC)-((c4:3)*lz))
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Genr y05=(WF5-((b5:1)*LTEF)-((b5:2)*LIC)-((b5:3)*lz))
Genr y15=(LnV5-((c5:1)*LTEF)-((c5:2)*LIC)-((c5:3)*lz))
Genr y06=(WF6-((b6:1)*LTEF)-((b6:2)*LIC)-((b6:3)*lz))
Genr y16=(LnV6-((c6:1)*LTEF)-((c6:2)*LIC)-((c6:3)*lz))
Genr y07=(WF7-((b7:1)*LTEF)-((b7:2)*LIC)-((b7:3)*lz))
Genr y17=(LnV7-((c7:1)*LTEF)-((c7:2)*LIC)-((c7:3)*lz))
Genr y08=(WF8-((b8:1)*LTEF)-((b8:2)*LIC)-((b8:3)*lz))
Genr y18=(LnV8-((c8:1)*LTEF)-((c8:2)*LIC)-((c8:3)*lz))
Genr y09=(WF9-((b9:1)*LTEF)-((b9:2)*LIC)-((b9:3)*lz))
Genr y19=(LnV9-((c9:1)*LTEF)-((c9:2)*LIC)-((c9:3)*lz))
Genr y010=(WF10-((b10:1)*LTEF)-((b10:2)*LIC)-((b10:3)*lz))
Genr y110=(LnV10-((c10:1)*LTEF)-((c10:2)*LIC)-((c10:3)*lz))
Genr y011=(WF11-((b11:1)*LTEF)-((b11:2)*LIC)-((b11:3)*lz))
Genr y111=(LnV11-((c11:1)*LTEF)-((c11:2)*LIC)-((c11:3)*lz))
Genr y012=(WF12-((b12:1)*LTEF)-((b12:2)*LIC)-((b12:3)*lz))
Genr y112=(LnV12-((c12:1)*LTEF)-((c12:2)*LIC)-((c12:3)*lz))
Genr y013=(WF13-((b13:1)*LTEF)-((b13:2)*LIC)-((b13:3)*lz))
Genr y113=(LnV13-((c13:1)*LTEF)-((c13:2)*LIC)-((c13:3)*lz))

*Print Y01 Y02 Y03 Y04
*Print Y01 Y02 Y03 Y04
*Print Y05 Y06 Y07 Y08
*Print Y05 Y06 Y07 Y08
*Print Y09 Y010 Y011 Y012 Y013
*Print Y09 Y010 Y011 Y012 Y013
*Print Y11 Y12 Y13 Y14
*Print Y11 Y12 Y13 Y14
*Print Y15 Y16 Y17 Y18
*Print Y15 Y16 Y17 Y18
*Print Y19 Y110 Y111 Y112 Y113
*Print Y19 Y110 Y111 Y112 Y113

*End
*Stop

Sample 1 64422

*Commodity 1

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
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Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF1e_0=((TEF/z)**(-A1))*(TEF*WF1)
Genr WF1e_01=((TEF/z)**(-A2))*(TEF*WF1)
Genr WF1e_015=((TEF/z)**(-A3))*(TEF*WF1)
Genr WF1e_02=((TEF/z)**(-A4))*(TEF*WF1)
Genr WF1e_025=((TEF/z)**(-A5))*(TEF*WF1)
Genr WF1e_029=((TEF/z)**(-A6))*(TEF*WF1)
Genr WF1e_033=((TEF/z)**(-A7))*(TEF*WF1)
Genr WF1e_035=((TEF/z)**(-A8))*(TEF*WF1)
Genr WF1e_04=((TEF/z)**(-A9))*(TEF*WF1)
Genr WF1e_045=((TEF/z)**(-A10))*(TEF*WF1)
Genr WF1e_05=((TEF/z)**(-A11))*(TEF*WF1)
Genr WF1e_1=((TEF/z)**(-A12))*(TEF*WF1)
Genr WF1e_15=((TEF/z)**(-A13))*(TEF*WF1)
Genr WF1e_2=((TEF/z)**(-A14))*(TEF*WF1)
Genr WF1e_25=((TEF/z)**(-A15))*(TEF*WF1)

Gen1 N1=$N
Gen1 WFe1_0=sum(WF1e_0,N1)/sum(TEF,N1)
Gen1 WFe1_01=sum(WF1e_01,N1)/sum(TEF,N1)
Gen1 WFe1_015=sum(WF1e_015,N1)/sum(TEF,N1)
Gen1 WFe1_02=sum(WF1e_02,N1)/sum(TEF,N1)
Gen1 WFe1_025=sum(WF1e_025,N1)/sum(TEF,N1)
Gen1 WFe1_029=sum(WF1e_029,N1)/sum(TEF,N1)
Gen1 WFe1_033=sum(WF1e_033,N1)/sum(TEF,N1)
Gen1 WFe1_035=sum(WF1e_035,N1)/sum(TEF,N1)
Gen1 WFe1_04=sum(WF1e_04,N1)/sum(TEF,N1)
Gen1 WFe1_045=sum(WF1e_045,N1)/sum(TEF,N1)
Gen1 WFe1_05=sum(WF1e_05,N1)/sum(TEF,N1)
Gen1 WFe1_1=sum(WF1e_1,N1)/sum(TEF,N1)
Gen1 WFe1_15=sum(WF1e_15,N1)/sum(TEF,N1)
Gen1 WFe1_2=sum(WF1e_2,N1)/sum(TEF,N1)
Gen1 WFe1_25=sum(WF1e_25,N1)/sum(TEF,N1)

Genr sWF1=TEF*WF1

Gen1 WF1c=sum(sWF1,N1)/sum(TEF,N1)
Print WF1c
Gen1 l1n_0=WFe1_0/WF1c
Gen1 l1n_01=WFe1_01/WF1c
Gen1 l1n_015=WFe1_015/WF1c
Gen1 l1n_02=WFe1_02/WF1c
Gen1 l1n_025=WFe1_025/WF1c
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```
Gen1 l1n_029=WFe1_029/WF1c
Gen1 l1n_033=WFe1_033/WF1c
Gen1 l1n_035=WFe1_035/WF1c
Gen1 l1n_04=WFe1_04/WF1c
Gen1 l1n_045=WFe1_045/WF1c
Gen1 l1n_05=WFe1_05/WF1c
Gen1 l1n_1=WFe1_1/WF1c
Gen1 l1n_15=WFe1_15/WF1c
Gen1 l1n_2=WFe1_2/WF1c
Gen1 l1n_25=WFe1_25/WF1c

*Commodity 2

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF2e_0=((TEF/z)**(-A1))*(TEF*WF2)
Genr WF2e_01=((TEF/z)**(-A2))*(TEF*WF2)
Genr WF2e_015=((TEF/z)**(-A3))*(TEF*WF2)
Genr WF2e_02=((TEF/z)**(-A4))*(TEF*WF2)
Genr WF2e_025=((TEF/z)**(-A5))*(TEF*WF2)
Genr WF2e_029=((TEF/z)**(-A6))*(TEF*WF2)
Genr WF2e_033=((TEF/z)**(-A7))*(TEF*WF2)
Genr WF2e_035=((TEF/z)**(-A8))*(TEF*WF2)
Genr WF2e_04=((TEF/z)**(-A9))*(TEF*WF2)
Genr WF2e_045=((TEF/z)**(-A10))*(TEF*WF2)
Genr WF2e_05=((TEF/z)**(-A11))*(TEF*WF2)
Genr WF2e_1=((TEF/z)**(-A12))*(TEF*WF2)
Genr WF2e_15=((TEF/z)**(-A13))*(TEF*WF2)
Genr WF2e_2=((TEF/z)**(-A14))*(TEF*WF2)
Genr WF2e_25=((TEF/z)**(-A15))*(TEF*WF2)

Gen1 N2=$N
Gen1 WFe2_0=sum(WF2e_0,N2)/sum(TEF,N2)
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```
Gen1 WFe2_01=sum(WF2e_01,N2)/sum(TEF,N2)
Gen1 WFe2_015=sum(WF2e_015,N2)/sum(TEF,N2)
Gen1 WFe2_02=sum(WF2e_02,N2)/sum(TEF,N2)
Gen1 WFe2_025=sum(WF2e_025,N2)/sum(TEF,N2)
Gen1 WFe2_029=sum(WF2e_029,N2)/sum(TEF,N2)
Gen1 WFe2_033=sum(WF2e_033,N2)/sum(TEF,N2)
Gen1 WFe2_035=sum(WF2e_035,N2)/sum(TEF,N2)
Gen1 WFe2_04=sum(WF2e_04,N2)/sum(TEF,N2)
Gen1 WFe2_045=sum(WF2e_045,N2)/sum(TEF,N2)
Gen1 WFe2_05=sum(WF2e_05,N2)/sum(TEF,N2)
Gen1 WFe2_1=sum(WF2e_1,N2)/sum(TEF,N2)
Gen1 WFe2_15=sum(WF2e_15,N2)/sum(TEF,N2)
Gen1 WFe2_2=sum(WF2e_2,N2)/sum(TEF,N2)
Gen1 WFe2_25=sum(WF2e_25,N2)/sum(TEF,N2)

Genr sWF2=TEF*WF2

Gen1 WF2c=sum(sWF2,N2)/sum(TEF,N2)
Print WF2c
Gen1 l2n_0=WFe2_0/WF2c
Gen1 l2n_01=WFe2_01/WF2c
Gen1 l2n_015=WFe2_015/WF2c
Gen1 l2n_02=WFe2_02/WF2c
Gen1 l2n_025=WFe2_025/WF2c
Gen1 l2n_029=WFe2_029/WF2c
Gen1 l2n_033=WFe2_033/WF2c
Gen1 l2n_035=WFe2_035/WF2c
Gen1 l2n_04=WFe2_04/WF2c
Gen1 l2n_045=WFe2_045/WF2c
Gen1 l2n_05=WFe2_05/WF2c
Gen1 l2n_1=WFe2_1/WF2c
Gen1 l2n_15=WFe2_15/WF2c
Gen1 l2n_2=WFe2_2/WF2c
Gen1 l2n_25=WFe2_25/WF2c

*Commodity 3

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
```

```
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF3e_0=((TEF/z)**(-A1))*(TEF*WF3)
Genr WF3e_01=((TEF/z)**(-A2))*(TEF*WF3)
Genr WF3e_015=((TEF/z)**(-A3))*(TEF*WF3)
Genr WF3e_02=((TEF/z)**(-A4))*(TEF*WF3)
Genr WF3e_025=((TEF/z)**(-A5))*(TEF*WF3)
Genr WF3e_029=((TEF/z)**(-A6))*(TEF*WF3)
Genr WF3e_033=((TEF/z)**(-A7))*(TEF*WF3)
Genr WF3e_035=((TEF/z)**(-A8))*(TEF*WF3)
Genr WF3e_04=((TEF/z)**(-A9))*(TEF*WF3)
Genr WF3e_045=((TEF/z)**(-A10))*(TEF*WF3)
Genr WF3e_05=((TEF/z)**(-A11))*(TEF*WF3)
Genr WF3e_1=((TEF/z)**(-A12))*(TEF*WF3)
Genr WF3e_15=((TEF/z)**(-A13))*(TEF*WF3)
Genr WF3e_2=((TEF/z)**(-A14))*(TEF*WF3)
Genr WF3e_25=((TEF/z)**(-A15))*(TEF*WF3)

Gen1 N3=$N
Gen1 WFe3_0=sum(WF3e_0,N3)/sum(TEF,N3)
Gen1 WFe3_01=sum(WF3e_01,N3)/sum(TEF,N3)
Gen1 WFe3_015=sum(WF3e_015,N3)/sum(TEF,N3)
Gen1 WFe3_02=sum(WF3e_02,N3)/sum(TEF,N3)
Gen1 WFe3_025=sum(WF3e_025,N3)/sum(TEF,N3)
Gen1 WFe3_029=sum(WF3e_029,N3)/sum(TEF,N3)
Gen1 WFe3_033=sum(WF3e_033,N3)/sum(TEF,N3)
Gen1 WFe3_035=sum(WF3e_035,N3)/sum(TEF,N3)
Gen1 WFe3_04=sum(WF3e_04,N3)/sum(TEF,N3)
Gen1 WFe3_045=sum(WF3e_045,N3)/sum(TEF,N3)
Gen1 WFe3_05=sum(WF3e_05,N3)/sum(TEF,N3)
Gen1 WFe3_1=sum(WF3e_1,N3)/sum(TEF,N3)
Gen1 WFe3_15=sum(WF3e_15,N3)/sum(TEF,N3)
Gen1 WFe3_2=sum(WF3e_2,N3)/sum(TEF,N3)
Gen1 WFe3_25=sum(WF3e_25,N3)/sum(TEF,N3)

Genr sWF3=TEF*WF3

Gen1 WF3c=sum(sWF3,N3)/sum(TEF,N3)
Print WF3c
Gen1 l3n_0=WFe3_0/WF3c
Gen1 l3n_01=WFe3_01/WF3c
Gen1 l3n_015=WFe3_015/WF3c
Gen1 l3n_02=WFe3_02/WF3c
Gen1 l3n_025=WFe3_025/WF3c
Gen1 l3n_029=WFe3_029/WF3c
Gen1 l3n_033=WFe3_033/WF3c
```

```
Gen1 l3n_035=WFe3_035/WF3c
Gen1 l3n_04=WFe3_04/WF3c
Gen1 l3n_045=WFe3_045/WF3c
Gen1 l3n_05=WFe3_05/WF3c
Gen1 l3n_1=WFe3_1/WF3c
Gen1 l3n_15=WFe3_15/WF3c
Gen1 l3n_2=WFe3_2/WF3c
Gen1 l3n_25=WFe3_25/WF3c

*Commodity 4

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF4e_0=((TEF/z)**(-A1))*(TEF*WF4)
Genr WF4e_01=((TEF/z)**(-A2))*(TEF*WF4)
Genr WF4e_015=((TEF/z)**(-A3))*(TEF*WF4)
Genr WF4e_02=((TEF/z)**(-A4))*(TEF*WF4)
Genr WF4e_025=((TEF/z)**(-A5))*(TEF*WF4)
Genr WF4e_029=((TEF/z)**(-A6))*(TEF*WF4)
Genr WF4e_033=((TEF/z)**(-A7))*(TEF*WF4)
Genr WF4e_035=((TEF/z)**(-A8))*(TEF*WF4)
Genr WF4e_04=((TEF/z)**(-A9))*(TEF*WF4)
Genr WF4e_045=((TEF/z)**(-A10))*(TEF*WF4)
Genr WF4e_05=((TEF/z)**(-A11))*(TEF*WF4)
Genr WF4e_1=((TEF/z)**(-A12))*(TEF*WF4)
Genr WF4e_15=((TEF/z)**(-A13))*(TEF*WF4)
Genr WF4e_2=((TEF/z)**(-A14))*(TEF*WF4)
Genr WF4e_25=((TEF/z)**(-A15))*(TEF*WF4)

Gen1 N4=$N
Gen1 WFe4_0=sum(WF4e_0,N4)/sum(TEF,N4)
Gen1 WFe4_01=sum(WF4e_01,N4)/sum(TEF,N4)
Gen1 WFe4_015=sum(WF4e_015,N4)/sum(TEF,N4)
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```
Gen1 WFe4_02=sum(WF4e_02,N4)/sum(TEF,N4)
Gen1 WFe4_025=sum(WF4e_025,N4)/sum(TEF,N4)
Gen1 WFe4_029=sum(WF4e_029,N4)/sum(TEF,N4)
Gen1 WFe4_033=sum(WF4e_033,N4)/sum(TEF,N4)
Gen1 WFe4_035=sum(WF4e_035,N4)/sum(TEF,N4)
Gen1 WFe4_04=sum(WF4e_04,N4)/sum(TEF,N4)
Gen1 WFe4_045=sum(WF4e_045,N4)/sum(TEF,N4)
Gen1 WFe4_05=sum(WF4e_05,N4)/sum(TEF,N4)
Gen1 WFe4_1=sum(WF4e_1,N4)/sum(TEF,N4)
Gen1 WFe4_15=sum(WF4e_15,N4)/sum(TEF,N4)
Gen1 WFe4_2=sum(WF4e_2,N4)/sum(TEF,N4)
Gen1 WFe4_25=sum(WF4e_25,N4)/sum(TEF,N4)

Genr sWF4=TEF*WF4

Gen1 WF4c=sum(sWF4,N4)/sum(TEF,N4)
Print WF4c
Gen1 l4n_0=WFe4_0/WF4c
Gen1 l4n_01=WFe4_01/WF4c
Gen1 l4n_015=WFe4_015/WF4c
Gen1 l4n_02=WFe4_02/WF4c
Gen1 l4n_025=WFe4_025/WF4c
Gen1 l4n_029=WFe4_029/WF4c
Gen1 l4n_033=WFe4_033/WF4c
Gen1 l4n_035=WFe4_035/WF4c
Gen1 l4n_04=WFe4_04/WF4c
Gen1 l4n_045=WFe4_045/WF4c
Gen1 l4n_05=WFe4_05/WF4c
Gen1 l4n_1=WFe4_1/WF4c
Gen1 l4n_15=WFe4_15/WF4c
Gen1 l4n_2=WFe4_2/WF4c
Gen1 l4n_25=WFe4_25/WF4c

*Commodity 5

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
```

```
Gen1 A14=2
Gen1 A15=2.5


Genr WF5e_0=((TEF/z)**(-A1))*(TEF*WF5)
Genr WF5e_01=((TEF/z)**(-A2))*(TEF*WF5)
Genr WF5e_015=((TEF/z)**(-A3))*(TEF*WF5)
Genr WF5e_02=((TEF/z)**(-A4))*(TEF*WF5)
Genr WF5e_025=((TEF/z)**(-A5))*(TEF*WF5)
Genr WF5e_029=((TEF/z)**(-A6))*(TEF*WF5)
Genr WF5e_033=((TEF/z)**(-A7))*(TEF*WF5)
Genr WF5e_035=((TEF/z)**(-A8))*(TEF*WF5)
Genr WF5e_04=((TEF/z)**(-A9))*(TEF*WF5)
Genr WF5e_045=((TEF/z)**(-A10))*(TEF*WF5)
Genr WF5e_05=((TEF/z)**(-A11))*(TEF*WF5)
Genr WF5e_1=((TEF/z)**(-A12))*(TEF*WF5)
Genr WF5e_15=((TEF/z)**(-A13))*(TEF*WF5)
Genr WF5e_2=((TEF/z)**(-A14))*(TEF*WF5)
Genr WF5e_25=((TEF/z)**(-A15))*(TEF*WF5)

Gen1 N5=$N
Gen1 WFe5_0=sum(WF5e_0,N5)/sum(TEF,N5)
Gen1 WFe5_01=sum(WF5e_01,N5)/sum(TEF,N5)
Gen1 WFe5_015=sum(WF5e_015,N5)/sum(TEF,N5)
Gen1 WFe5_02=sum(WF5e_02,N5)/sum(TEF,N5)
Gen1 WFe5_025=sum(WF5e_025,N5)/sum(TEF,N5)
Gen1 WFe5_029=sum(WF5e_029,N5)/sum(TEF,N5)
Gen1 WFe5_033=sum(WF5e_033,N5)/sum(TEF,N5)
Gen1 WFe5_035=sum(WF5e_035,N5)/sum(TEF,N5)
Gen1 WFe5_04=sum(WF5e_04,N5)/sum(TEF,N5)
Gen1 WFe5_045=sum(WF5e_045,N5)/sum(TEF,N5)
Gen1 WFe5_05=sum(WF5e_05,N5)/sum(TEF,N5)
Gen1 WFe5_1=sum(WF5e_1,N5)/sum(TEF,N5)
Gen1 WFe5_15=sum(WF5e_15,N5)/sum(TEF,N5)
Gen1 WFe5_2=sum(WF5e_2,N5)/sum(TEF,N5)
Gen1 WFe5_25=sum(WF5e_25,N5)/sum(TEF,N5)

Genr sWF5=TEF*WF5

Gen1 WF5c=sum(sWF5,N5)/sum(TEF,N5)
Print WF5c
Gen1 l5n_0=WFe5_0/WF5c
Gen1 l5n_01=WFe5_01/WF5c
Gen1 l5n_015=WFe5_015/WF5c
Gen1 l5n_02=WFe5_02/WF5c
Gen1 l5n_025=WFe5_025/WF5c
Gen1 l5n_029=WFe5_029/WF5c
Gen1 l5n_033=WFe5_033/WF5c
Gen1 l5n_035=WFe5_035/WF5c
Gen1 l5n_04=WFe5_04/WF5c
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```
Gen1 l5n_045=WFe5_045/WF5c
Gen1 l5n_05=WFe5_05/WF5c
Gen1 l5n_1=WFe5_1/WF5c
Gen1 l5n_15=WFe5_15/WF5c
Gen1 l5n_2=WFe5_2/WF5c
Gen1 l5n_25=WFe5_25/WF5c


*Commodity 6

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF6e_0=((TEF/z)**(-A1))*(TEF*WF6)
Genr WF6e_01=((TEF/z)**(-A2))*(TEF*WF6)
Genr WF6e_015=((TEF/z)**(-A3))*(TEF*WF6)
Genr WF6e_02=((TEF/z)**(-A4))*(TEF*WF6)
Genr WF6e_025=((TEF/z)**(-A5))*(TEF*WF6)
Genr WF6e_029=((TEF/z)**(-A6))*(TEF*WF6)
Genr WF6e_033=((TEF/z)**(-A7))*(TEF*WF6)
Genr WF6e_035=((TEF/z)**(-A8))*(TEF*WF6)
Genr WF6e_04=((TEF/z)**(-A9))*(TEF*WF6)
Genr WF6e_045=((TEF/z)**(-A10))*(TEF*WF6)
Genr WF6e_05=((TEF/z)**(-A11))*(TEF*WF6)
Genr WF6e_1=((TEF/z)**(-A12))*(TEF*WF6)
Genr WF6e_15=((TEF/z)**(-A13))*(TEF*WF6)
Genr WF6e_2=((TEF/z)**(-A14))*(TEF*WF6)
Genr WF6e_25=((TEF/z)**(-A15))*(TEF*WF6)

Gen1 N6=$N
Gen1 WFe6_0=sum(WF6e_0,N6)/sum(TEF,N6)
Gen1 WFe6_01=sum(WF6e_01,N6)/sum(TEF,N6)
Gen1 WFe6_015=sum(WF6e_015,N6)/sum(TEF,N6)
Gen1 WFe6_02=sum(WF6e_02,N6)/sum(TEF,N6)
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```
Gen1 WFe6_025=sum(WF6e_025,N6)/sum(TEF,N6)
Gen1 WFe6_029=sum(WF6e_029,N6)/sum(TEF,N6)
Gen1 WFe6_033=sum(WF6e_033,N6)/sum(TEF,N6)
Gen1 WFe6_035=sum(WF6e_035,N6)/sum(TEF,N6)
Gen1 WFe6_04=sum(WF6e_04,N6)/sum(TEF,N6)
Gen1 WFe6_045=sum(WF6e_045,N6)/sum(TEF,N6)
Gen1 WFe6_05=sum(WF6e_05,N6)/sum(TEF,N6)
Gen1 WFe6_1=sum(WF6e_1,N6)/sum(TEF,N6)
Gen1 WFe6_15=sum(WF6e_15,N6)/sum(TEF,N6)
Gen1 WFe6_2=sum(WF6e_2,N6)/sum(TEF,N6)
Gen1 WFe6_25=sum(WF6e_25,N6)/sum(TEF,N6)

Genr sWF6=TEF*WF6

Gen1 WF6c=sum(sWF6,N6)/sum(TEF,N6)
Print WF6c
Gen1 l6n_0=WFe6_0/WF6c
Gen1 l6n_01=WFe6_01/WF6c
Gen1 l6n_015=WFe6_015/WF6c
Gen1 l6n_02=WFe6_02/WF6c
Gen1 l6n_025=WFe6_025/WF6c
Gen1 l6n_029=WFe6_029/WF6c
Gen1 l6n_033=WFe6_033/WF6c
Gen1 l6n_035=WFe6_035/WF6c
Gen1 l6n_04=WFe6_04/WF6c
Gen1 l6n_045=WFe6_045/WF6c
Gen1 l6n_05=WFe6_05/WF6c
Gen1 l6n_1=WFe6_1/WF6c
Gen1 l6n_15=WFe6_15/WF6c
Gen1 l6n_2=WFe6_2/WF6c
Gen1 l6n_25=WFe6_25/WF6c

*Commodity 7

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
```

```
Gen1 A15=2.5


Genr WF7e_0=((TEF/z)**(-A1))*(TEF*WF7)
Genr WF7e_01=((TEF/z)**(-A2))*(TEF*WF7)
Genr WF7e_015=((TEF/z)**(-A3))*(TEF*WF7)
Genr WF7e_02=((TEF/z)**(-A4))*(TEF*WF7)
Genr WF7e_025=((TEF/z)**(-A5))*(TEF*WF7)
Genr WF7e_029=((TEF/z)**(-A6))*(TEF*WF7)
Genr WF7e_033=((TEF/z)**(-A7))*(TEF*WF7)
Genr WF7e_035=((TEF/z)**(-A8))*(TEF*WF7)
Genr WF7e_04=((TEF/z)**(-A9))*(TEF*WF7)
Genr WF7e_045=((TEF/z)**(-A10))*(TEF*WF7)
Genr WF7e_05=((TEF/z)**(-A11))*(TEF*WF7)
Genr WF7e_1=((TEF/z)**(-A12))*(TEF*WF7)
Genr WF7e_15=((TEF/z)**(-A13))*(TEF*WF7)
Genr WF7e_2=((TEF/z)**(-A14))*(TEF*WF7)
Genr WF7e_25=((TEF/z)**(-A15))*(TEF*WF7)

Gen1 N7=$N
Gen1 WFe7_0=sum(WF7e_0,N7)/sum(TEF,N7)
Gen1 WFe7_01=sum(WF7e_01,N7)/sum(TEF,N7)
Gen1 WFe7_015=sum(WF7e_015,N7)/sum(TEF,N7)
Gen1 WFe7_02=sum(WF7e_02,N7)/sum(TEF,N7)
Gen1 WFe7_025=sum(WF7e_025,N7)/sum(TEF,N7)
Gen1 WFe7_029=sum(WF7e_029,N7)/sum(TEF,N7)
Gen1 WFe7_033=sum(WF7e_033,N7)/sum(TEF,N7)
Gen1 WFe7_035=sum(WF7e_035,N7)/sum(TEF,N7)
Gen1 WFe7_04=sum(WF7e_04,N7)/sum(TEF,N7)
Gen1 WFe7_045=sum(WF7e_045,N7)/sum(TEF,N7)
Gen1 WFe7_05=sum(WF7e_05,N7)/sum(TEF,N7)
Gen1 WFe7_1=sum(WF7e_1,N7)/sum(TEF,N7)
Gen1 WFe7_15=sum(WF7e_15,N7)/sum(TEF,N7)
Gen1 WFe7_2=sum(WF7e_2,N7)/sum(TEF,N7)
Gen1 WFe7_25=sum(WF7e_25,N7)/sum(TEF,N7)

Genr sWF7=TEF*WF7

Gen1 WF7c=sum(sWF7,N7)/sum(TEF,N7)
Print WF7c
Gen1 l7n_0=WFe7_0/WF7c
Gen1 l7n_01=WFe7_01/WF7c
Gen1 l7n_015=WFe7_015/WF7c
Gen1 l7n_02=WFe7_02/WF7c
Gen1 l7n_025=WFe7_025/WF7c
Gen1 l7n_029=WFe7_029/WF7c
Gen1 l7n_033=WFe7_033/WF7c
Gen1 l7n_035=WFe7_035/WF7c
Gen1 l7n_04=WFe7_04/WF7c
Gen1 l7n_045=WFe7_045/WF7c
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Gen1 l7n_05=WFe7_05/WF7c
Gen1 l7n_1=WFe7_1/WF7c
Gen1 l7n_15=WFe7_15/WF7c
Gen1 l7n_2=WFe7_2/WF7c
Gen1 l7n_25=WFe7_25/WF7c

*Commodity 8

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF8e_0=((TEF/z)**(-A1))*(TEF*WF8)
Genr WF8e_01=((TEF/z)**(-A2))*(TEF*WF8)
Genr WF8e_015=((TEF/z)**(-A3))*(TEF*WF8)
Genr WF8e_02=((TEF/z)**(-A4))*(TEF*WF8)
Genr WF8e_025=((TEF/z)**(-A5))*(TEF*WF8)
Genr WF8e_029=((TEF/z)**(-A6))*(TEF*WF8)
Genr WF8e_033=((TEF/z)**(-A7))*(TEF*WF8)
Genr WF8e_035=((TEF/z)**(-A8))*(TEF*WF8)
Genr WF8e_04=((TEF/z)**(-A9))*(TEF*WF8)
Genr WF8e_045=((TEF/z)**(-A10))*(TEF*WF8)
Genr WF8e_05=((TEF/z)**(-A11))*(TEF*WF8)
Genr WF8e_1=((TEF/z)**(-A12))*(TEF*WF8)
Genr WF8e_15=((TEF/z)**(-A13))*(TEF*WF8)
Genr WF8e_2=((TEF/z)**(-A14))*(TEF*WF8)
Genr WF8e_25=((TEF/z)**(-A15))*(TEF*WF8)

Gen1 N8=$N
Gen1 WFe8_0=sum(WF8e_0,N8)/sum(TEF,N8)
Gen1 WFe8_01=sum(WF8e_01,N8)/sum(TEF,N8)
Gen1 WFe8_015=sum(WF8e_015,N8)/sum(TEF,N8)
Gen1 WFe8_02=sum(WF8e_02,N8)/sum(TEF,N8)
Gen1 WFe8_025=sum(WF8e_025,N8)/sum(TEF,N8)
Gen1 WFe8_029=sum(WF8e_029,N8)/sum(TEF,N8)
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Gen1 WFe8_033=sum(WF8e_033,N8)/sum(TEF,N8)
Gen1 WFe8_035=sum(WF8e_035,N8)/sum(TEF,N8)
Gen1 WFe8_04=sum(WF8e_04,N8)/sum(TEF,N8)
Gen1 WFe8_045=sum(WF8e_045,N8)/sum(TEF,N8)
Gen1 WFe8_05=sum(WF8e_05,N8)/sum(TEF,N8)
Gen1 WFe8_1=sum(WF8e_1,N8)/sum(TEF,N8)
Gen1 WFe8_15=sum(WF8e_15,N8)/sum(TEF,N8)
Gen1 WFe8_2=sum(WF8e_2,N8)/sum(TEF,N8)
Gen1 WFe8_25=sum(WF8e_25,N8)/sum(TEF,N8)

Genr sWF8=TEF*WF8

Gen1 WF8c=sum(sWF8,N8)/sum(TEF,N8)
Print WF8c
Gen1 l8n_0=WFe8_0/WF8c
Gen1 l8n_01=WFe8_01/WF8c
Gen1 l8n_015=WFe8_015/WF8c
Gen1 l8n_02=WFe8_02/WF8c
Gen1 l8n_025=WFe8_025/WF8c
Gen1 l8n_029=WFe8_029/WF8c
Gen1 l8n_033=WFe8_033/WF8c
Gen1 l8n_035=WFe8_035/WF8c
Gen1 l8n_04=WFe8_04/WF8c
Gen1 l8n_045=WFe8_045/WF8c
Gen1 l8n_05=WFe8_05/WF8c
Gen1 l8n_1=WFe8_1/WF8c
Gen1 l8n_15=WFe8_15/WF8c
Gen1 l8n_2=WFe8_2/WF8c
Gen1 l8n_25=WFe8_25/WF8c


*Commodity 9

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5
```

```
Genr WF9e_0=((TEF/z)**(-A1))*(TEF*WF9)
Genr WF9e_01=((TEF/z)**(-A2))*(TEF*WF9)
Genr WF9e_015=((TEF/z)**(-A3))*(TEF*WF9)
Genr WF9e_02=((TEF/z)**(-A4))*(TEF*WF9)
Genr WF9e_025=((TEF/z)**(-A5))*(TEF*WF9)
Genr WF9e_029=((TEF/z)**(-A6))*(TEF*WF9)
Genr WF9e_033=((TEF/z)**(-A7))*(TEF*WF9)
Genr WF9e_035=((TEF/z)**(-A8))*(TEF*WF9)
Genr WF9e_04=((TEF/z)**(-A9))*(TEF*WF9)
Genr WF9e_045=((TEF/z)**(-A10))*(TEF*WF9)
Genr WF9e_05=((TEF/z)**(-A11))*(TEF*WF9)
Genr WF9e_1=((TEF/z)**(-A12))*(TEF*WF9)
Genr WF9e_15=((TEF/z)**(-A13))*(TEF*WF9)
Genr WF9e_2=((TEF/z)**(-A14))*(TEF*WF9)
Genr WF9e_25=((TEF/z)**(-A15))*(TEF*WF9)

Gen1 N9=$N
Gen1 WFe9_0=sum(WF9e_0,N9)/sum(TEF,N9)
Gen1 WFe9_01=sum(WF9e_01,N9)/sum(TEF,N9)
Gen1 WFe9_015=sum(WF9e_015,N9)/sum(TEF,N9)
Gen1 WFe9_02=sum(WF9e_02,N9)/sum(TEF,N9)
Gen1 WFe9_025=sum(WF9e_025,N9)/sum(TEF,N9)
Gen1 WFe9_029=sum(WF9e_029,N9)/sum(TEF,N9)
Gen1 WFe9_033=sum(WF9e_033,N9)/sum(TEF,N9)
Gen1 WFe9_035=sum(WF9e_035,N9)/sum(TEF,N9)
Gen1 WFe9_04=sum(WF9e_04,N9)/sum(TEF,N9)
Gen1 WFe9_045=sum(WF9e_045,N9)/sum(TEF,N9)
Gen1 WFe9_05=sum(WF9e_05,N9)/sum(TEF,N9)
Gen1 WFe9_1=sum(WF9e_1,N9)/sum(TEF,N9)
Gen1 WFe9_15=sum(WF9e_15,N9)/sum(TEF,N9)
Gen1 WFe9_2=sum(WF9e_2,N9)/sum(TEF,N9)
Gen1 WFe9_25=sum(WF9e_25,N9)/sum(TEF,N9)

Genr sWF9=TEF*WF9

Gen1 WF9c=sum(sWF9,N9)/sum(TEF,N9)
Print WF9c
Gen1 l9n_0=WFe9_0/WF9c
Gen1 l9n_01=WFe9_01/WF9c
Gen1 l9n_015=WFe9_015/WF9c
Gen1 l9n_02=WFe9_02/WF9c
Gen1 l9n_025=WFe9_025/WF9c
Gen1 l9n_029=WFe9_029/WF9c
Gen1 l9n_033=WFe9_033/WF9c
Gen1 l9n_035=WFe9_035/WF9c
Gen1 l9n_04=WFe9_04/WF9c
Gen1 l9n_045=WFe9_045/WF9c
Gen1 l9n_05=WFe9_05/WF9c
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```
Gen1 l9n_1=WFe9_1/WF9c
Gen1 l9n_15=WFe9_15/WF9c
Gen1 l9n_2=WFe9_2/WF9c
Gen1 l9n_25=WFe9_25/WF9c


*Commodity 10

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5


Genr WF10e_0=((TEF/z)**(-A1))*(TEF*WF10)
Genr WF10e_01=((TEF/z)**(-A2))*(TEF*WF10)
Genr WF10e_015=((TEF/z)**(-A3))*(TEF*WF10)
Genr WF10e_02=((TEF/z)**(-A4))*(TEF*WF10)
Genr WF10e_025=((TEF/z)**(-A5))*(TEF*WF10)
Genr WF10e_029=((TEF/z)**(-A6))*(TEF*WF10)
Genr WF10e_033=((TEF/z)**(-A7))*(TEF*WF10)
Genr WF10e_035=((TEF/z)**(-A8))*(TEF*WF10)
Genr WF10e_04=((TEF/z)**(-A9))*(TEF*WF10)
Genr WF10e_045=((TEF/z)**(-A10))*(TEF*WF10)
Genr WF10e_05=((TEF/z)**(-A11))*(TEF*WF10)
Genr WF10e_1=((TEF/z)**(-A12))*(TEF*WF10)
Genr WF10e_15=((TEF/z)**(-A13))*(TEF*WF10)
Genr WF10e_2=((TEF/z)**(-A14))*(TEF*WF10)
Genr WF10e_25=((TEF/z)**(-A15))*(TEF*WF10)

Gen1 N10=$N
Gen1 WFe10_0=sum(WF10e_0,N10)/sum(TEF,N10)
Gen1 WFe10_01=sum(WF10e_01,N10)/sum(TEF,N10)
Gen1 WFe10_015=sum(WF10e_015,N10)/sum(TEF,N10)
Gen1 WFe10_02=sum(WF10e_02,N10)/sum(TEF,N10)
Gen1 WFe10_025=sum(WF10e_025,N10)/sum(TEF,N10)
Gen1 WFe10_029=sum(WF10e_029,N10)/sum(TEF,N10)
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Gen1 WFe10_033=sum(WF10e_033,N10)/sum(TEF,N10)
Gen1 WFe10_035=sum(WF10e_035,N10)/sum(TEF,N10)
Gen1 WFe10_04=sum(WF10e_04,N10)/sum(TEF,N10)
Gen1 WFe10_045=sum(WF10e_045,N10)/sum(TEF,N10)
Gen1 WFe10_05=sum(WF10e_05,N10)/sum(TEF,N10)
Gen1 WFe10_1=sum(WF10e_1,N10)/sum(TEF,N10)
Gen1 WFe10_15=sum(WF10e_15,N10)/sum(TEF,N10)
Gen1 WFe10_2=sum(WF10e_2,N10)/sum(TEF,N10)
Gen1 WFe10_25=sum(WF10e_25,N10)/sum(TEF,N10)

Genr sWF10=TEF*WF10

Gen1 WF10c=sum(sWF10,N10)/sum(TEF,N10)
Print WF10c
Gen1 l10n_0=WFe10_0/WF10c
Gen1 l10n_01=WFe10_01/WF10c
Gen1 l10n_015=WFe10_015/WF10c
Gen1 l10n_02=WFe10_02/WF10c
Gen1 l10n_025=WFe10_025/WF10c
Gen1 l10n_029=WFe10_029/WF10c
Gen1 l10n_033=WFe10_033/WF10c
Gen1 l10n_035=WFe10_035/WF10c
Gen1 l10n_04=WFe10_04/WF10c
Gen1 l10n_045=WFe10_045/WF10c
Gen1 l10n_05=WFe10_05/WF10c
Gen1 l10n_1=WFe10_1/WF10c
Gen1 l10n_15=WFe10_15/WF10c
Gen1 l10n_2=WFe10_2/WF10c
Gen1 l10n_25=WFe10_25/WF10c

*Commodity 11

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5
```

```
Genr WF11e_0=((TEF/z)**(-A1))*(TEF*WF11)
Genr WF11e_01=((TEF/z)**(-A2))*(TEF*WF11)
Genr WF11e_015=((TEF/z)**(-A3))*(TEF*WF11)
Genr WF11e_02=((TEF/z)**(-A4))*(TEF*WF11)
Genr WF11e_025=((TEF/z)**(-A5))*(TEF*WF11)
Genr WF11e_029=((TEF/z)**(-A6))*(TEF*WF11)
Genr WF11e_033=((TEF/z)**(-A7))*(TEF*WF11)
Genr WF11e_035=((TEF/z)**(-A8))*(TEF*WF11)
Genr WF11e_04=((TEF/z)**(-A9))*(TEF*WF11)
Genr WF11e_045=((TEF/z)**(-A10))*(TEF*WF11)
Genr WF11e_05=((TEF/z)**(-A11))*(TEF*WF11)
Genr WF11e_1=((TEF/z)**(-A12))*(TEF*WF11)
Genr WF11e_15=((TEF/z)**(-A13))*(TEF*WF11)
Genr WF11e_2=((TEF/z)**(-A14))*(TEF*WF11)
Genr WF11e_25=((TEF/z)**(-A15))*(TEF*WF11)

Gen1 N11=$N
Gen1 WFe11_0=sum(WF11e_0,N11)/sum(TEF,N11)
Gen1 WFe11_01=sum(WF11e_01,N11)/sum(TEF,N11)
Gen1 WFe11_015=sum(WF11e_015,N11)/sum(TEF,N11)
Gen1 WFe11_02=sum(WF11e_02,N11)/sum(TEF,N11)
Gen1 WFe11_025=sum(WF11e_025,N11)/sum(TEF,N11)
Gen1 WFe11_029=sum(WF11e_029,N11)/sum(TEF,N11)
Gen1 WFe11_033=sum(WF11e_033,N11)/sum(TEF,N11)
Gen1 WFe11_035=sum(WF11e_035,N11)/sum(TEF,N11)
Gen1 WFe11_04=sum(WF11e_04,N11)/sum(TEF,N11)
Gen1 WFe11_045=sum(WF11e_045,N11)/sum(TEF,N11)
Gen1 WFe11_05=sum(WF11e_05,N11)/sum(TEF,N11)
Gen1 WFe11_1=sum(WF11e_1,N11)/sum(TEF,N11)
Gen1 WFe11_15=sum(WF11e_15,N11)/sum(TEF,N11)
Gen1 WFe11_2=sum(WF11e_2,N11)/sum(TEF,N11)
Gen1 WFe11_25=sum(WF11e_25,N11)/sum(TEF,N11)

Genr sWF11=TEF*WF11

Gen1 WF11c=sum(sWF11,N11)/sum(TEF,N11)
Print WF11c
Gen1 l11n_0=WFe11_0/WF11c
Gen1 l11n_01=WFe11_01/WF11c
Gen1 l11n_015=WFe11_015/WF11c
Gen1 l11n_02=WFe11_02/WF11c
Gen1 l11n_025=WFe11_025/WF11c
Gen1 l11n_029=WFe11_029/WF11c
Gen1 l11n_033=WFe11_033/WF11c
Gen1 l11n_035=WFe11_035/WF11c
Gen1 l11n_04=WFe11_04/WF11c
Gen1 l11n_045=WFe11_045/WF11c
Gen1 l11n_05=WFe11_05/WF11c
Gen1 l11n_1=WFe11_1/WF11c
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Gen1 l11n_15=WFe11_15/WF11c
Gen1 l11n_2=WFe11_2/WF11c
Gen1 l11n_25=WFe11_25/WF11c

*Commodity 12

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5

Genr WF12e_0=((TEF/z)**(-A1))*(TEF*WF12)
Genr WF12e_01=((TEF/z)**(-A2))*(TEF*WF12)
Genr WF12e_015=((TEF/z)**(-A3))*(TEF*WF12)
Genr WF12e_02=((TEF/z)**(-A4))*(TEF*WF12)
Genr WF12e_025=((TEF/z)**(-A5))*(TEF*WF12)
Genr WF12e_029=((TEF/z)**(-A6))*(TEF*WF12)
Genr WF12e_033=((TEF/z)**(-A7))*(TEF*WF12)
Genr WF12e_035=((TEF/z)**(-A8))*(TEF*WF12)
Genr WF12e_04=((TEF/z)**(-A9))*(TEF*WF12)
Genr WF12e_045=((TEF/z)**(-A10))*(TEF*WF12)
Genr WF12e_05=((TEF/z)**(-A11))*(TEF*WF12)
Genr WF12e_1=((TEF/z)**(-A12))*(TEF*WF12)
Genr WF12e_15=((TEF/z)**(-A13))*(TEF*WF12)
Genr WF12e_2=((TEF/z)**(-A14))*(TEF*WF12)
Genr WF12e_25=((TEF/z)**(-A15))*(TEF*WF12)

Gen1 N12=$N
Gen1 WFe12_0=sum(WF12e_0,N12)/sum(TEF,N12)
Gen1 WFe12_01=sum(WF12e_01,N12)/sum(TEF,N12)
Gen1 WFe12_015=sum(WF12e_015,N12)/sum(TEF,N12)
Gen1 WFe12_02=sum(WF12e_02,N12)/sum(TEF,N12)
Gen1 WFe12_025=sum(WF12e_025,N12)/sum(TEF,N12)
Gen1 WFe12_029=sum(WF12e_029,N12)/sum(TEF,N12)
Gen1 WFe12_033=sum(WF12e_033,N12)/sum(TEF,N12)
Gen1 WFe12_035=sum(WF12e_035,N12)/sum(TEF,N12)
Gen1 WFe12_04=sum(WF12e_04,N12)/sum(TEF,N12)
```

```
Gen1 WFe12_045=sum(WF12e_045,N12)/sum(TEF,N12)
Gen1 WFe12_05=sum(WF12e_05,N12)/sum(TEF,N12)
Gen1 WFe12_1=sum(WF12e_1,N12)/sum(TEF,N12)
Gen1 WFe12_15=sum(WF12e_15,N12)/sum(TEF,N12)
Gen1 WFe12_2=sum(WF12e_2,N12)/sum(TEF,N12)
Gen1 WFe12_25=sum(WF12e_25,N12)/sum(TEF,N12)

Genr sWF12=TEF*WF12

Gen1 WF12c=sum(sWF12,N12)/sum(TEF,N12)
Print WF12c
Gen1 l12n_0=WFe12_0/WF12c
Gen1 l12n_01=WFe12_01/WF12c
Gen1 l12n_015=WFe12_015/WF12c
Gen1 l12n_02=WFe12_02/WF12c
Gen1 l12n_025=WFe12_025/WF12c
Gen1 l12n_029=WFe12_029/WF12c
Gen1 l12n_033=WFe12_033/WF12c
Gen1 l12n_035=WFe12_035/WF12c
Gen1 l12n_04=WFe12_04/WF12c
Gen1 l12n_045=WFe12_045/WF12c
Gen1 l12n_05=WFe12_05/WF12c
Gen1 l12n_1=WFe12_1/WF12c
Gen1 l12n_15=WFe12_15/WF12c
Gen1 l12n_2=WFe12_2/WF12c
Gen1 l12n_25=WFe12_25/WF12c

*Commodity 13

*GINI (0.29 -0.33), TI(0.1164 – 0.1891), LI(0.1017 – 0.1616)

Gen1 A1=0
Gen1 A2=0.1
Gen1 A3=0.15
Gen1 A4=0.2
Gen1 A5=0.25
Gen1 A6=0.29
Gen1 A7=0.33
Gen1 A8=0.35
Gen1 A9=0.4
Gen1 A10=0.45
Gen1 A11=0.5
Gen1 A12=1
Gen1 A13=1.5
Gen1 A14=2
Gen1 A15=2.5

Genr WF13e_0=((TEF/z)**(-A1))*(TEF*WF13)
Genr WF13e_01=((TEF/z)**(-A2))*(TEF*WF13)
Genr WF13e_015=((TEF/z)**(-A3))*(TEF*WF13)
```

```
Genr WF13e_02=((TEF/z)**(-A4))*(TEF*WF13)
Genr WF13e_025=((TEF/z)**(-A5))*(TEF*WF13)
Genr WF13e_029=((TEF/z)**(-A6))*(TEF*WF13)
Genr WF13e_033=((TEF/z)**(-A7))*(TEF*WF13)
Genr WF13e_035=((TEF/z)**(-A8))*(TEF*WF13)
Genr WF13e_04=((TEF/z)**(-A9))*(TEF*WF13)
Genr WF13e_045=((TEF/z)**(-A10))*(TEF*WF13)
Genr WF13e_05=((TEF/z)**(-A11))*(TEF*WF13)
Genr WF13e_1=((TEF/z)**(-A12))*(TEF*WF13)
Genr WF13e_15=((TEF/z)**(-A13))*(TEF*WF13)
Genr WF13e_2=((TEF/z)**(-A14))*(TEF*WF13)
Genr WF13e_25=((TEF/z)**(-A15))*(TEF*WF13)

Gen1 N13=$N
Gen1 WFe13_0=sum(WF13e_0,N13)/sum(TEF,N13)
Gen1 WFe13_01=sum(WF13e_01,N13)/sum(TEF,N13)
Gen1 WFe13_015=sum(WF13e_015,N13)/sum(TEF,N13)
Gen1 WFe13_02=sum(WF13e_02,N13)/sum(TEF,N13)
Gen1 WFe13_025=sum(WF13e_025,N13)/sum(TEF,N13)
Gen1 WFe13_029=sum(WF13e_029,N13)/sum(TEF,N13)
Gen1 WFe13_033=sum(WF13e_033,N13)/sum(TEF,N13)
Gen1 WFe13_035=sum(WF13e_035,N13)/sum(TEF,N13)
Gen1 WFe13_04=sum(WF13e_04,N13)/sum(TEF,N13)
Gen1 WFe13_045=sum(WF13e_045,N13)/sum(TEF,N13)
Gen1 WFe13_05=sum(WF13e_05,N13)/sum(TEF,N13)
Gen1 WFe13_1=sum(WF13e_1,N13)/sum(TEF,N13)
Gen1 WFe13_15=sum(WF13e_15,N13)/sum(TEF,N13)
Gen1 WFe13_2=sum(WF13e_2,N13)/sum(TEF,N13)
Gen1 WFe13_25=sum(WF13e_25,N13)/sum(TEF,N13)

Genr sWF13=TEF*WF13

Gen1 WF13c=sum(sWF13,N13)/sum(TEF,N13)
Print WF13c
Gen1 l13n_0=WFe13_0/WF13c
Gen1 l13n_01=WFe13_01/WF13c
Gen1 l13n_015=WFe13_015/WF13c
Gen1 l13n_02=WFe13_02/WF13c
Gen1 l13n_025=WFe13_025/WF13c
Gen1 l13n_029=WFe13_029/WF13c
Gen1 l13n_033=WFe13_033/WF13c
Gen1 l13n_035=WFe13_035/WF13c
Gen1 l13n_04=WFe13_04/WF13c
Gen1 l13n_045=WFe13_045/WF13c
Gen1 l13n_05=WFe13_05/WF13c
Gen1 l13n_1=WFe13_1/WF13c
Gen1 l13n_15=WFe13_15/WF13c
Gen1 l13n_2=WFe13_2/WF13c
Gen1 l13n_25=WFe13_25/WF13c
```

```
*Concenate WF1c-WF13c
Matrix
WFc=(WF1c|WF2c|WF3c|WF4c|WF5c|WF6c|WF7c|WF8c|WF9c|WF10c|WF11c|WF
12c|WF13c)

Print WFc

*Concenate l1n-l15n
Matrix
ln_0=(l1n_0|l2n_0|l3n_0|l4n_0|l5n_0|l6n_0|l7n_0|l8n_0|l9n_0|l10n_0|l11n_0|l12n_0|l
13n_0)
Print ln_0
Matrix
ln_01=(l1n_01|l2n_01|l3n_01|l4n_01|l5n_01|l6n_01|l7n_01|l8n_01|l9n_01|l10n_01|l1
1n_01|l12n_01|l13n_01)
Print ln_01
Matrix
ln_015=(l1n_015|l2n_015|l3n_015|l4n_015|l5n_015|l6n_015|l7n_015|l8n_015|l9n_01
5|l10n_015|l11n_015|l12n_015|l13n_015)
Print ln_015
Matrix
ln_02=(l1n_02|l2n_02|l3n_02|l4n_02|l5n_02|l6n_02|l7n_02|l8n_02|l9n_02|l10n_02|l1
1n_02|l12n_02|l13n_02)
Print ln_02
Matrix
ln_025=(l1n_025|l2n_025|l3n_025|l4n_025|l5n_025|l6n_025|l7n_025|l8n_025|l9n_02
5|l10n_025|l11n_025|l12n_025|l13n_025)
Print ln_025
Matrix
ln_029=(l1n_029|l2n_029|l3n_029|l4n_029|l5n_029|l6n_029|l7n_029|l8n_029|l9n_02
9|l10n_029|l11n_029|l12n_029|l13n_029)
Print ln_029
Matrix
ln_033=(l1n_033|l2n_033|l3n_033|l4n_033|l5n_033|l6n_033|l7n_033|l8n_033|l9n_03
3|l10n_033|l11n_033|l12n_033|l13n_033)
Print ln_033
Matrix
ln_035=(l1n_035|l2n_035|l3n_035|l4n_035|l5n_035|l6n_035|l7n_035|l8n_035|l9n_03
5|l10n_035|l11n_035|l12n_035|l13n_035)
Print ln_035
Matrix
ln_04=(l1n_04|l2n_04|l3n_04|l4n_04|l5n_04|l6n_04|l7n_04|l8n_04|l9n_04|l10n_04|l1
1n_04|l12n_04|l13n_04)
Print ln_04
Matrix
ln_045=(l1n_045|l2n_045|l3n_045|l4n_045|l5n_045|l6n_045|l7n_045|l8n_045|l9n_04
5|l10n_045|l11n_045|l12n_045|l13n_045)
Print ln_045
```

```
Matrix
ln_05=(l1n_05|l2n_05|l3n_05|l4n_05|l5n_05|l6n_05|l7n_05|l8n_05|l9n_05|l10n_05|l1
1n_05|l12n_05|l13n_05)
Print ln_05
Matrix
ln_1=(l1n_1|l2n_1|l3n_1|l4n_1|l5n_1|l6n_1|l7n_1|l8n_1|l9n_1|l10n_1|l11n_1|l12n_1|l
13n_1)
Print ln_1
Matrix
ln_15=(l1n_15|l2n_15|l3n_15|l4n_15|l5n_15|l6n_15|l7n_15|l8n_15|l9n_15|l10n_15|l1
1n_15|l12n_15|l13n_15)
Print ln_15
Matrix
ln_2=(l1n_2|l2n_2|l3n_2|l4n_2|l5n_2|l6n_2|l7n_2|l8n_2|l9n_2|l10n_2|l11n_2|l12n_2|l
13n_2)
Print ln_2
Matrix
ln_25=(l1n_25|l2n_25|l3n_25|l4n_25|l5n_25|l6n_25|l7n_25|l8n_25|l9n_25|l10n_25|l1
1n_25|l12n_25|l13n_25)
Print ln_25


Matrix Tln_0=ln_0'
Matrix Tln_01=ln_01'
Matrix Tln_015=ln_015'
Matrix Tln_02=ln_02'
Matrix Tln_025=ln_025'
Matrix Tln_029=ln_029'
Matrix Tln_033=ln_033'
Matrix Tln_035=ln_035'
Matrix Tln_04=ln_04'
Matrix Tln_045=ln_045'
Matrix Tln_05=ln_05'
Matrix Tln_1=ln_1'
Matrix Tln_15=ln_15'
Matrix Tln_2=ln_2'
Matrix Tln_25=ln_25'

Matrix
Tln=(Tln_0|Tln_01|Tln_015|Tln_02|Tln_025|Tln_029|Tln_033|Tln_035|Tln_04|Tln_0
45|Tln_05|Tln_1|Tln_15|Tln_2|Tln_25)

Sample 1 3976
Set Skipmiss
read (C:\Data August\Indonesia\Table AY01_AY113 ICWF All 23 Oct.txt) Island
Region Area Regency SubDist Village ay01 ay02 ay03 ay04 ay05 &
ay06 ay07 ay08 ay09 ay010 ay011 ay012 ay013 ay11 ay12 ay13 ay14 ay15 ay16
ay17 ay18 ay19 ay110 ay111 ay112 ay113/skiplines=1

Stat ay01 ay02 ay03 ay04 ay05 ay06 ay07 ay08 ay09 ay010 ay011 ay012 ay013 &
```

```
ay11 ay12 ay13 ay14 ay15 ay16 ay17 ay18 ay19 ay110 ay111 ay112
ay113/mean=aybar cov=vcvy
Print aybar
Print vcvy

*sGH=cov(y1G,y1H)
Matrix S11=vcvy(14,14)
Matrix S12=vcvy(14,15)
Matrix S21=s12
Matrix S22=vcvy(15,15)

Matrix S11=vcvy(14,14)
Matrix S13=vcvy(14,16)
Matrix S31=s13
Matrix S33=vcvy(16,16)

Matrix S11=vcvy(14,14)
Matrix S14=vcvy(14,17)
Matrix S41=s14
Matrix S44=vcvy(17,17)

Matrix S11=vcvy(14,14)
Matrix S15=vcvy(14,18)
Matrix S51=s15
Matrix S55=vcvy(18,18)

Matrix S11=vcvy(14,14)
Matrix S16=vcvy(14,19)
Matrix S61=s16
Matrix S66=vcvy(19,19)

Matrix S11=vcvy(14,14)
Matrix S17=vcvy(14,20)
Matrix S71=s17
Matrix S77=vcvy(20,20)

Matrix S11=vcvy(14,14)
Matrix S18=vcvy(14,21)
Matrix S81=S18
Matrix S88=vcvy(21,21)

Matrix S11=vcvy(14,14)
Matrix S19=vcvy(14,22)
Matrix S91=S19
Matrix S99=vcvy(22,22)

Matrix S11=vcvy(14,14)
Matrix S110=vcvy(14,23)
Matrix S101=s110
Matrix S1010=vcvy(23,23)
```

```
Matrix S11=vcvy(14,14)
Matrix S111=vcvy(14,24)
Matrix S111=s111
Matrix S1111=vcvy(24,24)


Matrix S11=vcvy(14,14)
Matrix S112=vcvy(14,25)
Matrix S121=s112
Matrix S1212=vcvy(25,25)

Matrix S11=vcvy(14,14)
Matrix S113=vcvy(14,26)
Matrix S131=s113
Matrix S1313=vcvy(26,26)

*

Matrix S22=vcvy(15,15)
Matrix S23=vcvy(15,16)
Matrix S32=s23
Matrix S33=vcvy(16,16)

Matrix S22=vcvy(15,15)
Matrix S24=vcvy(15,17)
Matrix S42=s24
Matrix S44=vcvy(17,17)

Matrix S22=vcvy(15,15)
Matrix S25=vcvy(15,18)
Matrix S52=s25
Matrix S55=vcvy(18,18)

Matrix S22=vcvy(15,15)
Matrix S26=vcvy(1,19)
Matrix S62=s26
Matrix S66=vcvy(19,19)

Matrix S22=vcvy(15,15)
Matrix S27=vcvy(15,20)
Matrix S72=s27
Matrix S77=vcvy(20,20)

Matrix S22=vcvy(15,15)
Matrix S28=vcvy(15,21)
Matrix S82=s28
Matrix S88=vcvy(21,21)

Matrix S22=vcvy(15,15)
```

Matrix S29=vcvy(15,22)
Matrix S92=s29
Matrix S99=vcvy(22,22)

Matrix S22=vcvy(15,15)
Matrix S210=vcvy(15,23)
Matrix S102=s210
Matrix S1010=vcvy(23,23)

Matrix S22=vcvy(15,15)
Matrix S211=vcvy(15,24)
Matrix S112=S211
Matrix S1111=vcvy(24,24)

Matrix S22=vcvy(15,15)
Matrix S212=vcvy(15,25)
Matrix S122=s212
Matrix S1212=vcvy(25,25)

Matrix S22=vcvy(15,15)
Matrix S213=vcvy(15,26)
Matrix S132=s213
Matrix S1313=vcvy(26,26)

*

Matrix S33=vcvy(16,16)
Matrix S34=vcvy(15,17)
Matrix S43=s34
Matrix S44=vcvy(17,17)

Matrix S33=vcvy(16,16)
Matrix S35=vcvy(16,18)
Matrix S53=s35
Matrix S55=vcvy(18,18)

Matrix S33=vcvy(16,16)
Matrix S36=vcvy(16,19)
Matrix S63=s36
Matrix S66=vcvy(19,19)

Matrix S33=vcvy(16,16)
Matrix S37=vcvy(16,20)
Matrix S73=s37
Matrix S77=vcvy(20,20)

Matrix S33=vcvy(16,16)
Matrix S38=vcvy(16,21)
Matrix S83=s38
Matrix S88=vcvy(21,21)

```
Matrix S33=vcvy(16,16)
Matrix S39=vcvy(16,22)
Matrix S93=s39
Matrix S99=vcvy(22,22)

Matrix S33=vcvy(16,16)
Matrix S310=vcvy(16,23)
Matrix S103=s310
Matrix S1010=vcvy(23,23)

Matrix S33=vcvy(16,16)
Matrix S311=vcvy(16,24)
Matrix S113=s311
Matrix S1111=vcvy(24,24)

Matrix S33=vcvy(16,16)
Matrix S312=vcvy(16,25)
Matrix S123=s312
Matrix S1212=vcvy(25,25)

Matrix S33=vcvy(16,16)
Matrix S313=vcvy(16,26)
Matrix S133=s313
Matrix S1313=vcvy(26,26)

*

Matrix S44=vcvy(17,17)
Matrix S45=vcvy(17,18)
Matrix S54=s45
Matrix S55=vcvy(18,18)

Matrix S44=vcvy(17,17)
Matrix S46=vcvy(17,19)
Matrix S64=s46
Matrix S66=vcvy(19,19)

Matrix S44=vcvy(17,17)
Matrix S47=vcvy(17,20)
Matrix S74=s47
Matrix S77=vcvy(20,20)

Matrix S44=vcvy(17,17)
Matrix S48=vcvy(17,21)
Matrix S84=s48
Matrix S88=vcvy(21,21)

Matrix S44=vcvy(17,17)
Matrix S49=vcvy(17,22)
```

```
Matrix S94=s49
Matrix S99=vcvy(22,22)

Matrix S44=vcvy(17,17)
Matrix S410=vcvy(17,23)
Matrix S104=s410
Matrix S1010=vcvy(23,23)

Matrix S44=vcvy(17,17)
Matrix S411=vcvy(17,24)
Matrix S114=s411
Matrix S1111=vcvy(24,24)

Matrix S44=vcvy(17,17)
Matrix S412=vcvy(17,25)
Matrix S124=s412
Matrix S1212=vcvy(25,25)

Matrix S44=vcvy(17,17)
Matrix S413=vcvy(17,26)
Matrix S134=s413
Matrix S1313=vcvy(26,26)

*
Matrix S55=vcvy(18,18)
Matrix S56=vcvy(18,19)
Matrix S65=s56
Matrix S66=vcvy(19,19)

Matrix S55=vcvy(18,18)
Matrix S57=vcvy(18,20)
Matrix S75=s57
Matrix S77=vcvy(20,20)

Matrix S55=vcvy(18,18)
Matrix S58=vcvy(18,21)
Matrix S85=s58
Matrix S88=vcvy(21,21)

Matrix S55=vcvy(18,18)
Matrix S59=vcvy(18,22)
Matrix S95=s59
Matrix S99=vcvy(22,22)

Matrix S55=vcvy(18,18)
Matrix S510=vcvy(18,23)
Matrix S105=s510
Matrix S1010=vcvy(23,23)

Matrix S55=vcvy(18,18)
```

```
Matrix S511=vcvy(18,24)
Matrix S115=s511
Matrix S1111=vcvy(24,24)

Matrix S55=vcvy(18,18)
Matrix S512=vcvy(18,25)
Matrix S125=s512
Matrix S1212=vcvy(25,25)

Matrix S55=vcvy(18,18)
Matrix S513=vcvy(18,26)
Matrix S135=s513
Matrix S1313=vcvy(26,26)

*

Matrix S66=vcvy(19,19)
Matrix S67=vcvy(19,20)
Matrix S76=s67
Matrix S77=vcvy(20,20)

Matrix S66=vcvy(19,19)
Matrix S68=vcvy(19,21)
Matrix S86=s68
Matrix S88=vcvy(21,21)

Matrix S66=vcvy(19,19)
Matrix S69=vcvy(19,22)
Matrix S96=s69
Matrix S99=vcvy(22,22)

Matrix S66=vcvy(19,19)
Matrix S610=vcvy(19,23)
Matrix S106=s610
Matrix S1010=vcvy(23,23)

Matrix S66=vcvy(19,19)
Matrix S611=vcvy(19,24)
Matrix S116=s611
Matrix S1111=vcvy(24,24)

Matrix S66=vcvy(19,19)
Matrix S612=vcvy(19,25)
Matrix S126=s612
Matrix S1212=vcvy(25,25)

Matrix S66=vcvy(19,19)
Matrix S613=vcvy(19,26)
Matrix S136=s613
Matrix S1313=vcvy(26,26)
```

```
*
Matrix S77=vcvy(20,20)
Matrix S78=vcvy(20,21)
Matrix S87=s78
Matrix S88=vcvy(21,21)

Matrix S77=vcvy(20,20)
Matrix S79=vcvy(20,22)
Matrix S97=s79
Matrix S99=vcvy(22,22)

Matrix S77=vcvy(20,20)
Matrix S710=vcvy(20,23)
Matrix S107=s710
Matrix S1010=vcvy(23,23)

Matrix S77=vcvy(20,20)
Matrix S711=vcvy(20,24)
Matrix S117=s711
Matrix S1111=vcvy(24,24)

Matrix S77=vcvy(20,20)
Matrix S712=vcvy(20,25)
Matrix S127=s712
Matrix S1212=vcvy(25,25)

Matrix S77=vcvy(20,20)
Matrix S713=vcvy(20,26)
Matrix S137=s713
Matrix S1313=vcvy(26,26)

*

Matrix S88=vcvy(21,21)
Matrix S89=vcvy(21,22)
Matrix S98=s89
Matrix S99=vcvy(22,22)

Matrix S88=vcvy(21,21)
Matrix S810=vcvy(21,23)
Matrix S108=s810
Matrix S1010=vcvy(23,23)

Matrix S88=vcvy(21,21)
Matrix S811=vcvy(21,24)
Matrix S118=s811
Matrix S1111=vcvy(24,24)

Matrix S88=vcvy(21,21)
```

```
Matrix S812=vcvy(21,25)
Matrix S128=s812
Matrix S1212=vcvy(25,25)

Matrix S88=vcvy(21,21)
Matrix S813=vcvy(21,26)
Matrix S138=s813
Matrix S1313=vcvy(26,26)

*

Matrix S99=vcvy(22,22)
Matrix S910=vcvy(22,23)
Matrix S109=s910
Matrix S1010=vcvy(23,23)

Matrix S99=vcvy(22,22)
Matrix S911=vcvy(23,24)
Matrix S119=s911
Matrix S1111=vcvy(24,24)

Matrix S99=vcvy(22,22)
Matrix S912=vcvy(22,25)
Matrix S129=s912
Matrix S1212=vcvy(25,25)

Matrix S99=vcvy(22,22)
Matrix S913=vcvy(22,26)
Matrix S139=s913
Matrix S1313=vcvy(26,26)

*

Matrix S1010=vcvy(23,23)
Matrix S1011=vcvy(23,24)
Matrix S1110=s1011
Matrix S1111=vcvy(24,24)

Matrix S1010=vcvy(23,23)
Matrix S1012=vcvy(23,25)
Matrix S1210=s1012
Matrix S1212=vcvy(25,25)

Matrix S1010=vcvy(23,23)
Matrix S1013=vcvy(23,26)
Matrix S1310=s1013
Matrix S1313=vcvy(26,26)

*
```

```
Matrix S1111=vcvy(24,24)
Matrix S1112=vcvy(24,25)
Matrix S1211=s1112
Matrix S1212=vcvy(25,25)

Matrix S1111=vcvy(24,24)
Matrix S1113=vcvy(24,26)
Matrix S1311=s1113
Matrix S1313=vcvy(26,26)

*

Matrix S1212=vcvy(25,25)
Matrix S1213=vcvy(25,26)
Matrix S1312=s1213
Matrix S1313=vcvy(26,26)

*

*RGH=cov(y1G,y0H)
Matrix R11=vcvy(14,1)
Matrix R12=vcvy(14,2)
Matrix R21=R12
Matrix R22=vcvy(15,2)

Matrix R11=vcvy(14,1)
Matrix R13=vcvy(14,3)
Matrix R31=R13
Matrix R33=vcvy(16,3)

Matrix R11=vcvy(14,1)
Matrix R14=vcvy(14,4)
Matrix R41=R14
Matrix R44=vcvy(17,4)

Matrix R11=vcvy(14,1)
Matrix R15=vcvy(14,5)
Matrix R51=R15
Matrix R55=vcvy(18,5)

Matrix R11=vcvy(14,1)
Matrix R16=vcvy(14,6)
Matrix R61=R16
Matrix R66=vcvy(19,6)

Matrix R11=vcvy(14,1)
Matrix R17=vcvy(14,7)
Matrix R71=R17
Matrix R77=vcvy(20,7)
```

```
Matrix R11=vcvy(14,1)
Matrix R18=vcvy(14,8)
Matrix R81=R18
Matrix R88=vcvy(21,8)

Matrix R11=vcvy(14,1)
Matrix R19=vcvy(14,9)
Matrix R91=R19
Matrix R99=vcvy(22,10)

Matrix R11=vcvy(14,1)
Matrix R110=vcvy(14,10)
Matrix R101=R110
Matrix R1010=vcvy(23,10)

Matrix R11=vcvy(14,1)
Matrix R111=vcvy(14,11)
Matrix R111=R111
Matrix R1111=vcvy(24,11)

Matrix R11=vcvy(14,1)
Matrix R112=vcvy(14,12)
Matrix R121=R112
Matrix R1212=vcvy(25,12)

Matrix R11=vcvy(14,1)
Matrix R113=vcvy(14,13)
Matrix R131=R113
Matrix R1313=vcvy(26,13)

*

Matrix R12=vcvy(15,2)
Matrix R23=vcvy(15,3)
Matrix R32=R23
Matrix R33=vcvy(16,3)

Matrix R12=vcvy(15,2)
Matrix R24=vcvy(15,4)
Matrix R42=R24
Matrix R44=vcvy(17,4)

Matrix R12=vcvy(15,2)
Matrix R25=vcvy(15,5)
Matrix R52=R25
Matrix R55=vcvy(18,5)

Matrix R12=vcvy(15,2)
Matrix R26=vcvy(15,6)
Matrix R62=R26
```

Matrix R66=vcvy(19,6)

Matrix R12=vcvy(15,2)
Matrix R27=vcvy(15,7)
Matrix R72=R27
Matrix R77=vcvy(20,7)

Matrix R12=vcvy(15,2)
Matrix R28=vcvy(15,8)
Matrix R82=R28
Matrix R88=vcvy(21,8)

Matrix R12=vcvy(15,2)
Matrix R29=vcvy(15,9)
Matrix R92=R29
Matrix R99=vcvy(22,10)

Matrix R12=vcvy(15,2)
Matrix R210=vcvy(15,10)
Matrix R102=R210
Matrix R1010=vcvy(23,10)

Matrix R12=vcvy(15,2)
Matrix R211=vcvy(15,11)
Matrix R112=R211
Matrix R1111=vcvy(24,11)

Matrix R12=vcvy(15,2)
Matrix R212=vcvy(15,12)
Matrix R122=R212
Matrix R1212=vcvy(25,12)

Matrix R12=vcvy(15,2)
Matrix R213=vcvy(15,13)
Matrix R132=R213
Matrix R1313=vcvy(26,13)

*

Matrix R33=vcvy(16,3)
Matrix R34=vcvy(16,4)
Matrix R43=R34
Matrix R44=vcvy(17,4)

Matrix R33=vcvy(16,3)
Matrix R35=vcvy(16,5)
Matrix R53=R35
Matrix R55=vcvy(18,5)

Matrix R33=vcvy(16,3)

```
Matrix R36=vcvy(16,6)
Matrix R63=R36
Matrix R66=vcvy(19,6)

Matrix R33=vcvy(16,3)
Matrix R37=vcvy(16,7)
Matrix R73=R37
Matrix R77=vcvy(20,7)

Matrix R33=vcvy(16,3)
Matrix R38=vcvy(16,8)
Matrix R83=R38
Matrix R88=vcvy(21,8)

Matrix R33=vcvy(16,3)
Matrix R39=vcvy(16,9)
Matrix R93=R39
Matrix R99=vcvy(22,10)

Matrix R33=vcvy(16,3)
Matrix R310=vcvy(16,10)
Matrix R103=R310
Matrix R1010=vcvy(23,10)

Matrix R33=vcvy(16,3)
Matrix R311=vcvy(16,11)
Matrix R113=R311
Matrix R1111=vcvy(24,11)

Matrix R33=vcvy(16,3)
Matrix R312=vcvy(16,12)
Matrix R123=R312
Matrix R1212=vcvy(25,12)

Matrix R33=vcvy(16,3)
Matrix R313=vcvy(16,13)
Matrix R133=R313
Matrix R1313=vcvy(26,13)

*

Matrix R44=vcvy(17,4)
Matrix R45=vcvy(17,5)
Matrix R54=R45
Matrix R55=vcvy(18,5)

Matrix R44=vcvy(17,4)
Matrix R46=vcvy(17,6)
Matrix R64=R46
Matrix R66=vcvy(19,6)
```

```
Matrix R44=vcvy(17,4)
Matrix R47=vcvy(17,7)
Matrix R74=R47
Matrix R77=vcvy(20,7)

Matrix R44=vcvy(17,4)
Matrix R48=vcvy(17,8)
Matrix R84=R48
Matrix R88=vcvy(21,8)

Matrix R44=vcvy(17,4)
Matrix R49=vcvy(17,9)
Matrix R94=R49
Matrix R99=vcvy(22,9)

Matrix R44=vcvy(17,4)
Matrix R410=vcvy(17,10)
Matrix R104=R410
Matrix R1010=vcvy(23,10)

Matrix R44=vcvy(17,4)
Matrix R411=vcvy(17,11)
Matrix R114=R411
Matrix R1111=vcvy(24,11)

Matrix R44=vcvy(17,4)
Matrix R412=vcvy(17,12)
Matrix R124=R412
Matrix R1212=vcvy(25,12)

Matrix R44=vcvy(17,4)
Matrix R413=vcvy(17,13)
Matrix R134=R413
Matrix R1313=vcvy(26,13)

*

Matrix R55=vcvy(18,5)
Matrix R56=vcvy(18,6)
Matrix R65=R56
Matrix R66=vcvy(19,6)

Matrix R55=vcvy(18,5)
Matrix R57=vcvy(18,7)
Matrix R75=R57
Matrix R77=vcvy(20,7)

Matrix R55=vcvy(18,5)
Matrix R58=vcvy(18,8)
```

```
Matrix R85=R58
Matrix R88=vcvy(21,8)

Matrix R55=vcvy(18,5)
Matrix R59=vcvy(18,9)
Matrix R95=R59
Matrix R99=vcvy(22,10)

Matrix R55=vcvy(18,5)
Matrix R510=vcvy(20,10)
Matrix R105=R510
Matrix R1010=vcvy(23,10)

Matrix R55=vcvy(18,5)
Matrix R511=vcvy(20,11)
Matrix R115=R511
Matrix R1111=vcvy(24,11)

Matrix R55=vcvy(18,5)
Matrix R512=vcvy(20,12)
Matrix R125=R512
Matrix R1212=vcvy(25,12)

Matrix R55=vcvy(18,5)
Matrix R513=vcvy(20,13)
Matrix R135=R513
Matrix R1313=vcvy(26,13)

*

Matrix R66=vcvy(19,6)
Matrix R67=vcvy(19,7)
Matrix R76=R67
Matrix R77=vcvy(20,7)

Matrix R66=vcvy(19,6)
Matrix R68=vcvy(19,8)
Matrix R86=R68
Matrix R88=vcvy(21,8)

Matrix R66=vcvy(19,6)
Matrix R69=vcvy(19,9)
Matrix R96=R69
Matrix R99=vcvy(22,9)

Matrix R66=vcvy(19,6)
Matrix R610=vcvy(19,10)
Matrix R106=R610
Matrix R1010=vcvy(23,10)
```

```
Matrix R66=vcvy(19,6)
Matrix R611=vcvy(19,11)
Matrix R116=R611
Matrix R1111=vcvy(24,11)

Matrix R66=vcvy(19,6)
Matrix R612=vcvy(19,12)
Matrix R126=R612
Matrix R1212=vcvy(25,12)

Matrix R66=vcvy(19,6)
Matrix R613=vcvy(19,13)
Matrix R136=R613
Matrix R1313=vcvy(26,13)

*

Matrix R77=vcvy(20,7)
Matrix R78=vcvy(20,8)
Matrix R87=R78
Matrix R88=vcvy(21,8)

Matrix R77=vcvy(20,7)
Matrix R79=vcvy(20,9)
Matrix R97=R79
Matrix R99=vcvy(22,9)

Matrix R77=vcvy(20,7)
Matrix R710=vcvy(20,10)
Matrix R107=R710
Matrix R1010=vcvy(23,10)

Matrix R77=vcvy(20,7)
Matrix R711=vcvy(20,11)
Matrix R117=R711
Matrix R1111=vcvy(24,11)

Matrix R77=vcvy(20,7)
Matrix R712=vcvy(20,12)
Matrix R127=R712
Matrix R1212=vcvy(25,12)

Matrix R77=vcvy(20,7)
Matrix R713=vcvy(20,13)
Matrix R137=R713
Matrix R1313=vcvy(26,13)

*

Matrix R88=vcvy(21,8)
```

```
Matrix R89=vcvy(21,9)
Matrix R98=R89
Matrix R99=vcvy(22,9)

Matrix R88=vcvy(21,8)
Matrix R810=vcvy(21,10)
Matrix R108=R810
Matrix R1010=vcvy(23,10)

Matrix R88=vcvy(21,8)
Matrix R811=vcvy(21,11)
Matrix R118=R811
Matrix R1111=vcvy(24,11)

Matrix R88=vcvy(21,8)
Matrix R812=vcvy(21,12)
Matrix R128=R812
Matrix R1212=vcvy(25,12)

Matrix R88=vcvy(21,8)
Matrix R813=vcvy(21,13)
Matrix R138=R813
Matrix R1313=vcvy(26,13)

*

Matrix R99=vcvy(22,9)
Matrix R910=vcvy(22,10)
Matrix R109=R910
Matrix R1010=vcvy(23,10)

Matrix R99=vcvy(22,9)
Matrix R911=vcvy(22,11)
Matrix R119=R911
Matrix R1111=vcvy(24,11)

Matrix R99=vcvy(22,9)
Matrix R912=vcvy(23,12)
Matrix R129=R912
Matrix R1212=vcvy(25,12)

Matrix R99=vcvy(22,9)
Matrix R913=vcvy(22,13)
Matrix R139=R913
Matrix R1313=vcvy(26,13)

*

Matrix R1010=vcvy(23,10)
Matrix R1011=vcvy(23,11)
```

```
Matrix R1110=R1011
Matrix R1111=vcvy(24,11)

Matrix R1010=vcvy(23,10)
Matrix R1012=vcvy(23,12)
Matrix R1210=R1012
Matrix R1212=vcvy(25,12)

Matrix R1010=vcvy(23,10)
Matrix R1013=vcvy(23,13)
Matrix R1310=R1013
Matrix R1313=vcvy(26,13)

*
Matrix R1111=vcvy(24,11)
Matrix R1112=vcvy(24,12)
Matrix R1211=R1112
Matrix R1212=vcvy(25,12)

Matrix R1111=vcvy(24,11)
Matrix R1113=vcvy(24,13)
Matrix R1311=R1113
Matrix R1313=vcvy(26,13)

*

Matrix R1212=vcvy(25,12)
Matrix R1213=vcvy(25,13)
Matrix R1312=R1213
Matrix R1313=vcvy(26,13)


*Concenate S1-S13
Matrix S1=(S11|S12|S13|S14|S15|S16|S17|S18|S19|S110|S111|S112|S113)
Print S1
Matrix S2=(S21|S22|S23|S24|S25|S26|S27|S28|S29|S210|S211|S212|S213)
Print S2
Matrix S3=(S31|S32|S33|S34|S35|S36|S37|S38|S39|S310|S311|S312|S313)
Print S3
Matrix S4=(S41|S42|S43|S44|S45|S46|S47|S48|S49|S410|S411|S412|S413)
Print S4
Matrix S5=(S51|S52|S53|S54|S55|S56|S57|S58|S59|S510|S511|S512|S513)
Print S5
Matrix S6=(S61|S62|S63|S64|S65|S66|S67|S68|S69|S610|S611|S612|S613)
Print S6
Matrix S7=(S71|S72|S73|S74|S75|S76|S77|S78|S79|S710|S711|S712|S713)
Print S7
Matrix S8=(S81|S82|S83|S84|S85|S86|S87|S88|S89|S810|S811|S812|S813)
Print S8
Matrix S9=(S91|S92|S93|S94|S95|S96|S97|S98|S99|S910|S911|S912|S913)
```

```
Print S9
Matrix
S10=(S101|S102|S103|S104|S105|S106|S107|S108|S109|S1010|S1011|S1012|S1013)
Print S10
Matrix
S11=(S111|S112|S113|S114|S115|S116|S117|S118|S119|S1111|S1111|S1112|S1113)
Print S11
Matrix
S12=(S121|S122|S123|S124|S125|S126|S127|S128|S129|S1212|S1211|S1212|S1213)
Print S12
Matrix
S13=(S131|S132|S133|S134|S135|S136|S137|S138|S139|S1313|S1311|S1312|S1313)
Print S13

Matrix S=(S1'|S2'|S3'|S4'|S5'|S6'|S7'|S8'|S9'|S10'|S11'|S12'|S13')
Matrix TS=S'
Print TS

*Concenate R1-R13
Matrix R1=(R11|R12|R13|R14|R15|R16|R17|R18|R19|R110|R111|R112|R113)
Print R1
Matrix R2=(R21|R22|R23|R24|R25|R26|R27|R28|R29|R210|R211|R212|R213)
Print R2
Matrix R3=(R31|R32|R33|R34|R35|R36|R37|R38|R39|R310|R311|R312|R313)
Print R3
Matrix R4=(R41|R42|R43|R44|R45|R46|R47|R48|R49|R410|R411|R412|R413)
Print R4
Matrix R5=(R51|R52|R53|R54|R55|R56|R57|R58|R59|R510|R511|R512|R513)
Print R5
Matrix R6=(R61|R62|R63|R64|R65|R66|R67|R68|R69|R610|R611|R612|R613)
Print R6
Matrix R7=(R71|R72|R73|R74|R75|R76|R77|R78|R79|R710|R711|R712|R713)
Print R7
Matrix R8=(R81|R82|R83|R84|R85|R86|R87|R88|R89|R810|R811|R812|R813)
Print R8
Matrix R9=(R91|R92|R93|R94|R95|R96|R97|R98|R99|R910|R911|R912|R913)
Print R9
Matrix
R10=(R101|R102|R103|R104|R105|R106|R107|R108|R109|R1010|R1011|R1012|R10
13)
Print R10
Matrix
R11=(R111|R112|R113|R114|R115|R116|R117|R118|R119|R1111|R1111|R1112|R11
13)
Print R11
Matrix
R12=(R121|R122|R123|R124|R125|R126|R127|R128|R129|R1212|R1211|R1212|R12
13)
Print R12
```

```
Matrix
R13=(R131|R132|R133|R134|R135|R136|R137|R138|R139|R1313|R1311|R1312|R13
13)
Print R13

*
Matrix R=(R1'|R2'|R3'|R4'|R5'|R6'|R7'|R8'|R9'|R10'|R11'|R12'|R13')
Matrix TR=R'
Print TR

Sample 1 64422

Stat e0_1 e0_2 e0_3 e0_4 e0_5 e0_6 e0_7 e0_8 e0_9 e0_10 e0_11 e0_12 e0_13 &
e1_1 e1_2 e1_3 e1_4 e1_5 e1_6 e1_7 e1_8 e1_9 e1_11 e1_11 e1_12
e1_13/mean=erbar cov=vcve

Print vcve

Gen1 Ne0_1=(64422-3976-3)
Gen1 Ne0_2=(64422-3976-3)
Gen1 Ne0_3=(64422-3976-3)
Gen1 Ne0_4=(64422-3976-3)
Gen1 Ne0_5=(64422-3976-3)
Gen1 Ne0_6=(64422-3976-3)
Gen1 Ne0_7=(64422-3976-3)
Gen1 Ne0_8=(64422-3976-3)
Gen1 Ne0_9=(64422-3976-3)
Gen1 Ne0_10=(64422-3976-3)
Gen1 Ne0_11=(64422-3976-3)
Gen1 Ne0_12=(64422-3976-3)
Gen1 Ne0_13=(64422-3976-3)

Gen1 Ne1_1=(64405-3974-3)
Gen1 Ne1_2=(60436-3718-3)
Gen1 Ne1_3=(59519-3658-3)
Gen1 Ne1_4=(47050-2859-3)
Gen1 Ne1_5=(45065-2732-3)
Gen1 Ne1_6=(45033-2730-3)
Gen1 Ne1_7=(43369-2622-3)
Gen1 Ne1_8=(42349-2556-3)
Gen1 Ne1_9=(42318-2554-3)
Gen1 Ne1_10=(42224-2548-3)
Gen1 Ne1_11=(42197-2546-3)
Gen1 Ne1_12=(38788-2331-3)
Gen1 Ne1_13=(38337-2301-3)

*Concenate Ne0 and Ne1

Matrix
Ne0_Ne1=(Ne0_1|Ne0_2|Ne0_3|Ne0_4|Ne0_5|Ne0_6|Ne0_7|Ne0_8|Ne0_9|Ne0_10|N
```

```
e0_11|Ne0_12|Ne0_13|Ne1_1|Ne1_2|Ne1_3|Ne1_4|Ne1_5|Ne1_6|Ne1_7|Ne1_8|Ne1_
9|Ne1_10|Ne1_11|Ne1_12|Ne1_13)

Print Ne0_Ne1

Matrix DNe0_Ne1=Diag(Ne0_Ne1')
Print DNe0_Ne1
Matrix INe0_Ne1=INV(DNe0_Ne1)
Matrix vcve_c=(64422-3)*(INe0_Ne1)*vcve
Print vcve_c

*Omega=cov(e1G,e1H)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg12=vcve_c(14,15)
Matrix Omeg21=Omeg12
Matrix Omeg22=vcve_c(15,15)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg13=vcve_c(14,16)
Matrix Omeg31=Omeg13
Matrix Omeg33=vcve_c(16,16)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg14=vcve_c(14,17)
Matrix Omeg41=Omeg14
Matrix Omeg44=vcve_c(17,17)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg15=vcve_c(14,18)
Matrix Omeg51=Omeg15
Matrix Omeg55=vcve_c(18,18)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg16=vcve_c(14,19)
Matrix Omeg61=Omeg16
Matrix Omeg66=vcve_c(19,19)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg17=vcve_c(14,20)
Matrix Omeg71=Omeg17
Matrix Omeg77=vcve_c(20,20)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg18=vcve_c(14,21)
Matrix Omeg81=Omeg18
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg19=vcve_c(14,22)
```

```
Matrix Omeg91=Omeg19
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg110=vcve_c(14,23)
Matrix Omeg101=Omeg110
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg111=vcve_c(14,24)
Matrix Omeg111=Omeg111
Matrix Omeg1111=vcve_c(24,24)


Matrix Omeg11=vcve_c(14,14)
Matrix Omeg112=vcve_c(14,25)
Matrix Omeg121=Omeg112
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg11=vcve_c(14,14)
Matrix Omeg113=vcve_c(14,26)
Matrix Omeg131=Omeg113
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg23=vcve_c(15,16)
Matrix Omeg32=Omeg23
Matrix Omeg33=vcve_c(16,16)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg24=vcve_c(15,17)
Matrix Omeg42=Omeg24
Matrix Omeg44=vcve_c(17,17)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg25=vcve_c(15,18)
Matrix Omeg52=Omeg25
Matrix Omeg55=vcve_c(18,18)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg26=vcve_c(15,19)
Matrix Omeg62=Omeg26
Matrix Omeg66=vcve_c(19,19)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg27=vcve_c(15,20)
Matrix Omeg72=Omeg27
Matrix Omeg77=vcve_c(20,20)
```

```
Matrix Omeg22=vcve_c(15,15)
Matrix Omeg28=vcve_c(15,21)
Matrix Omeg82=Omeg28
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg29=vcve_c(15,22)
Matrix Omeg92=Omeg29
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg210=vcve_c(15,23)
Matrix Omeg102=Omeg210
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg211=vcve_c(15,24)
Matrix Omeg112=Omeg211
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg212=vcve_c(15,25)
Matrix Omeg122=Omeg212
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg22=vcve_c(15,15)
Matrix Omeg213=vcve_c(15,26)
Matrix Omeg132=Omeg213
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg34=vcve_c(16,17)
Matrix Omeg43=Omeg34
Matrix Omeg44=vcve_c(17,17)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg35=vcve_c(16,18)
Matrix Omeg53=Omeg35
Matrix Omeg55=vcve_c(18,18)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg36=vcve_c(16,19)
Matrix Omeg63=Omeg36
Matrix Omeg66=vcve_c(19,19)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg37=vcve_c(16,20)
```

```
Matrix Omeg73=Omeg37
Matrix Omeg77=vcve_c(20,20)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg38=vcve_c(16,21)
Matrix Omeg83=Omeg38
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg39=vcve_c(16,22)
Matrix Omeg93=Omeg39
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg310=vcve_c(16,23)
Matrix Omeg103=Omeg310
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg311=vcve_c(16,24)
Matrix Omeg113=Omeg311
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg312=vcve_c(16,25)
Matrix Omeg123=Omeg312
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg33=vcve_c(16,16)
Matrix Omeg313=vcve_c(16,26)
Matrix Omeg133=Omeg313
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg45=vcve_c(17,18)
Matrix Omeg54=Omeg45
Matrix Omeg55=vcve_c(18,18)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg46=vcve_c(17,19)
Matrix Omeg64=Omeg46
Matrix Omeg66=vcve_c(19,19)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg47=vcve_c(17,20)
Matrix Omeg74=Omeg47
Matrix Omeg77=vcve_c(20,20)
```

```
Matrix Omeg44=vcve_c(17,17)
Matrix Omeg48=vcve_c(17,21)
Matrix Omeg84=Omeg48
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg49=vcve_c(17,22)
Matrix Omeg94=Omeg49
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg410=vcve_c(17,23)
Matrix Omeg104=Omeg410
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg411=vcve_c(17,24)
Matrix Omeg114=Omeg411
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg412=vcve_c(17,25)
Matrix Omeg124=Omeg412
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg44=vcve_c(17,17)
Matrix Omeg413=vcve_c(17,26)
Matrix Omeg134=Omeg413
Matrix Omeg1313=vcve_c(26,26)

*
Matrix Omeg55=vcve_c(18,18)
Matrix Omeg56=vcve_c(18,19)
Matrix Omeg65=Omeg56
Matrix Omeg66=vcve_c(19,19)

Matrix Omeg55=vcve_c(18,18)
Matrix Omeg57=vcve_c(18,20)
Matrix Omeg75=Omeg57
Matrix Omeg77=vcve_c(20,20)

Matrix Omeg55=vcve_c(18,18)
Matrix Omeg58=vcve_c(18,21)
Matrix Omeg85=Omeg58
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg55=vcve_c(18,18)
Matrix Omeg59=vcve_c(18,22)
Matrix Omeg95=Omeg59
Matrix Omeg99=vcve_c(22,22)
```

```
Matrix Omeg55=vcve_c(18,18)
Matrix Omeg510=vcve_c(18,23)
Matrix Omeg105=Omeg510
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg55=vcve_c(18,18)
Matrix Omeg511=vcve_c(18,24)
Matrix Omeg115=Omeg511
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg55=vcve_c(18,18)
Matrix Omeg512=vcve_c(18,25)
Matrix Omeg125=Omeg512
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg55=vcve_c(18,18)
Matrix Omeg513=vcve_c(18,26)
Matrix Omeg135=Omeg513
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg67=vcve_c(19,20)
Matrix Omeg76=Omeg67
Matrix Omeg77=vcve_c(20,20)

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg68=vcve_c(19,21)
Matrix Omeg86=Omeg68
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg69=vcve_c(19,22)
Matrix Omeg96=Omeg69
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg610=vcve_c(19,23)
Matrix Omeg106=Omeg610
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg611=vcve_c(19,24)
Matrix Omeg116=Omeg611
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg612=vcve_c(19,25)
```

```
Matrix Omeg126=Omeg612
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg66=vcve_c(19,19)
Matrix Omeg613=vcve_c(19,26)
Matrix Omeg136=Omeg613
Matrix Omeg1313=vcve_c(26,26)

*
Matrix Omeg77=vcve_c(20,20)
Matrix Omeg78=vcve_c(20,21)
Matrix Omeg87=Omeg78
Matrix Omeg88=vcve_c(21,21)

Matrix Omeg77=vcve_c(20,20)
Matrix Omeg79=vcve_c(20,22)
Matrix Omeg97=Omeg79
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg77=vcve_c(20,20)
Matrix Omeg710=vcve_c(20,23)
Matrix Omeg107=Omeg710
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg77=vcve_c(20,20)
Matrix Omeg711=vcve_c(20,24)
Matrix Omeg117=Omeg711
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg77=vcve_c(20,20)
Matrix Omeg712=vcve_c(20,25)
Matrix Omeg127=Omeg712
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg77=vcve_c(20,20)
Matrix Omeg713=vcve_c(20,26)
Matrix Omeg137=Omeg713
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg88=vcve_c(21,21)
Matrix Omeg89=vcve_c(21,22)
Matrix Omeg98=Omeg89
Matrix Omeg99=vcve_c(22,22)

Matrix Omeg88=vcve_c(21,21)
Matrix Omeg810=vcve_c(21,23)
Matrix Omeg108=Omeg810
Matrix Omeg1010=vcve_c(23,23)
```

```
Matrix Omeg88=vcve_c(21,21)
Matrix Omeg811=vcve_c(21,24)
Matrix Omeg118=Omeg811
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg88=vcve_c(21,21)
Matrix Omeg812=vcve_c(21,25)
Matrix Omeg128=Omeg812
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg88=vcve_c(21,21)
Matrix Omeg813=vcve_c(21,26)
Matrix Omeg138=Omeg813
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg99=vcve_c(22,22)
Matrix Omeg910=vcve_c(22,23)
Matrix Omeg109=Omeg910
Matrix Omeg1010=vcve_c(23,23)

Matrix Omeg99=vcve_c(22,22)
Matrix Omeg911=vcve_c(23,24)
Matrix Omeg119=Omeg911
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg99=vcve_c(22,22)
Matrix Omeg912=vcve_c(22,25)
Matrix Omeg129=Omeg912
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg99=vcve_c(22,22)
Matrix Omeg913=vcve_c(22,26)
Matrix Omeg139=Omeg913
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg1010=vcve_c(23,23)
Matrix Omeg1011=vcve_c(23,24)
Matrix Omeg1110=Omeg1011
Matrix Omeg1111=vcve_c(24,24)

Matrix Omeg1010=vcve_c(23,23)
Matrix Omeg1012=vcve_c(23,25)
Matrix Omeg1210=Omeg1012
Matrix Omeg1212=vcve_c(25,25)
```

```
Matrix Omeg1010=vcve_c(23,23)
Matrix Omeg1013=vcve_c(23,26)
Matrix Omeg1310=Omeg1013
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg1111=vcve_c(24,24)
Matrix Omeg1112=vcve_c(24,25)
Matrix Omeg1211=Omeg1112
Matrix Omeg1212=vcve_c(25,25)

Matrix Omeg1111=vcve_c(24,24)
Matrix Omeg1113=vcve_c(24,26)
Matrix Omeg1311=Omeg1113
Matrix Omeg1313=vcve_c(26,26)

*

Matrix Omeg1212=vcve_c(25,25)
Matrix Omeg1213=vcve_c(25,26)
Matrix Omeg1312=Omeg1213
Matrix Omeg1313=vcve_c(26,26)

*

*ChiGH=cov(y1G,y0H)
Matrix Chi11=vcve_c(14,1)
Matrix Chi12=vcve_c(14,2)
Matrix Chi21=Chi12
Matrix Chi22=vcve_c(15,2)

Matrix Chi11=vcve_c(14,1)
Matrix Chi13=vcve_c(14,3)
Matrix Chi31=Chi13
Matrix Chi33=vcve_c(16,3)

Matrix Chi11=vcve_c(14,1)
Matrix Chi14=vcve_c(14,4)
Matrix Chi41=Chi14
Matrix Chi44=vcve_c(17,4)

Matrix Chi11=vcve_c(14,1)
Matrix Chi15=vcve_c(14,5)
Matrix Chi51=Chi15
Matrix Chi55=vcve_c(18,5)

Matrix Chi11=vcve_c(14,1)
Matrix Chi16=vcve_c(14,6)
Matrix Chi61=Chi16
```

```
Matrix Chi66=vcve_c(19,6)

Matrix Chi11=vcve_c(14,1)
Matrix Chi17=vcve_c(14,7)
Matrix Chi71=Chi17
Matrix Chi77=vcve_c(20,7)

Matrix Chi11=vcve_c(14,1)
Matrix Chi18=vcve_c(14,8)
Matrix Chi81=Chi18
Matrix Chi88=vcve_c(21,8)

Matrix Chi11=vcve_c(14,1)
Matrix Chi19=vcve_c(14,9)
Matrix Chi91=Chi19
Matrix Chi99=vcve_c(22,9)

Matrix Chi11=vcve_c(14,1)
Matrix Chi110=vcve_c(14,10)
Matrix Chi101=Chi110
Matrix Chi1010=vcve_c(23,10)

Matrix Chi11=vcve_c(14,1)
Matrix Chi111=vcve_c(14,11)
Matrix Chi111=Chi111
Matrix Chi1111=vcve_c(24,11)

Matrix Chi11=vcve_c(14,1)
Matrix Chi112=vcve_c(14,12)
Matrix Chi121=Chi112
Matrix Chi1212=vcve_c(25,12)

Matrix Chi11=vcve_c(14,1)
Matrix Chi113=vcve_c(14,13)
Matrix Chi131=Chi113
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi22=vcve_c(15,2)
Matrix Chi23=vcve_c(15,3)
Matrix Chi32=Chi23
Matrix Chi33=vcve_c(16,3)

Matrix Chi22=vcve_c(15,2)
Matrix Chi24=vcve_c(15,4)
Matrix Chi42=Chi24
Matrix Chi44=vcve_c(17,4)

Matrix Chi22=vcve_c(15,2)
```

```
Matrix Chi25=vcve_c(15,5)
Matrix Chi52=Chi25
Matrix Chi55=vcve_c(18,5)

Matrix Chi22=vcve_c(15,2)
Matrix Chi26=vcve_c(15,6)
Matrix Chi62=Chi26
Matrix Chi66=vcve_c(19,6)

Matrix Chi22=vcve_c(15,2)
Matrix Chi27=vcve_c(15,7)
Matrix Chi72=Chi27
Matrix Chi77=vcve_c(20,7)

Matrix Chi22=vcve_c(15,2)
Matrix Chi28=vcve_c(15,8)
Matrix Chi82=Chi28
Matrix Chi88=vcve_c(21,8)

Matrix Chi22=vcve_c(15,2)
Matrix Chi29=vcve_c(15,9)
Matrix Chi92=Chi29
Matrix Chi99=vcve_c(22,9)

Matrix Chi22=vcve_c(15,2)
Matrix Chi210=vcve_c(15,10)
Matrix Chi102=Chi210
Matrix Chi1010=vcve_c(23,10)

Matrix Chi22=vcve_c(15,2)
Matrix Chi211=vcve_c(15,11)
Matrix Chi112=Chi211
Matrix Chi1111=vcve_c(24,11)

Matrix Chi22=vcve_c(15,2)
Matrix Chi212=vcve_c(15,12)
Matrix Chi122=Chi212
Matrix Chi1212=vcve_c(25,12)

Matrix Chi22=vcve_c(15,2)
Matrix Chi213=vcve_c(15,13)
Matrix Chi132=Chi213
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi33=vcve_c(16,3)
Matrix Chi34=vcve_c(16,4)
Matrix Chi43=Chi34
Matrix Chi44=vcve_c(17,4)
```

```
Matrix Chi33=vcve_c(16,3)
Matrix Chi35=vcve_c(16,5)
Matrix Chi53=Chi35
Matrix Chi55=vcve_c(18,5)

Matrix Chi33=vcve_c(16,3)
Matrix Chi36=vcve_c(16,6)
Matrix Chi63=Chi36
Matrix Chi66=vcve_c(19,6)

Matrix Chi33=vcve_c(16,3)
Matrix Chi37=vcve_c(16,7)
Matrix Chi73=Chi37
Matrix Chi77=vcve_c(20,7)

Matrix Chi33=vcve_c(16,3)
Matrix Chi38=vcve_c(16,8)
Matrix Chi83=Chi38
Matrix Chi88=vcve_c(21,8)

Matrix Chi33=vcve_c(16,3)
Matrix Chi39=vcve_c(16,9)
Matrix Chi93=Chi39
Matrix Chi99=vcve_c(22,9)

Matrix Chi33=vcve_c(16,3)
Matrix Chi310=vcve_c(16,10)
Matrix Chi103=Chi310
Matrix Chi1010=vcve_c(23,10)

Matrix Chi33=vcve_c(16,3)
Matrix Chi311=vcve_c(16,11)
Matrix Chi113=Chi311
Matrix Chi1111=vcve_c(24,11)

Matrix Chi33=vcve_c(16,3)
Matrix Chi312=vcve_c(16,12)
Matrix Chi123=Chi312
Matrix Chi1212=vcve_c(25,12)

Matrix Chi33=vcve_c(16,3)
Matrix Chi313=vcve_c(16,13)
Matrix Chi133=Chi313
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi44=vcve_c(17,4)
Matrix Chi45=vcve_c(17,5)
```

```
Matrix Chi54=Chi45
Matrix Chi55=vcve_c(18,5)

Matrix Chi44=vcve_c(17,4)
Matrix Chi46=vcve_c(17,6)
Matrix Chi64=Chi46
Matrix Chi66=vcve_c(19,6)

Matrix Chi44=vcve_c(17,4)
Matrix Chi47=vcve_c(17,7)
Matrix Chi74=Chi47
Matrix Chi77=vcve_c(20,7)

Matrix Chi44=vcve_c(17,4)
Matrix Chi48=vcve_c(17,8)
Matrix Chi84=Chi48
Matrix Chi88=vcve_c(21,8)

Matrix Chi44=vcve_c(17,4)
Matrix Chi49=vcve_c(17,9)
Matrix Chi94=Chi49
Matrix Chi99=vcve_c(22,9)

Matrix Chi44=vcve_c(17,4)
Matrix Chi410=vcve_c(17,10)
Matrix Chi104=Chi410
Matrix Chi1010=vcve_c(23,10)

Matrix Chi44=vcve_c(17,4)
Matrix Chi411=vcve_c(17,11)
Matrix Chi114=Chi411
Matrix Chi1111=vcve_c(24,11)

Matrix Chi44=vcve_c(17,4)
Matrix Chi412=vcve_c(17,12)
Matrix Chi124=Chi412
Matrix Chi1212=vcve_c(25,12)

Matrix Chi44=vcve_c(17,4)
Matrix Chi413=vcve_c(17,13)
Matrix Chi134=Chi413
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi55=vcve_c(18,5)
Matrix Chi56=vcve_c(18,6)
Matrix Chi65=Chi56
Matrix Chi66=vcve_c(19,6)
```

Matrix Chi55=vcve_c(18,5)
Matrix Chi57=vcve_c(18,7)
Matrix Chi75=Chi57
Matrix Chi77=vcve_c(20,7)

Matrix Chi55=vcve_c(18,5)
Matrix Chi58=vcve_c(18,8)
Matrix Chi85=Chi58
Matrix Chi88=vcve_c(21,8)

Matrix Chi55=vcve_c(18,5)
Matrix Chi59=vcve_c(18,9)
Matrix Chi95=Chi59
Matrix Chi99=vcve_c(22,9)

Matrix Chi55=vcve_c(18,5)
Matrix Chi510=vcve_c(18,10)
Matrix Chi105=Chi510
Matrix Chi1010=vcve_c(23,10)

Matrix Chi55=vcve_c(18,5)
Matrix Chi511=vcve_c(18,11)
Matrix Chi115=Chi511
Matrix Chi1111=vcve_c(24,11)

Matrix Chi55=vcve_c(18,5)
Matrix Chi512=vcve_c(18,12)
Matrix Chi125=Chi512
Matrix Chi1212=vcve_c(25,12)

Matrix Chi55=vcve_c(18,5)
Matrix Chi513=vcve_c(18,13)
Matrix Chi135=Chi513
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi66=vcve_c(19,6)
Matrix Chi67=vcve_c(19,7)
Matrix Chi76=Chi67
Matrix Chi77=vcve_c(20,7)

Matrix Chi66=vcve_c(19,6)
Matrix Chi68=vcve_c(19,8)
Matrix Chi86=Chi68
Matrix Chi88=vcve_c(21,8)

Matrix Chi66=vcve_c(19,6)
Matrix Chi69=vcve_c(19,9)
Matrix Chi96=Chi69

```
Matrix Chi99=vcve_c(22,9)

Matrix Chi66=vcve_c(19,6)
Matrix Chi610=vcve_c(19,10)
Matrix Chi106=Chi610
Matrix Chi1010=vcve_c(23,10)

Matrix Chi66=vcve_c(19,6)
Matrix Chi611=vcve_c(19,11)
Matrix Chi116=Chi611
Matrix Chi1111=vcve_c(24,11)

Matrix Chi66=vcve_c(19,6)
Matrix Chi612=vcve_c(19,12)
Matrix Chi126=Chi612
Matrix Chi1212=vcve_c(25,12)

Matrix Chi66=vcve_c(19,6)
Matrix Chi613=vcve_c(19,13)
Matrix Chi136=Chi613
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi77=vcve_c(20,7)
Matrix Chi78=vcve_c(20,8)
Matrix Chi87=Chi78
Matrix Chi88=vcve_c(21,8)

Matrix Chi77=vcve_c(20,7)
Matrix Chi79=vcve_c(20,9)
Matrix Chi97=Chi79
Matrix Chi99=vcve_c(22,9)

Matrix Chi77=vcve_c(20,7)
Matrix Chi710=vcve_c(20,10)
Matrix Chi107=Chi710
Matrix Chi1010=vcve_c(23,10)

Matrix Chi77=vcve_c(20,7)
Matrix Chi711=vcve_c(20,11)
Matrix Chi117=Chi711
Matrix Chi1111=vcve_c(24,11)

Matrix Chi77=vcve_c(20,7)
Matrix Chi712=vcve_c(20,12)
Matrix Chi127=Chi712
Matrix Chi1212=vcve_c(25,12)

Matrix Chi77=vcve_c(20,7)
```

```
Matrix Chi713=vcve_c(20,13)
Matrix Chi137=Chi713
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi88=vcve_c(21,8)
Matrix Chi89=vcve_c(21,9)
Matrix Chi98=Chi89
Matrix Chi99=vcve_c(22,9)

Matrix Chi88=vcve_c(21,8)
Matrix Chi810=vcve_c(21,10)
Matrix Chi108=Chi810
Matrix Chi1010=vcve_c(23,10)

Matrix Chi88=vcve_c(21,8)
Matrix Chi811=vcve_c(21,11)
Matrix Chi118=Chi811
Matrix Chi1111=vcve_c(24,11)

Matrix Chi88=vcve_c(21,8)
Matrix Chi812=vcve_c(21,12)
Matrix Chi128=Chi812
Matrix Chi1212=vcve_c(25,12)

Matrix Chi88=vcve_c(21,8)
Matrix Chi813=vcve_c(21,13)
Matrix Chi138=Chi813
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi99=vcve_c(22,9)
Matrix Chi910=vcve_c(22,10)
Matrix Chi109=Chi910
Matrix Chi1010=vcve_c(23,10)

Matrix Chi99=vcve_c(22,9)
Matrix Chi911=vcve_c(22,11)
Matrix Chi119=Chi911
Matrix Chi1111=vcve_c(24,11)

Matrix Chi99=vcve_c(22,9)
Matrix Chi912=vcve_c(22,12)
Matrix Chi129=Chi912
Matrix Chi1212=vcve_c(25,12)

Matrix Chi99=vcve_c(22,9)
Matrix Chi913=vcve_c(22,13)
```

```
Matrix Chi139=Chi913
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi1010=vcve_c(23,10)
Matrix Chi1011=vcve_c(23,11)
Matrix Chi1110=Chi1011
Matrix Chi1111=vcve_c(24,11)

Matrix Chi1010=vcve_c(23,10)
Matrix Chi1012=vcve_c(23,12)
Matrix Chi1210=Chi1012
Matrix Chi1212=vcve_c(25,12)

Matrix Chi1010=vcve_c(23,10)
Matrix Chi1013=vcve_c(23,13)
Matrix Chi1310=Chi1013
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi1111=vcve_c(24,11)
Matrix Chi1112=vcve_c(24,12)
Matrix Chi1211=Chi1112
Matrix Chi1212=vcve_c(25,12)

Matrix Chi1111=vcve_c(24,11)
Matrix Chi1113=vcve_c(24,13)
Matrix Chi1311=Chi1113
Matrix Chi1313=vcve_c(26,13)

*

Matrix Chi1212=vcve_c(25,12)
Matrix Chi1213=vcve_c(25,13)
Matrix Chi1312=Chi1213
Matrix Chi1313=vcve_c(26,13)

*Concenate omeg1-omeg13
Matrix
omeg1=(Omeg11|Omeg12|Omeg13|Omeg14|Omeg15|Omeg16|Omeg17|Omeg18|Om
eg19|Omeg110|Omeg111|Omeg112|Omeg113)
Print omeg1
Matrix
omeg2=(Omeg21|Omeg22|Omeg23|Omeg24|Omeg25|Omeg26|Omeg27|Omeg28|Om
eg29|Omeg210|Omeg211|Omeg212|Omeg213)
Print omeg2
```

```
Matrix
omeg3=(Omeg31|Omeg32|Omeg33|Omeg34|Omeg35|Omeg36|Omeg37|Omeg38|Om
eg39|Omeg310|Omeg311|Omeg312|Omeg313)
Print omeg3
Matrix
omeg4=(Omeg41|Omeg42|Omeg43|Omeg44|Omeg45|Omeg46|Omeg47|Omeg48|Om
eg49|Omeg410|Omeg411|Omeg412|Omeg413)
Print omeg4
Matrix
omeg5=(Omeg51|Omeg52|Omeg53|Omeg54|Omeg55|Omeg56|Omeg57|Omeg58|Om
eg59|Omeg510|Omeg511|Omeg512|Omeg513)
Print omeg5
Matrix
omeg6=(Omeg61|Omeg62|Omeg63|Omeg64|Omeg65|Omeg66|Omeg67|Omeg68|Om
eg69|Omeg610|Omeg611|Omeg612|Omeg613)
Print omeg6
Matrix
omeg7=(Omeg71|Omeg72|Omeg73|Omeg74|Omeg75|Omeg76|Omeg77|Omeg78|Om
eg79|Omeg710|Omeg711|Omeg712|Omeg713)
Print omeg7
Matrix
omeg8=(Omeg81|Omeg82|Omeg83|Omeg84|Omeg85|Omeg86|Omeg87|Omeg88|Om
eg89|Omeg810|Omeg811|Omeg812|Omeg813)
Print omeg8
Matrix
omeg9=(Omeg91|Omeg92|Omeg93|Omeg94|Omeg95|Omeg96|Omeg97|Omeg98|Om
eg99|Omeg910|Omeg911|Omeg912|Omeg913)
Print omeg9
Matrix
omeg10=(Omeg101|Omeg102|Omeg103|Omeg104|Omeg105|Omeg106|Omeg107|O
meg108|Omeg109|Omeg1010|Omeg1011|Omeg1012|Omeg1013)
Print omeg10
Matrix
omeg11=(Omeg111|Omeg112|Omeg113|Omeg114|Omeg115|Omeg116|Omeg117|O
meg118|Omeg119|Omeg1111|Omeg1111|Omeg1112|Omeg1113)
Print omeg11
Matrix
omeg12=(Omeg121|Omeg122|Omeg123|Omeg124|Omeg125|Omeg126|Omeg127|O
meg128|Omeg129|Omeg1212|Omeg1211|Omeg1212|Omeg1213)
Print omeg12
Matrix
omeg13=(Omeg131|Omeg132|Omeg133|Omeg134|Omeg135|Omeg136|Omeg137|O
meg138|Omeg139|Omeg1313|Omeg1311|Omeg1312|Omeg1313)
Print omeg13

*
Matrix
omeg=(omeg1'|omeg2'|omeg3'|omeg4'|omeg5'|omeg6'|omeg7'|omeg8'|omeg9'|omeg10'
|omeg11'|omeg12'|omeg13')
Matrix Tomeg=omeg'
```

```
Print Tomeg

*Concenate chi1-chi13
Matrix
chi1=(Chi11|Chi12|Chi13|Chi14|Chi15|Chi16|Chi17|Chi18|Chi19|Chi110|Chi111|Chi
112|Chi113)
Print chi1
Matrix
chi2=(Chi21|Chi22|Chi23|Chi24|Chi25|Chi26|Chi27|Chi28|Chi29|Chi210|Chi211|Chi
212|Chi213)
Print chi2
Matrix
chi3=(Chi31|Chi32|Chi33|Chi34|Chi35|Chi36|Chi37|Chi38|Chi39|Chi310|Chi311|Chi
312|Chi313)
Print chi3
Matrix
chi4=(Chi41|Chi42|Chi43|Chi44|Chi45|Chi46|Chi47|Chi48|Chi49|Chi410|Chi411|Chi
412|Chi413)
Print chi4
Matrix
chi5=(Chi51|Chi52|Chi53|Chi54|Chi55|Chi56|Chi57|Chi58|Chi59|Chi510|Chi511|Chi
512|Chi513)
Print chi5
Matrix
chi6=(Chi61|Chi62|Chi63|Chi64|Chi65|Chi66|Chi67|Chi68|Chi69|Chi610|Chi611|Chi
612|Chi613)
Print chi6
Matrix
chi7=(Chi71|Chi72|Chi73|Chi74|Chi75|Chi76|Chi77|Chi78|Chi79|Chi710|Chi711|Chi
712|Chi713)
Print chi7
Matrix
chi8=(Chi81|Chi82|Chi83|Chi84|Chi85|Chi86|Chi87|Chi88|Chi89|Chi810|Chi811|Chi
812|Chi813)
Print chi8
Matrix
chi9=(Chi91|Chi92|Chi93|Chi94|Chi95|Chi96|Chi97|Chi98|Chi99|Chi910|Chi911|Chi
912|Chi913)
Print chi9
Matrix
chi10=(Chi101|Chi102|Chi103|Chi104|Chi105|Chi106|Chi107|Chi108|Chi109|Chi101
0|Chi1011|Chi1012|Chi1013)
Print chi10
Matrix
chi11=(Chi111|Chi112|Chi113|Chi114|Chi115|Chi116|Chi117|Chi118|Chi119|Chi111
1|Chi1111|Chi1112|Chi1113)
Print chi11
Matrix
chi12=(Chi121|Chi122|Chi123|Chi124|Chi125|Chi126|Chi127|Chi128|Chi129|Chi121
2|Chi1211|Chi1212|Chi1213)
```

```
Print chi12
Matrix
chi13=(Chi131|Chi132|Chi133|Chi134|Chi135|Chi136|Chi137|Chi138|Chi139|Chi131
3|Chi1311|Chi1312|Chi1313)
Print chi13

*
Matrix chi=(chi1'|chi2'|chi3'|chi4'|chi5'|chi6'|chi7'|chi8'|chi9'|chi10'|chi11'|chi12'|chi13')
Matrix Tchi=chi'
Print Tchi

Read NWF/roWs=13 cols=1 list
64422
64422
64422
64422
64422
64422
64422
64422
64422
64422
64422
64422
64422

Read NV/roWs=13 cols=1 list
64405
60436
59519
47050
45065
45033
43369
42349
42318
42224
42197
38788
38337

Read NCV/roWs=13 cols=1 list
3974
3718
3658
2859
2732
2730
2622
2556
```

```
2554
2548
2546
2331
2301

Matrix DNV=Diag(NV)
Print DNV
Matrix DNCV=Diag(NCV)
Matrix IDNCV=INV(DNCV)
Print IDNCV
Matrix NV_c=IDNCV*DNV
Print NV_c
Matrix DNWF=Diag(NWF)


Matrix B=INV((TS-Tomeg*NV_c))*(TR-Tchi*DNWF)
Print B
Matrix TB=B'

Read I/roWs=13 cols=13 list
1 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 1


Matrix beta1=b1(1,1)
Matrix beta2=b2(1,1)
Matrix beta3=b3(1,1)
Matrix beta4=b4(1,1)
Matrix beta5=b5(1,1)
Matrix beta6=b6(1,1)
Matrix beta7=b7(1,1)
Matrix beta8=b8(1,1)
Matrix beta9=b9(1,1)
Matrix beta10=b10(1,1)
Matrix beta11=b11(1,1)
Matrix beta12=b12(1,1)
Matrix beta13=b13(1,1)
```

```
Matrix rho1=b1(2,1)
Matrix rho2=b2(2,1)
Matrix rho3=b3(2,1)
Matrix rho4=b4(2,1)
Matrix rho5=b5(2,1)
Matrix rho6=b6(2,1)
Matrix rho7=b7(2,1)
Matrix rho8=b8(2,1)
Matrix rho9=b9(2,1)
Matrix rho10=b10(2,1)
Matrix rho11=b11(2,1)
Matrix rho12=b12(2,1)
Matrix rho13=b13(2,1)

Matrix delta1=b1(3,1)
Matrix delta2=b2(3,1)
Matrix delta3=b3(3,1)
Matrix delta4=b4(3,1)
Matrix delta5=b5(3,1)
Matrix delta6=b6(3,1)
Matrix delta7=b7(3,1)
Matrix delta8=b8(3,1)
Matrix delta9=b9(3,1)
Matrix delta10=b10(3,1)
Matrix delta11=b11(3,1)
Matrix delta12=b12(3,1)
Matrix delta13=b13(3,1)

Matrix
delta=(delta1|delta2|delta3|delta4|delta5|delta6|delta7|delta8|delta9|delta10|delta11|delt
a12|delta13)

print delta

Matrix gama1=c1(1,1)
Matrix gama2=c2(1,1)
Matrix gama3=c3(1,1)
Matrix gama4=c4(1,1)
Matrix gama5=c5(1,1)
Matrix gama6=c6(1,1)
Matrix gama7=c7(1,1)
Matrix gama8=c8(1,1)
Matrix gama9=c9(1,1)
Matrix gama10=c10(1,1)
Matrix gama11=c11(1,1)
Matrix gama12=c12(1,1)
Matrix gama13=c13(1,1)

Matrix phi1=c1(2,1)
Matrix phi2=c2(2,1)
```

```
Matrix phi3=c3(2,1)
Matrix phi4=c4(2,1)
Matrix phi5=c5(2,1)
Matrix phi6=c6(2,1)
Matrix phi7=c7(2,1)
Matrix phi8=c8(2,1)
Matrix phi9=c9(2,1)
Matrix phi10=c10(2,1)
Matrix phi11=c11(2,1)
Matrix phi12=c12(2,1)
Matrix phi13=c13(2,1)

Matrix alfa1=c1(3,1)
Matrix alfa2=c2(3,1)
Matrix alfa3=c3(3,1)
Matrix alfa4=c4(3,1)
Matrix alfa5=c5(3,1)
Matrix alfa6=c6(3,1)
Matrix alfa7=c7(3,1)
Matrix alfa8=c8(3,1)
Matrix alfa9=c9(3,1)
Matrix alfa10=c10(3,1)
Matrix alfa11=c11(3,1)
Matrix alfa12=c12(3,1)
Matrix alfa13=c13(3,1)

Matrix
alfa=(alfa1|alfa2|alfa3|alfa4|alfa5|alfa6|alfa7|alfa8|alfa9|alfa10|alfa11|alfa12|alfa13)

print alfa

*Concenate beta1-beta13
Matrix
beta=(beta1|beta2|beta3|beta4|beta5|beta6|beta7|beta8|beta9|beta10|beta11|beta12|beta1
3)
Print beta
Matrix DTbeta=DIAG(beta')
Print DTbeta

*Concenate rho1-rho15
Matrix rho=(rho1|rho2|rho3|rho4|rho5|rho6|rho7|rho8|rho9|rho10|rho11|rho12|rho13)
Print rho
Matrix DTrho=DIAG(rho')
Print DTrho

*Concenate gama1-gama15
Matrix
gama=(gama1|gama2|gama3|gama4|gama5|gama6|gama7|gama8|gama9|gama10|gama
11|gama12|gama13)
Print gama
```

```
Matrix DTgama=DIAG(gama')
Print DTgama

*Concenate phi1-phi15
Matrix phi=(phi1|phi2|phi3|phi4|phi5|phi6|phi7|phi8|phi9|phi10|phi11|phi12|phi13)
Print phi
Matrix DTphi=DIAG(phi')
Print DTphi

Matrix J=INV(I-(DTgama*DTWFb)+DTbeta)*DTgama
Print J
Matrix EL=((DTWFb*TB)-I)*INV(I-(J*TB)+(J*DTWFb))
Print EL

Gen1 t1=1.17
Gen1 t2=0.1
Gen1 t3=0.1
Gen1 t4=0.1
Gen1 t5=0.2
Gen1 t6=0.1
Gen1 t7=0.1
Gen1 t8=0.1
Gen1 t9=0.2
Gen1 t10=0.67
Gen1 t11=0.1
Gen1 t12=0.1
Gen1 t13=0.15

Gen1 tf1=t1/(1+t1)
Gen1 tf2=t2/(1+t2)
Gen1 tf3=t3/(1+t3)
Gen1 tf4=t4/(1+t4)
Gen1 tf5=t5/(1+t5)
Gen1 tf6=t6/(1+t6)
Gen1 tf7=t7/(1+t7)
Gen1 tf8=t8/(1+t8)
Gen1 tf9=t9/(1+t9)
Gen1 tf10=t10/(1+t10)
Gen1 tf11=t11/(1+t11)
Gen1 tf12=t12/(1+t12)
Gen1 tf13=t13/(1+t13)

*All

*Computing lamda denumerator

Matrix EL1_1=EL(1,1)
Matrix EL1_2=EL(1,2)
Matrix EL1_3=EL(1,3)
Matrix EL1_4=EL(1,4)
```

Matrix EL1_5=EL(1,5)
Matrix EL1_6=EL(1,6)
Matrix EL1_7=EL(1,7)
Matrix EL1_8=EL(1,8)
Matrix EL1_9=EL(1,9)
Matrix EL1_10=EL(1,10)
Matrix EL1_11=EL(1,11)
Matrix EL1_12=EL(1,12)
Matrix EL1_13=EL(1,13)

Matrix EL2_1=EL(2,1)
Matrix EL2_2=EL(2,2)
Matrix EL2_3=EL(2,3)
Matrix EL2_4=EL(2,4)
Matrix EL2_5=EL(2,5)
Matrix EL2_6=EL(2,6)
Matrix EL2_7=EL(2,7)
Matrix EL2_8=EL(2,8)
Matrix EL2_9=EL(2,9)
Matrix EL2_10=EL(2,10)
Matrix EL2_11=EL(2,11)
Matrix EL2_12=EL(2,12)
Matrix EL2_13=EL(2,13)

Matrix EL3_1=EL(3,1)
Matrix EL3_2=EL(3,2)
Matrix EL3_3=EL(3,3)
Matrix EL3_4=EL(3,4)
Matrix EL3_5=EL(3,5)
Matrix EL3_6=EL(3,6)
Matrix EL3_7=EL(3,7)
Matrix EL3_8=EL(3,8)
Matrix EL3_9=EL(3,9)
Matrix EL3_10=EL(3,10)
Matrix EL3_11=EL(3,11)
Matrix EL3_12=EL(3,12)
Matrix EL3_13=EL(3,13)

Matrix EL4_1=EL(4,1)
Matrix EL4_2=EL(4,2)
Matrix EL4_3=EL(4,3)
Matrix EL4_4=EL(4,4)
Matrix EL4_5=EL(4,5)
Matrix EL4_6=EL(4,6)
Matrix EL4_7=EL(4,7)
Matrix EL4_8=EL(4,8)
Matrix EL4_9=EL(4,9)
Matrix EL4_10=EL(4,10)
Matrix EL4_11=EL(4,11)

Matrix EL4_12=EL(4,12)
Matrix EL4_13=EL(4,13)

Matrix EL5_1=EL(5,1)
Matrix EL5_2=EL(5,2)
Matrix EL5_3=EL(5,3)
Matrix EL5_4=EL(5,4)
Matrix EL5_5=EL(5,5)
Matrix EL5_6=EL(5,6)
Matrix EL5_7=EL(5,7)
Matrix EL5_8=EL(5,8)
Matrix EL5_9=EL(5,9)
Matrix EL5_10=EL(5,10)
Matrix EL5_11=EL(5,11)
Matrix EL5_12=EL(5,12)
Matrix EL5_13=EL(5,13)

Matrix EL6_1=EL(6,1)
Matrix EL6_2=EL(6,2)
Matrix EL6_3=EL(6,3)
Matrix EL6_4=EL(6,4)
Matrix EL6_5=EL(6,5)
Matrix EL6_6=EL(6,6)
Matrix EL6_7=EL(6,7)
Matrix EL6_8=EL(6,8)
Matrix EL6_9=EL(6,9)
Matrix EL6_10=EL(6,10)
Matrix EL6_11=EL(6,11)
Matrix EL6_12=EL(6,12)
Matrix EL6_13=EL(6,13)

Matrix EL7_1=EL(7,1)
Matrix EL7_2=EL(7,2)
Matrix EL7_3=EL(7,3)
Matrix EL7_4=EL(7,4)
Matrix EL7_5=EL(7,5)
Matrix EL7_6=EL(7,6)
Matrix EL7_7=EL(7,7)
Matrix EL7_8=EL(7,8)
Matrix EL7_9=EL(7,9)
Matrix EL7_10=EL(7,10)
Matrix EL7_11=EL(7,11)
Matrix EL7_12=EL(7,12)
Matrix EL7_13=EL(7,13)

Matrix EL8_1=EL(8,1)
Matrix EL8_2=EL(8,2)
Matrix EL8_3=EL(8,3)
Matrix EL8_4=EL(8,4)
Matrix EL8_5=EL(8,5)

```
Matrix EL8_6=EL(8,6)
Matrix EL8_7=EL(8,7)
Matrix EL8_8=EL(8,8)
Matrix EL8_9=EL(8,9)
Matrix EL8_10=EL(8,10)
Matrix EL8_11=EL(8,11)
Matrix EL8_12=EL(8,12)
Matrix EL8_13=EL(8,13)

Matrix EL9_1=EL(9,1)
Matrix EL9_2=EL(9,2)
Matrix EL9_3=EL(9,3)
Matrix EL9_4=EL(9,4)
Matrix EL9_5=EL(9,5)
Matrix EL9_6=EL(9,6)
Matrix EL9_7=EL(9,7)
Matrix EL9_8=EL(9,8)
Matrix EL9_9=EL(9,9)
Matrix EL9_10=EL(9,10)
Matrix EL9_11=EL(9,11)
Matrix EL9_12=EL(9,12)
Matrix EL9_13=EL(9,13)

Matrix EL10_1=EL(10,1)
Matrix EL10_2=EL(10,2)
Matrix EL10_3=EL(10,3)
Matrix EL10_4=EL(10,4)
Matrix EL10_5=EL(10,5)
Matrix EL10_6=EL(10,6)
Matrix EL10_7=EL(10,7)
Matrix EL10_8=EL(10,8)
Matrix EL10_9=EL(10,9)
Matrix EL10_10=EL(10,10)
Matrix EL10_11=EL(10,11)
Matrix EL10_12=EL(10,12)
Matrix EL10_13=EL(10,13)

Matrix EL11_1=EL(11,1)
Matrix EL11_2=EL(11,2)
Matrix EL11_3=EL(11,3)
Matrix EL11_4=EL(11,4)
Matrix EL11_5=EL(11,5)
Matrix EL11_6=EL(11,6)
Matrix EL11_7=EL(11,7)
Matrix EL11_8=EL(11,8)
Matrix EL11_9=EL(11,9)
Matrix EL11_10=EL(11,10)
Matrix EL11_11=EL(11,11)
Matrix EL11_12=EL(11,12)
Matrix EL11_13=EL(11,13)
```

```
Matrix EL12_1=EL(12,1)
Matrix EL12_2=EL(12,2)
Matrix EL12_3=EL(12,3)
Matrix EL12_4=EL(12,4)
Matrix EL12_5=EL(12,5)
Matrix EL12_6=EL(12,6)
Matrix EL12_7=EL(12,7)
Matrix EL12_8=EL(12,8)
Matrix EL12_9=EL(12,9)
Matrix EL12_10=EL(12,10)
Matrix EL12_11=EL(12,11)
Matrix EL12_12=EL(12,12)
Matrix EL12_13=EL(12,13)

Matrix EL13_1=EL(13,1)
Matrix EL13_2=EL(13,2)
Matrix EL13_3=EL(13,3)
Matrix EL13_4=EL(13,4)
Matrix EL13_5=EL(13,5)
Matrix EL13_6=EL(13,6)
Matrix EL13_7=EL(13,7)
Matrix EL13_8=EL(13,8)
Matrix EL13_9=EL(13,9)
Matrix EL13_10=EL(13,10)
Matrix EL13_11=EL(13,11)
Matrix EL13_12=EL(13,12)
Matrix EL13_13=EL(13,13)

Matrix
ELOWN=(EL1_1|EL2_2|EL3_3|EL4_4|EL5_5|EL6_6|EL7_7|EL8_8|EL9_9|EL10_10
|EL11_11|EL12_12|EL13_13)
Print ELOWN

Gen1 taxf1=1+(tf1*((EL1_1/WF1c)-1))
Gen1
taxfa1=(tf2*(EL2_1/WF1c))+(tf3*(EL3_1/WF1c))+(tf4*(EL4_1/WF1c))+(tf5*(EL5_
1/WF1c))+(tf6*(EL6_1/WF1c))+(tf7*(EL7_1/WF1c))+(tf8*(EL8_1/WF1c))+(tf9*(E
L9_1/WF1c))+(tf10*(EL10_1/WF1c))+(tf11*(EL11_1/WF1c))+(tf12*(EL12_1/WF1
c))+(tf13*(EL13_1/WF1c))
Gen1 l1d=taxf1+taxfa1
Print l1d

Gen1 lmd1_0=l1n_0/l1d
Gen1 lmd1_01=l1n_01/l1d
Gen1 lmd1_015=l1n_015/l1d
Gen1 lmd1_02=l1n_02/l1d
Gen1 lmd1_025=l1n_025/l1d
Gen1 lmd1_029=l1n_029/l1d
Gen1 lmd1_033=l1n_033/l1d
```

```
Gen1 lmd1_035=l1n_035/l1d
Gen1 lmd1_04=l1n_04/l1d
Gen1 lmd1_045=l1n_045/l1d
Gen1 lmd1_05=l1n_05/l1d
Gen1 lmd1_1=l1n_1/l1d
Gen1 lmd1_15=l1n_15/l1d
Gen1 lmd1_2=l1n_2/l1d
Gen1 lmd1_25=l1n_25/l1d

Gen1 taxf2=1+(tf2*((EL2_2/WF2c)-1))
Gen1
taxfa2=(tf1*(EL1_2/WF2c))+(tf3*(EL3_2/WF2c))+(tf4*(EL4_2/WF2c))+(tf5*(EL5_
2/WF2c))+(tf6*(EL6_2/WF2c))+(tf7*(EL7_2/WF2c))+(tf8*(EL8_2/WF2c))+(tf9*(E
L9_2/WF2c))+(tf10*(EL10_2/WF2c))+(tf11*(EL11_2/WF2c))+(tf12*(EL12_2/WF2
c))+(tf13*(EL13_2/WF2c))
Gen1 l2d=taxf2+taxfa2
Print l2d
Gen1 lmd2_0=l2n_0/l2d
Gen1 lmd2_01=l2n_01/l2d
Gen1 lmd2_015=l2n_015/l2d
Gen1 lmd2_02=l2n_02/l2d
Gen1 lmd2_025=l2n_025/l2d
Gen1 lmd2_029=l2n_029/l2d
Gen1 lmd2_033=l2n_033/l2d
Gen1 lmd2_035=l2n_035/l2d
Gen1 lmd2_04=l2n_04/l2d
Gen1 lmd2_045=l2n_045/l2d
Gen1 lmd2_05=l2n_05/l2d
Gen1 lmd2_1=l2n_1/l2d
Gen1 lmd2_15=l2n_15/l2d
Gen1 lmd2_2=l2n_2/l2d
Gen1 lmd2_25=l2n_25/l2d

Gen1 taxf3=1+(tf3*((EL3_3/WF3c)-1))
Gen1
taxfa3=(tf1*(EL1_3/WF3c))+(tf3*(EL2_3/WF3c))+(tf4*(EL4_3/WF3c))+(tf5*(EL5_
3/WF3c))+(tf6*(EL6_3/WF3c))+(tf7*(EL7_3/WF3c))+(tf8*(EL8_3/WF3c))+(tf9*(E
L9_3/WF3c))+(tf10*(EL10_3/WF3c))+(tf11*(EL11_3/WF3c))+(tf12*(EL12_3/WF3
c))+(tf13*(EL13_3/WF3c))
Gen1 l3d=taxf3+taxfa3
Print l3d
Gen1 lmd3_0=l3n_0/l3d
Gen1 lmd3_01=l3n_01/l3d
Gen1 lmd3_015=l3n_015/l3d
Gen1 lmd3_02=l3n_02/l3d
Gen1 lmd3_025=l3n_025/l3d
Gen1 lmd3_029=l3n_029/l3d
Gen1 lmd3_033=l3n_033/l3d
Gen1 lmd3_035=l3n_035/l3d
Gen1 lmd3_04=l3n_04/l3d
```

```
Gen1 lmd3_045=l3n_045/l3d
Gen1 lmd3_05=l3n_05/l3d
Gen1 lmd3_1=l3n_1/l3d
Gen1 lmd3_15=l3n_15/l3d
Gen1 lmd3_2=l3n_2/l3d
Gen1 lmd3_25=l3n_25/l3d

Gen1 taxf4=1+(tf4*((EL4_4/WF4c)-1))
Gen1
taxfa4=(tf1*(EL1_4/WF4c))+(tf2*(EL2_4/WF4c))+(tf3*(EL3_4/WF4c))+(tf5*(EL5_
4/WF4c))+(tf6*(EL6_4/WF4c))+(tf7*(EL7_4/WF4c))+(tf8*(EL8_4/WF4c))+(tf9*(E
L9_4/WF4c))+(tf10*(EL10_4/WF4c))+(tf11*(EL11_4/WF4c))+(tf12*(EL12_4/WF4
c))+(tf13*(EL13_4/WF4c))
Gen1 l4d=taxf4+taxfa4
Print l4d
Gen1 lmd4_0=l4n_0/l4d
Gen1 lmd4_01=l4n_01/l4d
Gen1 lmd4_015=l4n_015/l4d
Gen1 lmd4_02=l4n_02/l4d
Gen1 lmd4_025=l4n_025/l4d
Gen1 lmd4_029=l4n_029/l4d
Gen1 lmd4_033=l4n_033/l4d
Gen1 lmd4_035=l4n_035/l4d
Gen1 lmd4_04=l4n_04/l4d
Gen1 lmd4_045=l4n_045/l4d
Gen1 lmd4_05=l4n_05/l4d
Gen1 lmd4_1=l4n_1/l4d
Gen1 lmd4_15=l4n_15/l4d
Gen1 lmd4_2=l4n_2/l4d
Gen1 lmd4_25=l4n_25/l4d

Gen1 taxf5=1+(tf5*((EL5_5/WF5c)-1))
Gen1
taxfa5=(tf1*(EL1_5/WF5c))+(tf2*(EL2_5/WF5c))+(tf3*(EL3_5/WF5c))+(tf4*(EL4_
5/WF5c))+(tf6*(EL6_5/WF5c))+(tf7*(EL7_5/WF5c))+(tf8*(EL8_5/WF5c))+(tf9*(E
L9_5/WF5c))+(tf10*(EL10_5/WF5c))+(tf11*(EL11_5/WF5c))+(tf12*(EL12_5/WF5
c))+(tf13*(EL13_5/WF5c))
Gen1 l5d=taxf5+taxfa5
Print l5d
Gen1 lmd5_0=l5n_0/l5d
Gen1 lmd5_01=l5n_01/l5d
Gen1 lmd5_015=l5n_015/l5d
Gen1 lmd5_02=l5n_02/l5d
Gen1 lmd5_025=l5n_025/l5d
Gen1 lmd5_029=l5n_029/l5d
Gen1 lmd5_033=l5n_033/l5d
Gen1 lmd5_035=l5n_035/l5d
Gen1 lmd5_04=l5n_04/l5d
Gen1 lmd5_045=l5n_045/l5d
Gen1 lmd5_05=l5n_05/l5d
```

```
Gen1 lmd5_1=l5n_1/l5d
Gen1 lmd5_15=l5n_15/l5d
Gen1 lmd5_2=l5n_2/l5d
Gen1 lmd5_25=l5n_25/l5d

Gen1 taxf6=1+(tf6*((EL6_6/WF6c)-1))
Gen1
taxfa6=(tf1*(EL1_6/WF6c))+(tf2*(EL2_6/WF6c))+(tf3*(EL3_6/WF6c))+(tf4*(EL4_
6/WF6c))+(tf5*(EL5_6/WF6c))+(tf7*(EL7_6/WF6c))+(tf8*(EL8_6/WF6c))+(tf9*(E
L9_6/WF6c))+(tf10*(EL10_6/WF6c))+(tf11*(EL11_6/WF6c))+(tf12*(EL12_6/WF6
c))+(tf13*(EL13_6/WF6c))
Gen1 l6d=taxf6+taxfa6
Print l6d
Gen1 lmd6_0=l6n_0/l6d
Gen1 lmd6_01=l6n_01/l6d
Gen1 lmd6_015=l6n_015/l6d
Gen1 lmd6_02=l6n_02/l6d
Gen1 lmd6_025=l6n_025/l6d
Gen1 lmd6_029=l6n_029/l6d
Gen1 lmd6_033=l6n_033/l6d
Gen1 lmd6_035=l6n_035/l6d
Gen1 lmd6_04=l6n_04/l6d
Gen1 lmd6_045=l6n_045/l6d
Gen1 lmd6_05=l6n_05/l6d
Gen1 lmd6_1=l6n_1/l6d
Gen1 lmd6_15=l6n_15/l6d
Gen1 lmd6_2=l6n_2/l6d
Gen1 lmd6_25=l6n_25/l6d

Gen1 taxf7=1+(tf7*((EL7_7/WF7c)-1))
Gen1
taxfa7=(tf1*(EL1_7/WF7c))+(tf2*(EL2_7/WF7c))+(tf3*(EL3_7/WF7c))+(tf4*(EL4_
7/WF7c))+(tf5*(EL5_7/WF7c))+(tf6*(EL6_7/WF7c))+(tf8*(EL8_7/WF7c))+(tf9*(E
L9_7/WF7c))+(tf10*(EL10_7/WF7c))+(tf11*(EL11_7/WF7c))+(tf12*(EL12_7/WF7
c))+(tf13*(EL13_7/WF7c))
Gen1 l7d=taxf7+taxfa7
Print l7d
Gen1 lmd7_0=l7n_0/l7d
Gen1 lmd7_01=l7n_01/l7d
Gen1 lmd7_015=l7n_015/l7d
Gen1 lmd7_02=l7n_02/l7d
Gen1 lmd7_025=l7n_025/l7d
Gen1 lmd7_029=l7n_029/l7d
Gen1 lmd7_033=l7n_033/l7d
Gen1 lmd7_035=l7n_035/l7d
Gen1 lmd7_04=l7n_04/l7d
Gen1 lmd7_045=l7n_045/l7d
Gen1 lmd7_05=l7n_05/l7d
Gen1 lmd7_1=l7n_1/l7d
Gen1 lmd7_15=l7n_15/l7d
```

```
Gen1 lmd7_2=l7n_2/l7d
Gen1 lmd7_25=l7n_25/l7d

Gen1 taxf8=1+(tf8*((EL8_8/WF8c)-1))
Gen1
taxfa8=(tf1*(EL1_8/WF8c))+(tf2*(EL2_8/WF8c))+(tf3*(EL3_8/WF8c))+(tf4*(EL4_
8/WF8c))+(tf5*(EL5_8/WF8c))+(tf6*(EL6_8/WF8c))+(tf7*(EL7_8/WF8c))+(tf9*(E
L9_8/WF8c))+(tf10*(EL10_8/WF8c))+(tf11*(EL11_8/WF8c))+(tf12*(EL12_8/WF8
c))+(tf13*(EL13_8/WF8c))
Gen1 l8d=taxf8+taxfa8
Print l8d
Gen1 lmd8_0=l8n_0/l8d
Gen1 lmd8_01=l8n_01/l8d
Gen1 lmd8_015=l8n_015/l8d
Gen1 lmd8_02=l8n_02/l8d
Gen1 lmd8_025=l8n_025/l8d
Gen1 lmd8_029=l8n_029/l8d
Gen1 lmd8_033=l8n_033/l8d
Gen1 lmd8_035=l8n_035/l8d
Gen1 lmd8_04=l8n_04/l8d
Gen1 lmd8_045=l8n_045/l8d
Gen1 lmd8_05=l8n_05/l8d
Gen1 lmd8_1=l8n_1/l8d
Gen1 lmd8_15=l8n_15/l8d
Gen1 lmd8_2=l8n_2/l8d
Gen1 lmd8_25=l8n_25/l8d

Gen1 taxf9=1+(tf9*((EL9_9/WF9c)-1))
Gen1
taxfa9=(tf1*(EL1_9/WF9c))+(tf2*(EL2_9/WF9c))+(tf3*(EL3_9/WF9c))+(tf4*(EL4_
9/WF9c))+(tf5*(EL5_9/WF9c))+(tf6*(EL6_9/WF9c))+(tf7*(EL7_9/WF9c))+(tf8*(E
L8_9/WF9c))+(tf10*(EL10_9/WF9c))+(tf11*(EL11_9/WF9c))+(tf12*(EL12_9/WF9
c))+(tf13*(EL13_9/WF9c))
Gen1 l9d=taxf9+taxfa9
Print l9d
Gen1 lmd9_0=l9n_0/l9d
Gen1 lmd9_01=l9n_01/l9d
Gen1 lmd9_015=l9n_015/l9d
Gen1 lmd9_02=l9n_02/l9d
Gen1 lmd9_025=l9n_025/l9d
Gen1 lmd9_029=l9n_029/l9d
Gen1 lmd9_033=l9n_033/l9d
Gen1 lmd9_035=l9n_035/l9d
Gen1 lmd9_04=l9n_04/l9d
Gen1 lmd9_045=l9n_045/l9d
Gen1 lmd9_05=l9n_05/l9d
Gen1 lmd9_1=l9n_1/l9d
Gen1 lmd9_15=l9n_15/l9d
Gen1 lmd9_2=l9n_2/l9d
Gen1 lmd9_25=l9n_25/l9d
```

```
Gen1 taxf10=1+(tf10*((EL10_10/WF10c)-1))
Gen1
taxfa10=(tf1*(EL1_10/WF10c))+(tf2*(EL2_10/WF10c))+(tf3*(EL3_10/WF10c))+(tf
4*(EL4_10/WF10c))+(tf5*(EL5_10/WF10c))+(tf6*(EL6_10/WF10c))+(tf7*(EL7_10
/WF10c))+(tf8*(EL8_10/WF10c))+(tf9*(EL9_10/WF10c))+(tf11*(EL11_10/WF10c)
)+(tf12*(EL12_10/WF10c))+(tf13*(EL13_10/WF10c))
Gen1 l10d=taxf10+taxfa10
Print l10d
Gen1 lmd10_0=l10n_0/l10d
Gen1 lmd10_01=l10n_01/l10d
Gen1 lmd10_015=l10n_015/l10d
Gen1 lmd10_02=l10n_02/l10d
Gen1 lmd10_025=l10n_025/l10d
Gen1 lmd10_029=l10n_029/l10d
Gen1 lmd10_033=l10n_033/l10d
Gen1 lmd10_035=l10n_035/l10d
Gen1 lmd10_04=l10n_04/l10d
Gen1 lmd10_045=l10n_045/l10d
Gen1 lmd10_05=l10n_05/l10d
Gen1 lmd10_1=l10n_1/l10d
Gen1 lmd10_15=l10n_15/l10d
Gen1 lmd10_2=l10n_2/l10d
Gen1 lmd10_25=l10n_25/l10d

Gen1 taxf11=1+(tf11*((EL11_11/WF11c)-1))
Gen1
taxfa11=(tf1*(EL1_11/WF11c))+(tf2*(EL2_11/WF11c))+(tf3*(EL3_11/WF11c))+(tf
4*(EL4_11/WF11c))+(tf5*(EL5_11/WF11c))+(tf6*(EL6_11/WF11c))+(tf7*(EL7_11
/WF11c))+(tf8*(EL8_11/WF11c))+(tf9*(EL9_11/WF11c))+(tf10*(EL10_11/WF11c)
)+(tf12*(EL12_11/WF11c))+(tf13*(EL13_11/WF11c))
Gen1 l11d=taxf11+taxfa11
Print l11d
Gen1 lmd11_0=l11n_0/l11d
Gen1 lmd11_01=l11n_01/l11d
Gen1 lmd11_015=l11n_015/l11d
Gen1 lmd11_02=l11n_02/l11d
Gen1 lmd11_025=l11n_025/l11d
Gen1 lmd11_029=l11n_029/l11d
Gen1 lmd11_033=l11n_033/l11d
Gen1 lmd11_035=l11n_035/l11d
Gen1 lmd11_04=l11n_04/l11d
Gen1 lmd11_045=l11n_045/l11d
Gen1 lmd11_05=l11n_05/l11d
Gen1 lmd11_1=l11n_1/l11d
Gen1 lmd11_15=l11n_15/l11d
Gen1 lmd11_2=l11n_2/l11d
Gen1 lmd11_25=l11n_25/l11d

Gen1 taxf12=1+(tf12*((EL12_12/WF12c)-1))
```

```
Genl
taxfa12=(tf1*(EL1_12/WF12c))+(tf2*(EL2_12/WF12c))+(tf3*(EL3_12/WF12c))+(tf
4*(EL4_12/WF12c))+(tf5*(EL5_12/WF12c))+(tf6*(EL6_12/WF12c))+(tf7*(EL7_12
/WF12c))+(tf8*(EL8_12/WF12c))+(tf9*(EL9_12/WF12c))+(tf10*(EL10_12/WF12c)
)+(tf11*(EL11_12/WF12c))+(tf13*(EL13_12/WF12c))
Genl l12d=taxf12+taxfa12
Print l12d
Genl lmd12_0=l12n_0/l12d
Genl lmd12_01=l12n_01/l12d
Genl lmd12_015=l12n_015/l12d
Genl lmd12_02=l12n_02/l12d
Genl lmd12_025=l12n_025/l12d
Genl lmd12_029=l12n_029/l12d
Genl lmd12_033=l12n_033/l12d
Genl lmd12_035=l12n_035/l12d
Genl lmd12_04=l12n_04/l12d
Genl lmd12_045=l12n_045/l12d
Genl lmd12_05=l12n_05/l12d
Genl lmd12_1=l12n_1/l12d
Genl lmd12_15=l12n_15/l12d
Genl lmd12_2=l12n_2/l12d
Genl lmd12_25=l12n_25/l12d

Genl taxf13=1+(tf13*((EL13_13/WF13c)-1))
Genl
taxfa13=(tf1*(EL1_13/WF13c))+(tf2*(EL2_13/WF13c))+(tf3*(EL3_13/WF13c))+(tf
4*(EL4_13/WF13c))+(tf5*(EL5_13/WF13c))+(tf6*(EL6_13/WF13c))+(tf7*(EL7_13
/WF13c))+(tf8*(EL8_13/WF13c))+(tf9*(EL9_13/WF13c))+(tf10*(EL10_13/WF13c)
)+(tf11*(EL11_13/WF13c))+(tf12*(EL12_13/WF13c))
Genl l13d=taxf13+taxfa13
Print l13d
Genl lmd13_0=l13n_0/l13d
Genl lmd13_01=l13n_01/l13d
Genl lmd13_015=l13n_015/l13d
Genl lmd13_02=l13n_02/l13d
Genl lmd13_025=l13n_025/l13d
Genl lmd13_029=l13n_029/l13d
Genl lmd13_033=l13n_033/l13d
Genl lmd13_035=l13n_035/l13d
Genl lmd13_04=l13n_04/l13d
Genl lmd13_045=l13n_045/l13d
Genl lmd13_05=l13n_05/l13d
Genl lmd13_1=l13n_1/l13d
Genl lmd13_15=l13n_15/l13d
Genl lmd13_2=l13n_2/l13d
Genl lmd13_25=l13n_25/l13d

*Lamda for All
```

Matrix
lmd_0=(lmd1_0|lmd2_0|lmd3_0|lmd4_0|lmd5_0|lmd6_0|lmd7_0|lmd8_0|lmd9_0|lmd
10_0|lmd11_0|lmd12_0|lmd13_0)
Matrix
lmd_01=(lmd1_01|lmd2_01|lmd3_01|lmd4_01|lmd5_01|lmd6_01|lmd7_01|lmd8_01|l
md9_01|lmd10_01|lmd11_01|lmd12_01|lmd13_01)
Matrix
lmd_015=(lmd1_015|lmd2_015|lmd3_015|lmd4_015|lmd5_015|lmd6_015|lmd7_015|l
md8_015|lmd9_015|lmd10_015|lmd11_015|lmd12_015|lmd13_015)
Matrix
lmd_02=(lmd1_02|lmd2_02|lmd3_02|lmd4_02|lmd5_02|lmd6_02|lmd7_02|lmd8_02|l
md9_02|lmd10_02|lmd11_02|lmd12_02|lmd13_02)
Matrix
lmd_025=(lmd1_025|lmd2_025|lmd3_025|lmd4_025|lmd5_025|lmd6_025|lmd7_025|l
md8_025|lmd9_025|lmd10_025|lmd11_025|lmd12_025|lmd13_025)
Matrix
lmd_029=(lmd1_029|lmd2_029|lmd3_029|lmd4_029|lmd5_029|lmd6_029|lmd7_029|l
md8_029|lmd9_029|lmd10_029|lmd11_029|lmd12_029|lmd13_029)
Matrix
lmd_033=(lmd1_033|lmd2_033|lmd3_033|lmd4_033|lmd5_033|lmd6_033|lmd7_033|l
md8_033|lmd9_033|lmd10_033|lmd11_033|lmd12_033|lmd13_033)
Matrix
lmd_035=(lmd1_035|lmd2_035|lmd3_035|lmd4_035|lmd5_035|lmd6_035|lmd7_035|l
md8_035|lmd9_035|lmd10_035|lmd11_035|lmd12_035|lmd13_035)
Matrix
lmd_04=(lmd1_04|lmd2_04|lmd3_04|lmd4_04|lmd5_04|lmd6_04|lmd7_04|lmd8_04|l
md9_04|lmd10_04|lmd11_04|lmd12_04|lmd13_04)
Matrix
lmd_045=(lmd1_045|lmd2_045|lmd3_045|lmd4_045|lmd5_045|lmd6_045|lmd7_045|l
md8_045|lmd9_045|lmd10_045|lmd11_045|lmd12_045|lmd13_045)
Matrix
lmd_05=(lmd1_05|lmd2_05|lmd3_05|lmd4_05|lmd5_05|lmd6_05|lmd7_05|lmd8_05|l
md9_05|lmd10_05|lmd11_05|lmd12_05|lmd13_05)
Matrix
lmd_1=(lmd1_1|lmd2_1|lmd3_1|lmd4_1|lmd5_1|lmd6_1|lmd7_1|lmd8_1|lmd9_1|lmd
10_1|lmd11_1|lmd12_1|lmd13_1)
Matrix
lmd_15=(lmd1_15|lmd2_15|lmd3_15|lmd4_15|lmd5_15|lmd6_15|lmd7_15|lmd8_15|l
md9_15|lmd10_15|lmd11_15|lmd12_15|lmd13_15)
Matrix
lmd_2=(lmd1_2|lmd2_2|lmd3_2|lmd4_2|lmd5_2|lmd6_2|lmd7_2|lmd8_2|lmd9_2|lmd
10_2|lmd11_2|lmd12_2|lmd13_2)
Matrix
lmd_25=(lmd1_25|lmd2_25|lmd3_25|lmd4_25|lmd5_25|lmd6_25|lmd7_25|lmd8_25|l
md9_25|lmd10_25|lmd11_25|lmd12_25|lmd13_25)

Matrix Tlmd_0=lmd_0'
Matrix Tlmd_01=lmd_01'
Matrix Tlmd_015=lmd_015'
Matrix Tlmd_02=lmd_02'

```
Matrix Tlmd_025=lmd_025'
Matrix Tlmd_029=lmd_029'
Matrix Tlmd_033=lmd_033'
Matrix Tlmd_035=lmd_035'
Matrix Tlmd_04=lmd_04'
Matrix Tlmd_045=lmd_045'
Matrix Tlmd_05=lmd_05'
Matrix Tlmd_1=lmd_1'
Matrix Tlmd_15=lmd_15'
Matrix Tlmd_2=lmd_2'
Matrix Tlmd_25=lmd_25'

Print lmd_0 lmd_01 lmd_015 lmd_02 lmd_025 lmd_029 lmd_033 lmd_035 lmd_04
lmd_045 lmd_05 lmd_1 lmd_15 lmd_2 lmd_25
Print Tlmd_0 Tlmd_01 Tlmd_015 Tlmd_02 Tlmd_025 Tlmd_029 Tlmd_033
Tlmd_035 Tlmd_04 Tlmd_045 Tlmd_05 Tlmd_1 Tlmd_15 Tlmd_2 Tlmd_25

Matrix
Tlmd_IA=(Tlmd_0|Tlmd_01|Tlmd_015|Tlmd_02|Tlmd_025|Tlmd_029|Tlmd_033|Tl
md_035|Tlmd_04|Tlmd_045|Tlmd_05|Tlmd_1|Tlmd_15|Tlmd_2|Tlmd_25)
Matrix
Tln=(Tln_0|Tln_01|Tln_015|Tln_02|Tln_025|Tln_029|Tln_033|Tln_035|Tln_04|Tln_0
45|Tln_05|Tln_1|Tln_15|Tln_2|Tln_25)
Print Tln
Print Tlmd_IA

*Computing tf (tax factor), teta_WF (oWFn-price), taxfa (cross-effect) and total (ld)
according to Table A7 Olivia (p.92)
Matrix tf=(tf1|tf2|tf3|tf4|tf5|tf6|tf7|tf8|tf9|tf10|tf11|tf12|tf13)
Matrix Ttf_IA=tf'
Print Ttf_IA

Gen1 teta_W1=(EL1_1/WF1c)-1
Gen1 teta_W2=(EL2_2/WF2c)-1
Gen1 teta_W3=(EL3_3/WF3c)-1
Gen1 teta_W4=(EL4_4/WF4c)-1
Gen1 teta_W5=(EL5_5/WF5c)-1
Gen1 teta_W6=(EL6_6/WF6c)-1
Gen1 teta_W7=(EL7_7/WF7c)-1
Gen1 teta_W8=(EL8_8/WF8c)-1
Gen1 teta_W9=(EL9_9/WF9c)-1
Gen1 teta_W10=(EL10_10/WF10c)-1
Gen1 teta_W11=(EL11_11/WF11c)-1
Gen1 teta_W12=(EL12_12/WF12c)-1
Gen1 teta_W13=(EL13_13/WF13c)-1

Matrix
teta_W=(teta_W1|teta_W2|teta_W3|teta_W4|teta_W5|teta_W6|teta_W7|teta_W8|teta_
W9|teta_W10|teta_W11|teta_W12|teta_W13)
Matrix Tteta_W_IA=teta_W'
```

```
Print Tteta_W_IA

Matrix
ELOWN_IA=(EL1_1|EL2_2|EL3_3|EL4_4|EL5_5|EL6_6|EL7_7|EL8_8|EL9_9|EL10
_10|EL11_11|EL12_12|EL13_13)
Print ELOWN_IA

Matrix EX_IA=Beta*IWFb
Print EX_IA

Matrix EI_IA=rho*IWFb
Print EI_IA

Gen1 EE1=(1-gama1)+(beta1/Wfb1)
Gen1 EE2=(1-gama2)+(beta2/Wfb2)
Gen1 EE3=(1-gama3)+(beta3/wfb3)
Gen1 EE4=(1-gama4)+(beta4/wfb4)
Gen1 EE5=(1-gama5)+(beta5/wfb5)
Gen1 EE6=(1-gama6)+(beta6/wfb6)
Gen1 EE7=(1-gama7)+(beta7/wfb7)
Gen1 EE8=(1-gama8)+(beta8/wfb8)
Gen1 EE9=(1-gama9)+(beta9/wfb9)
Gen1 EE10=(1-gama10)+(beta10/wfb10)
Gen1 EE11=(1-gama11)+(beta11/wfb11)
Gen1 EE12=(1-gama12)+(beta12/wfb12)
Gen1 EE13=(1-gama13)+(beta13/wfb13)

Matrix EE_IA=(EE1|EE2|EE3|EE4|EE5|EE6|EE7|EE8|EE9|EE10|EE11|EE12|EE13)

Print EE_IA

Matrix
OWnE=(taxf1|taxf2|taxf3|taxf4|taxf5|taxf6|taxf7|taxf8|taxf9|taxf10|taxf11|taxf12|taxf1
3)
Matrix TOWnE_IA=OWnE'
Print TOWnE_IA

Matrix
Cross=(taxfa1|taxfa2|taxfa3|taxfa4|taxfa5|taxfa6|taxfa7|taxfa8|taxfa9|taxfa10|taxfa11|ta
xfa12|taxfa13)
Matrix TCross_IA=Cross'
Print TCross_IA

Matrix Total=(l1d|l2d|l3d|l4d|l5d|l6d|l7d|l8d|l9d|l10d|l11d|l12d|l13d)
Matrix TTotal_IA=Total'
Print TTotal_IA

End
Stop
```