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Outward FDI and income inequality in the home country: The role of wage bargaining

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ABSTRACT

In the process of economic globalization, firms extending operations via Foreign Direct Investment (FDI) encounter significant effects on wage inequality. Workers with bargaining power can negotiate favorable terms, while those without this influence face pronounced disparities. Building on the framework of Helpman et al. (2010), this study examines the impact of non-bargaining workers on income inequality during the transition from autarky to outward FDI. The results highlight a marked increase in wage gaps, particularly with greater outward FDI intensity. Moreover, under certain conditions, there is a notable rise in overall inequality, as measured by the Theil index.

1. Introduction

The enduring phenomenon of (de)globalization holds a pivotal role in shaping the global economy. While globalization is generally believed to enhance economic growth through mechanisms like facilitating cross-border knowledge spillovers (Grossman & Helpman, 2015), concerns persist regarding its impact on poverty and inequality (Fischer, 2003; Harrison & McMillan, 2007; Helpman, 2016). Over the past few decades, the surge in globalization is evident in the increased trade and investment flows across the globe. According to the World Development Indicators (WDI), world trade as a percentage of GDP rose from 37.12 % in 1980 to 52.1 % in 2020. Correspondingly, net outflows of foreign direct investment (FDI) as a percentage of GDP increased from 0.56 % in 1980 to 1.13 % in 2020. Despite this, inequality seems to have escalated during this period, with within-country inequality documented to have increased from 1980 to 2020, despite a decline in between-country inequality, as reported by Chancel and Piketty (2021).

The intricate relationship between globalization and income inequality has been extensively explored. According to the neo-classical Heckscher-Ohlin trade model, the Stolper-Samuelson theorem suggests that globalization, particularly in the form of trade liberalization, reduces income inequality in the global south while exacerbating it in the global north. Trade liberalization allows the global south, with a surplus of unskilled labor, to specialize in the production and export of unskilled-labor-intensive products, leading to a reduction in income inequality. Conversely, in the global north, the opposite occurs.

However, despite theoretical expectations, empirical evidence supporting the inequality-alleviating effect of globalization in the global south is lacking (Kremer, 2006). Recognizing this dearth of empirical support, Kremer and Maskin (2003) look into the globalization of the production process, specifically focusing on the design, manufacturing, and customer service for a product across different countries. Their findings reveal that globalization exacerbates inequality in developing countries, challenging the

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neoclassical predictions.

Helpman et al. (2010), hereafter referred to as HIR, take this discussion further by introducing wage bargaining as a critical mechanism in the globalization-inequality nexus. By incorporating the Diamond–Mortensen–Pissarides search and match framework into a Melitz (2003) model, they examine how trade liberalization affects wage income inequality. In their model, firms make optimal decisions on serving the domestic market, exporting, and hiring workers. Workers possess heterogeneous capabilities, unobserved by firms ex ante. Firms sample workers and invest in screening their capabilities. Once firms are matched with workers, they engage in multilateral bargaining to set wages, revealing the complementary relationship between workers' ability and firms' productivity. This framework highlights the role of wage bargaining in amplifying income inequality, particularly when not all firms engage in exporting.[1]

Building on this theoretical foundation, more recent studies have emphasized the role of firm-level dynamics in shaping wage inequality. Card et al. (2018) reveal how firm-specific pay premiums and the sorting of workers across firms drive labor market inequality, with high-wage firms employing high-wage workers. Alvarez-Cuadrado et al. (2018) add to this by demonstrating how external shocks, such as export growth and increased competition, can narrow inter-firm wage differentials and reduce inequality. Together, these studies illustrate the interplay between firm-specific wage-setting practices and broader economic forces, underscoring the importance of considering firm-level dynamics in any analysis of globalization's impact on inequality.

Recognizing the significance of wage bargaining, the absence of which may alter the impact of globalization on wage income, we explore this mechanism by introducing workers with no bargaining power into the HIR model. Our model features three types of workers: skilled and unskilled production workers (Types 1 and 2), lacking wage bargaining power, and Type 3 workers, similar to those in the HIR model, possessing wage bargaining power and heterogeneous capabilities initially unobserved by firms. Melitz-type heterogeneous firms make optimal decisions on serving domestic and foreign markets (via outward FDI), optimal combinations of Types 1 and 2 production workers and hiring Type 3 workers.

To highlight the role of wage bargaining in driving income inequality, our focus narrows to situations where firms exclusively serve foreign markets through direct investment (outward FDI). When firms decide to invest in the foreign market, they produce goods there, not hiring additional production workers in the home country. Through wage bargaining, Type 3 workers receive part of the profits from investing in the foreign market, while Types 1 and 2 production workers do not. Consequently, from autarky to outward FDI, wage inequality between Types 1/2 and Type 3 workers unequivocally increases. Additionally, if the income share of Type 3 workers is sufficiently high, overall income inequality, measured by the Theil index, also increases.

Our modelling differs from the HIR model in two key aspects. First, the labor markets for Types 1 and 2 follow the classical supply-demand framework, whereas the Type 3 labor market is characterized by the Diamond–Mortensen–Pissarides framework, as in the HIR model. Our results are not a special case of the HIR model, as the zero-bargaining power of Type 1 and Type 2 workers is not equivalent to reducing the bargaining power of Type 3 workers to zero. Second, our model examines firms' optimal decisions to invest in foreign markets, whereas the HIR model focuses on export strategies. Our study contributes to the ongoing research exploring the nexus between FDI and income inequality, focusing on firms' decisions to serve foreign markets through direct investment and the resulting wage income inequality.[2] Existing studies have approached this nexus empirically and theoretically, considering both inward and outward FDI.

Inward FDI is widely acknowledged for its potential impact on income inequality in host countries, but existing studies yield mixed results. Regional variations, highlighted by Tsai (1995), and diverse outcomes, such as the significant contribution of FDI to increased income inequality in Europe reported by Asteriou et al. (2014) and rising inequality in Africa due to FDI found by Kaulihowa and Adjasi (2018), underscore the complexity of this relationship. Heimberger's (2020) meta-analysis reveals a stronger income-inequality increasing impact of financial globalization, including inward FDI. Wang et al. (2023) argue that inward FDI could influence income inequality, with regional-level analysis indicating varying impacts across emerging and developed economies.

Fewer studies have explored the impact of outward FDI on income inequality. Herzer and Nunnenkamp (2013) investigate both inward and outward FDI's impact on income inequality in Europe, finding that the long-term effect of outward FDI on income inequality in Europe is negative, but the short-term effect may be positive. Huang et al. (2016), using panel data for 39 middle-income countries over 1981–2006, show that the impact of outward FDI on income inequality varies across geographical regions. Joyce (2022) demonstrates that FDI increases income inequality in home countries. Liu et al. (2023) use 2000–2020 panel data from 128 advanced and emerging economies to show that short-term capital flows notably affect income distribution. Capital inflows increase, while outflows decrease income inequality. Liu et al. (2015) reveal that outward FDI has contributed to increased income inequity in Taiwan.

In this paper, we focus on a theoretical analysis of the nexus between outward FDI, a form of globalization, and home country income inequality. Specifically, we explore the role of wage bargaining in driving the change in wage income inequality when an economy opens up (from autarky to outward FDI). This unique focus, to the best of our knowledge, distinguishes our study in the existing literature.

The remainder of this paper is structured as follows. Section 2 sets up the model and examines firms' optimal decisions regarding

[1] Felbermayr et al. (2011) also explore the role of wage bargaining, search frictions, and firm heterogeneity in the nexus between globalization and labor market outcomes, although they do not specifically concentrate on wage income inequality.

[2] Our study also contributes to the theoretical research strand exploring wage and income inequality from various perspectives (see for example Anwar, 2010; Anwar & Sun, 2015; Artige & Cavenaile, 2023; Chu et al., 2021; Marimon & Quadrini, 2011; Pi & Fan, 2019; Pi & Zhou, 2012, 2014; Pupato, 2017; Sun & Anwar, 2015; Yang, 2020; Zeira, 2007). In comparison to these studies, our modelling approach differs, and we specifically focus on a particular mechanism.

prices, the composition of skilled and unskilled production workers, the hiring of workers with bargaining power, and the determination of whether to invest in the foreign market. Section 3 investigates the equilibria within the labor markets. In Section 4, we investigate wage inequality between production and non-production workers, as well as overall wage income inequality measured by the Theil index. Specifically, we compare inequality between autarky and outward FDI, demonstrating that inequality increases following market liberalization. Section five concludes the paper.

2. Firms' optimal decisions

To examine the impact of wage bargaining on income inequality when the economy moves from autarky to outward FDI, we extend the HIR model (Helpman et al., 2010) by incorporating workers lacking wage bargaining power. While wage bargaining is prevalent in certain positions, such as chief executives and R&D researchers, it is plausible that certain workers, like assembly line workers, do not possess such bargaining influence. These individuals are likely to receive a market wage rate, and if they decline the offer, firms can readily find substitutes in the market. In this scenario, it seems reasonable to anticipate that their circumstances may be influenced differently when firms expand into the foreign market.

The economy comprises heterogenous firms producing differentiated products and three types of workers: skilled (Type 1), unskilled (Type 2), and highly skilled (Type 3). The productivity of firms (θ) follows a Pareto distribution with a cumulative distribution function (CDF) denoted as $G_\theta(\theta) = 1 - (\underline{\theta}/\theta)^z$, where $\theta \geq \underline{\theta} > 0$, and $z > 1$.

Workers of Types 1 and 2 are skilled and unskilled production workers, respectively, without wage bargaining power and they are homogenous. Type 3 workers (such as managers, R&D researchers, marketing and financial professionals) are highly skilled. These workers possess wage bargaining power and are ex ante homogenous but ex post heterogeneous, as in the HIR model (Helpman et al., 2010). Workers of Types 1 and 2 are substitutable for each other, whereas Type 3 workers are not due to their unique professional skills.

Firms have the option to serve both domestic and foreign markets through foreign direct investment (FDI). Production in the domestic market incurs fixed costs (f_d), which are associated with such facilities as assembly lines and related equipment. In the foreign market, in addition to duplicating overhead production costs, firms must also cover fixed costs related to distribution, servicing network, and forming a subsidiary in a foreign country (Helpman et al., 2004), denoted as the total fixed costs f_i. Notably, $f_i > f_d$.[3]

With the production facilities, firms combine 1 unit of Type 1 worker with l units of Type 2 workers to produce y units of goods. The marginal product of production workers (y) depends on firms' productivity (θ), the measure of hired Type 3 workers (h), and their average ability ($\overline{a}$), as follows: $y = \theta h^\gamma \overline{a}$ where $0 < \gamma < 1$. Type 3 workers have heterogenous ability (a), which follows a Pareto distribution with CDF $G_a(a) = 1 - (\underline{a}/a)^k$, $a \geq \underline{a} > 0$, and $k > 1$.

Let wage of Type 1 workers be normalized to 1, Type 2 wage denoted as $\widetilde{w}$, and Type 3 wage denoted as w. Then the marginal cost of production (mc) is given by $mc = \frac{1+l\widetilde{w}}{y}$. Similarly, in the foreign market, the marginal cost of production (mc^*) is $mc^* = \frac{1+l^*\widetilde{w}^*}{y}$, where the * represents the foreign market.

Consumers in the domestic market maximize a constant-elasticity-of-substitution (CES) utility function, subject to their budget constraints, resulting in a demand function $q = Ap^{\frac{1}{\beta-1}}$, where p and q represents price and quantity of goods, respectively; A represents aggregate demand, defined as the representative consumer's income divided by a price index, which firms take as given. The parameter β is the preference parameter, constrained such that $0 < \beta < 1$. In the foreign market, the demand is denoted by $q^* = A^* p^{*\frac{1}{\beta-1}}$. Firms' optimal prices in the domestic and foreign markets are given by $p = \frac{1+l\widetilde{w}}{\beta y}$ and $p^* = \frac{1+l^*\widetilde{w}^*}{\beta y}$, respectively.

Firms combine the two types of production workers in a CES manner, where the bundle of aggregate production worker is $\left(l_0^\upsilon + l_1^\upsilon\right)^{1/\upsilon}$, with l_0 and l_1 representing Type 1 and Type 2 workers, respectively. Here, $0 < \upsilon < 1$; and $l = l_1/l_0$ is the relative demand for Type 2 workers. Firms choose an optimal combination (l) to equalize the ratio of marginal products against the wage rate, resulting in $l = \widetilde{w}^{\frac{1}{\upsilon-1}}$. Similarly, if firms invest in the foreign market, $l^* = \widetilde{w}^{*\frac{1}{\upsilon-1}}$.

Regarding the hiring of Type 3 workers, despite firms not observing workers' ability, they can screen workers through methods such as job interviews. Firms sample a measure of n Type 3 workers and choose a screening threshold a_c. Given the Pareto distribution of worker ability, firms hire a measure $h = n(\underline{a}/a_c)^k$ of Type 3 workers with an average ability of $\overline{a} = \frac{k}{k-1}a_c$. Accordingly, $y = \frac{k}{k-1}\underline{a}^{\gamma k}\theta n^\gamma a_c^{1-\gamma k}$, where $0 < \gamma k < 1$. Firms and their hired Type 3 workers engage in Stole and Zwiebel (1996a, 1996b) type wage bargaining, a strategic bargaining with equal weights to divide the production revenue net of the wage payments to Types 1 and 2 workers. The wage bargaining results in a split of $1/(1+\beta\gamma)$ proportion to firms and the remaining to Type 3 workers.

Let $\chi(\theta) = 1$ if a firm chooses to invest in the foreign market and 0 otherwise. In anticipation of the bargaining outcome, firms sample n Type 3 workers and choose a_c to maximize profits, as follows:

[3] Fixed costs in terms of domestic labor units offers clearer insight into the pivotal role of highly skilled (Type 3) workers in driving expansion into foreign markets.

$$\Pi = \frac{1}{1+\beta\gamma}(1-\beta)\beta^{\frac{\beta}{1-\beta}}A(1+l\widetilde{w})^{-\frac{\beta}{1-\beta}}\left[1+\chi\frac{A^*}{A}\left(\frac{1+l^*\widetilde{w}^*}{1+l\widetilde{w}}\right)^{-\frac{\beta}{1-\beta}}\right]\left(\frac{k}{k-1}\right)^{\frac{\beta}{1-\beta}}\underline{a}^{\frac{\beta\gamma k}{1-\beta}}\theta^{\frac{\beta}{1-\beta}}n^{\frac{\beta\gamma}{1-\beta}}a_c^{\frac{\beta(1-\gamma k)}{1-\beta}} - (f_d+\chi f_i) - bn - \frac{c}{\delta}a_c^{\delta}$$

$$= \frac{1}{1+\beta\gamma}(1-\beta)(r+\chi r^*) - (f_d+\chi f_i) - bn - \frac{c}{\delta}a_c^{\delta}$$

where b is the search cost; and $\frac{c}{\delta}a_c^{\delta}$ is the screening cost, with $\delta > 1$; the revenue from the domestic market, r, is $r = \beta^{\frac{\beta}{1-\beta}}A(1+l\widetilde{w})^{-\frac{\beta}{1-\beta}}\left(\frac{k}{k-1}\right)^{\frac{\beta}{1-\beta}}\underline{a}^{\frac{\beta\gamma k}{1-\beta}}\theta^{\frac{\beta}{1-\beta}}n^{\frac{\beta\gamma}{1-\beta}}a_c^{\frac{\beta(1-\gamma k)}{1-\beta}}$; whereas the revenue from the foreign market, r^*, is $r^* = \beta^{\frac{\beta}{1-\beta}}A^*(1+l^*\widetilde{w}^*)^{-\frac{\beta}{1-\beta}}\left(\frac{k}{k-1}\right)^{\frac{\beta}{1-\beta}}\underline{a}^{\frac{\beta\gamma k}{1-\beta}}\theta^{\frac{\beta}{1-\beta}}n^{\frac{\beta\gamma}{1-\beta}}a_c^{\frac{\beta(1-\gamma k)}{1-\beta}}$.

The first order conditions for profit maximization are as follows:

$$\begin{cases} \dfrac{\beta\gamma}{1+\beta\gamma}(r+\chi r^*) = bn \\ \dfrac{\beta(1-\gamma k)}{1+\beta\gamma}(r+\chi r^*) = ca_c^{\delta} \end{cases}$$

Given the optimal values for n and a_c, we can solve for the optimal measure of hired Type 3 workers (h) and their wage rate (w) as follows:

$$h(\theta) = n\left(\frac{\underline{a}}{a_c}\right)^k = \frac{\beta^{\frac{\delta-k}{\delta\Gamma}}\gamma^{\frac{\delta(1-\beta)-\beta}{\delta\Gamma}}}{(1+\beta\gamma)^{\frac{(1-\beta)(\delta-k)}{\delta\Gamma}}(1-\gamma k)^{\frac{-\beta+(1-\beta)k}{\delta\Gamma}}}A^{\frac{(1-\beta)(\delta-k)}{\delta\Gamma}}(1+l\widetilde{w})^{-\frac{\beta(\delta-k)}{\delta\Gamma}}\left[1+\chi\frac{A^*}{A}\left(\frac{1+l^*\widetilde{w}^*}{1+l\widetilde{w}}\right)^{-\frac{\beta}{1-\beta}}\right]^{\frac{(1-\beta)(\delta-k)}{\delta\Gamma}}$$

$$\left(\frac{k}{k-1}\right)^{\frac{\beta(\delta-k)}{\delta\Gamma}}\underline{a}^{\frac{\delta(1-\beta)-\beta}{\delta\Gamma}k}b^{-\frac{\delta(1-\beta)-\beta}{\delta\Gamma}}c^{\frac{k(1-\beta)-\beta}{\delta\Gamma}}\theta^{\frac{\beta(\delta-k)}{\delta\Gamma}},$$

$$w(\theta) = \frac{\beta\gamma}{1+\beta\gamma}[(p-mc)q+\chi(p^*-mc^*)q^*]$$

$$= \frac{\beta^{\frac{k}{\delta\Gamma}}\gamma^{\frac{\beta\gamma k}{\delta\Gamma}}}{(1+\beta\gamma)^{\frac{(1-\beta)k}{\delta\Gamma}}(1-\gamma k)^{\frac{\beta(1+\gamma)-1}{\delta\Gamma}}}A^{\frac{(1-\beta)k}{\delta\Gamma}}(1+l\widetilde{w})^{-\frac{\beta k}{\delta\Gamma}}\left[1+\chi\frac{A^*}{A}\left(\frac{1+l^*\widetilde{w}^*}{1+l\widetilde{w}}\right)^{-\frac{\beta}{1-\beta}}\right]^{\frac{(1-\beta)k}{\delta\Gamma}}\left(\frac{k}{k-1}\right)^{\frac{\beta k}{\delta\Gamma}}\underline{a}^{\frac{\beta-[1-\beta(1+\gamma)]\delta}{\delta\Gamma}k}b^{\frac{[1-\beta(1+\gamma)]\delta-\beta}{\delta\Gamma}}c^{\frac{\beta(1+\gamma)-1}{\delta\Gamma}k}\theta^{\frac{\beta k}{\delta\Gamma}},$$

where $\Gamma \equiv 1-\beta(1+\gamma)-\beta(1-\gamma k)/\delta$ and $\delta > k$.

More productive firms, characterized by higher θ values, tend to hire more Type 3 workers and offer higher wages to these workers. It is important to note that firm heterogeneity is the driving force behind variations in the Type 3 wages. When more productive firms expand into the foreign market, they share the resulting benefits with Type 3 workers through the wage bargaining. Consequently, the process of opening up or globalization exacerbates wage income inequality within the category of Type 3 workers. This phenomenon aligns with the findings of Proposition 3 in the HIR model (Helpman et al., 2010).

Firms' optimal profits from both the domestic and foreign markets exhibit monotone increasing behavior with their productivity endowment (θ). When θ is at a low level, negative profits are incurred in both the domestic and foreign markets. Consequently, there exists a cut-off productivity endowment, denoted as θ_d (θ_i), below which firms refrain from serving the domestic (foreign) market. Given that $f_i > f_d$, it follows that $\theta_d < \theta_i$. At the cut-off θ_d, $r_d \equiv r(\theta_d) = \frac{1+\beta\gamma}{\Gamma}f_d$, where r_d represents the revenue of the firm at the domestic market cut-off.

Let $\Upsilon(\theta) \equiv 1+\chi(\theta \geq \theta_i)\frac{A^*}{A}\left(\frac{1+l^*\widetilde{w}^*}{1+l\widetilde{w}}\right)^{-\frac{\beta}{1-\beta}}$, where $\Upsilon(\theta_d) = 1$ and $\mathrm{R}(\theta) \equiv r(\theta) + r^*(\theta)$. We can determine the values of the firm-specific variables relative to their cut-off levels as follows:

$$\begin{cases} \mathrm{R}(\theta) = \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} \mathrm{R}_d \left(\dfrac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}} \\ \mathrm{R}_d = r_d = \dfrac{1+\beta\gamma}{\Gamma} f_d \\ h(\theta) = \Upsilon(\theta)^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}} h_d \left(\dfrac{\theta}{\theta_d}\right)^{\frac{\beta(1-k/\delta)}{\Gamma}} \\ h_d = \underline{a}^k \dfrac{\beta^{1-k/\delta}\gamma \mathrm{c}^{k/\delta}}{\Gamma^{1-k/\delta} b(1-\gamma k)^{k/\delta}} f_d^{1-k/\delta} \\ w(\theta) = \Upsilon(\theta)^{\frac{(1-\beta)k}{\delta\Gamma}} w_d \left(\dfrac{\theta}{\theta_d}\right)^{\frac{\beta k}{\delta\Gamma}} \\ w_d = (1-\beta) b \left[\dfrac{\beta(1-\gamma k) f_d}{\underline{a}^\delta \Gamma \mathrm{c}}\right]^{k/\delta} \end{cases} \tag{1}$$

The model closure is grounded in the HIR framework (Helpman et al., 2010). More specifically, it integrates the free entry condition and zero cut-off profits in both the domestic and foreign markets to determine the cut-off productivity and aggregate demand in these markets. Furthermore, the equilibrium is attained in the production labor markets, ensuring that they clear.

3. Labor markets

As indicated earlier, there are three types of workers: Types 1 and 2, respectively, are skilled and unskilled production workers, without wage bargaining power. In contrast, Type 3 workers are highly skilled and possess wage bargaining power. In this section, we analyze the equilibria in the labor markets.

3.1. Production labor markets

Firms combine 1 unit of Type 1 worker with l units of Type 2 production workers to produce y units of goods. To achieve this, they need to hire q/y units of Type 1 workers and lq/y units of Type 2 workers to produce q units of goods. Hence, the aggregate demand for Type 1 workers is given by $\int_{\theta_d}^{+\infty} \frac{q}{y}\, \mathrm{dG}_\theta(\theta)$, and similarly, the aggregate demand for Type 2 workers is $\int_{\theta_d}^{+\infty} \frac{lq}{y}\, \mathrm{dG}_\theta(\theta)$. Therefore, the aggregate relative demand (L^D) for production workers is expressed as $L^D = l = \widetilde{w}^{\frac{1}{\upsilon-1}}$, $0 < \upsilon < 1$.

On the supply side, the economy is endowed with $\overline{L}$ production workers, of which μ proportion is Type 1 (i.e., skilled). Workers have a reservation wage due to existence of outside options such as utility derived from leisure. The reservation wage is a random variable varying among workers (different workers may have different outside options). The reservation wage of Type 1 production workers is ω_1, with a CDF of $G_1(\omega_1)$, and similarly the reservation wage (ω_2) of Type 2 workers has a CDF of $G_2(\omega_2)$. Skilled production workers tend to have a higher reservation wage due to their skill level, indicating better outside options. In other words, ω_1 first-order stochastically dominates ω_2.

A worker of either type will accept a job offer if its wage is higher than her reservation wage. Additionally, workers are randomly offered jobs. Thus, the aggregate supply of Type 1 production workers is $G_1(1)\mu\overline{L}$, and the aggregate supply of Type 2 production workers is $G_2(\widetilde{w})(1-\mu)\overline{L}$. Consequently, the relative supply of production workers is given by $L^S = \frac{(1-\mu)}{G_1(1)\mu} G_2(\widetilde{w})$. Equating the relative demand with relative supply, we can obtain the equilibrium Type 2 wage rate, implicitly defined by the following equation:

$$F(\widetilde{w}) = \frac{(1-\mu)}{G_1(1)\mu} G_2(\widetilde{w}) \widetilde{w}^{\frac{1}{1-\upsilon}} - 1 = 0 \tag{2}$$

Since $F(\widetilde{w})$ is a monotonically increasing function of $\widetilde{w}$ and $F(0) = -1 < 0$, equation (2) has a unique solution for $\widetilde{w}$. If there are more unskilled production workers than skilled production workers, i.e., $0 < \mu < 1/2$, then $0 < \widetilde{w} < 1$, as $G_2(1) > G_1(1)$. It is important to note that equation (2) remains unaffected by whether firms invest in the foreign market. The equilibrium Type 2 wage rate remains the same in both autarky economy and outward FDI.

In particular, from autarky to outward FDI, Type 3 workers' wage rate increases. Subsequently, demand for a firm's product in the domestic market increases. Responding to the demand increase, firms increase production, which requires hiring more production workers. Nevertheless, the need to hire more production workers does not translate into an increase of Type 2 workers' equilibrium wage rate (relative to that of Type 1 workers), since firms can substitute Type 2 production workers with Type 1 production workers.

If we specify the distribution of ω_2, we can solve explicitly for $\widetilde{w}$. For example, if ω_2 is uniform distributed over $[0, \overline{w}_2]$, then $\widetilde{w} = \left[\frac{\mu G_1(1)\overline{w}_2}{1-\mu}\right]^{\frac{1-\upsilon}{2-\upsilon}}$. If instead ω_2 follows a Pareto distribution with scale and shape parameters of $\underline{w}_2$ and $1/(1-\nu)$, then $\widetilde{w} = \left[\frac{\mu G_1(1) + (1-\mu)\underline{w}_2^{1/(1-\upsilon)}}{1-\mu}\right]^{1-\upsilon}$. A similar condition for the foreign market can be derived in the same manner, determining $\widetilde{w}^*$. This will be used

in the analysis of home country wage income inequality late.

3.2. Highly skilled type 3 labor market

Type 3 workers are highly skilled and engage in wage bargaining with firms. The modelling of the Type 3 labor market follows the standard Diamond-Mortensen-Pissarides approach, similar to the HIR model (Helpman et al., 2010). Specifically, the search cost (b) is an increasing function of the Type 3 labor market tightness (x), which is the ratio of aggregate sampled Type 3 workers to the total Type 3 workers searching for employment in the market. Mathematically, $b = \alpha_0 x^{\alpha_1}$, where $\alpha_0 > 1$ and $\alpha_1 > 0$.

Similar to Types 1 and 2 workers, Type 3 workers also have a reservation wage, due to their outside options. The expected reservation wage is denoted as $\overline{\omega}_2$. Workers are risk-neutral. When searching for jobs in the Type 3 labor market, workers' expected income is the probability of being sampled (x) times the expected wage, conditional on being sampled. On the other hand, their expected opportunity cost is $\overline{\omega}_2$. In equilibrium, arbitrage drives the expected income equal to expected opportunity cost, i.e., $\overline{\omega}_2 = xb$.

Combining the no-arbitrage condition with the search cost function, we can obtain the search cost and labor market tightness as a function of the expected reservation wage, as follows:

$$b = \alpha_0^{1/(1+a_1)} \overline{\omega}_2^{a_1/(1+a_1)} \text{ and } x = \left(\frac{\overline{\omega}_2}{\alpha_0}\right)^{1/(1+a_1)} \tag{3}$$

where, we need $\alpha_0 > \overline{\omega}_2$ to ensure $0 < x < 1$, as in the HIR model (Helpman et al., 2010).

Note that in equation (3), the search cost (b) and Type 3 labor market tightness (x) are monotonically increasing functions of expected reservation wage (Lemma 1 of Helpman et al., 2010). A similar derivation yields the equilibrium search cost (b^*) and Type 3 labor market tightness (x^*) as a function of the expected reservation wage ($\overline{\omega}_2^*$) in the foreign market.

4. Income inequality

In the home country, in equilibrium, the Type 1 wage is normalized to 1, with a measure of employment $\mu G_1(1)\overline{L}$. The equilibrium Type 2 wage is implicitly defined by equation (2), with a measure of employment $(1-\mu)G_2(\widetilde{w})\overline{L}$. For Type 3 workers, the equilibrium wage rate is defined in equation (1), namely: $w(\theta) = \Upsilon(\theta)^{\frac{(1-\beta)k}{\delta\Gamma}} w_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta k}{\delta\Gamma}}$. This depends on whether firms invest in the foreign market and is Pareto distributed since firm productivity (θ) has a Pareto distribution. The measure of employment is $\int_{\theta_d}^{+\infty} h(\theta) dG_\theta(\theta)$. In the foreign country, the wage income distribution is defined similarly. In our analysis of income inequality in the home country, we hold factors in the foreign country constant.

4.1. Skilled-unskilled wage inequality

Type 2 workers earn an equilibrium wage rate of $\widetilde{w}$, which remains constant within the group and does not depend on whether firms serve the foreign market or not, as shown in equation (2). Hence, from the autarky to outward FDI, $\widetilde{w}$ does not change.

Let $\overline{w}$ denote the average Type 3 wage, specifically $\overline{w} \equiv \int_{\theta_d}^{+\infty} w(\theta) dG_\theta(\theta) = \int_{\theta_d}^{+\infty} \Upsilon(\theta)^{\frac{(1-\beta)k}{\delta\Gamma}} w_d \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta k}{\delta\Gamma}} dG_\theta(\theta)$. By substituting the Pareto distribution of θ, we can then express the average Type 3 wage as: $\overline{w} = \frac{z\theta_d^z w_d}{[z-\beta k/(\delta\Gamma)]\theta_d^z}\left[1 + \left(Y_i^{\frac{(1-\beta)k}{\delta\Gamma}} - 1\right)\rho^{z-\beta k/(\delta\Gamma)}\right]$, where $Y_i = 1 + \frac{A^*}{A}\left(\frac{1+l^*\widetilde{w}}{1+l\widetilde{w}}\right)^{-\frac{\beta}{1-\beta}} > 1$ for outward FDI and $Y_i = 1$ for autarky.[4] Here, $\rho = \frac{\theta_d}{\theta_i}$, and $z > \beta k/(\delta\Gamma)$. In the autarky, the average Type 3 wage is $\overline{w} = \frac{z\theta_d^z w_d}{[z-\beta k/(\delta\Gamma)]\theta_d^z}$. Therefore, the transition from autarky to outward FDI (extensive margin) results in an unambiguous increase in the average Type 3 wage. As a result, the skilled-unskilled wage inequality, measured by $\overline{w}/\widetilde{w}$ unambiguously increases from autarky to outward FDI. Furthermore, ρ gauges the intensive margin of outward FDI. Since $z > \beta k/(\delta\Gamma)$, an increase in ρ (indicating more firms engaging in outward FDI) leads to an elevation of $\overline{w}$ and, consequently, an increase in skilled-unskilled wage inequality. We encapsulate this finding in the following proposition:

Proposition 1. *Outward FDI unambiguously exacerbates the skilled-unskilled wage inequality at both the extensive margin* (*from autarky to outward FDI*) *and intensive margin* (*as the intensity of outward FDI increases*).

As the economy opens up, more productive firms expand into the foreign market through outward FDI. Due to the wage bargaining power of Type 3 workers, they share in the benefits, leading to an increase in the average Type 3 wage. In contrast, the lack of wage

[4] Note that wage income inequality arises from both a within-firm effect (where Type 3 workers earn higher wages within a firm) and a between-firm effect (where Type 3 workers earn higher wages in firms with outward FDI compared to those in firms without outward FDI).

bargaining power prevents Types 1 and 2 production workers from benefiting from firms' expansion into the foreign market.[5] Consequently, their wage gap widens after globalization. This increase in inequality is solely attributed to workers' wage bargaining power, emphasizing the role of wage bargaining in driving the change in income inequality from autarky to outward FDI.

4.2. Theil index

Within the types 1 and 2 groups, the Theil indexes (T_1 and T_2) are 0 since every worker in the same group earns the same wage. For Type 3 workers, by Proposition 3 of HIR (Helpman et al., 2010), the Theil index (T_3) increases if not all firms invest in the foreign market, namely $\theta_i > \theta_d$. Due to its decomposability (see Bourguignon, 1979), the overall Theil index (T) can be written as follows:

$$T = \underbrace{s_3 T_3}_{within} + \underbrace{(s_2\ ln\widetilde{w} + s_3\ ln\overline{w} - ln\overline{W})}_{between}$$

where s_2 is the income share of Type 2 group and $s_2 = \frac{(1-\mu)G_2(\widetilde{w})\widetilde{L}\widetilde{w}}{\mu G_1(1)\overline{L}+(1-\mu)G_2(\widetilde{w})\widetilde{L}\widetilde{w}+\frac{z\theta^z}{z-\beta/\Gamma}h_d w_d \theta_d^{-z}\left[1+\left(Y_i^{\frac{1-\beta}{\Gamma}}-1\right)\rho^{z-\beta/\Gamma}\right]}$; s_3 is the income share of Type 3 group and $s_3 = \frac{\frac{z\theta^z}{z-\beta/\Gamma}h_d w_d \theta_d^{-z}\left[1+\left(Y_i^{\frac{1-\beta}{\Gamma}}-1\right)\rho^{z-\beta/\Gamma}\right]}{\mu G_1(1)\overline{L}+(1-\mu)G_2(\widetilde{w})\widetilde{L}\widetilde{w}+\frac{z\theta^z}{z-\beta/\Gamma}h_d w_d \theta_d^{-z}\left[1+\left(Y_i^{\frac{1-\beta}{\Gamma}}-1\right)\rho^{z-\beta/\Gamma}\right]}$; $\overline{W}$ is the population average income, and $\overline{W} = \frac{\mu G_1(1)\overline{L}+(1-\mu)G_2(\widetilde{w})\widetilde{L}\widetilde{w}+\frac{z^2\theta^{2z}}{\left(z-\frac{\beta k}{\delta\Gamma}\right)\left(z-\frac{\beta(1-k/\delta)}{\Gamma}\right)}h_d w_d \theta_d^{-2z}\left[1+\left(Y_i^{\frac{(1-\beta)k}{\delta\Gamma}}-1\right)\rho^{z-\frac{\beta k}{\delta\Gamma}}\right]\left[1+\left(Y_i^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}}-1\right)\rho^{z-\beta(1-k/\delta)/\Gamma}\right]}{\mu G_1(1)\overline{L}+(1-\mu)G_2(\widetilde{w})\widetilde{L}+\frac{z\theta^z}{z-\beta(1-k/\delta)/\Gamma}h_d \theta_d^{-z}\left[1+\left(Y_i^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}}-1\right)\rho^{z-\beta(1-k/\delta)/\Gamma}\right]}$; and the first component is the within inequality, while the second component measures the between inequality.

From the autarky to outward FDI, when $\theta_i > \theta_d$ (indicating not all firms invest in the foreign market), both T_3 and s_3 increase. If all firms invest in the foreign market ($\theta_i = \theta_d$), T_3 does not change, as per Proposition 3 of HIR (Helpman et al., 2010). However, the income share of Type 3 group (s_3) increases. Therefore, in either case, the within inequality unambiguously increases after globalization.

For the between inequality, the income share of Type 2 group (s_2) decreases from autarky to outward FDI. With a sufficiently more endowment of unskilled production workers ($0 < \mu < 1/2$) and the first-order stochastic dominance of Type 1 over Type 2 reservation wage, as demonstrated in Section 3, we have $0 < \widetilde{w} < 1$, and consequently, $ln\widetilde{w} < 0$. Therefore, from autarky to outward FDI, the term $s_2\ ln\widetilde{w}$ increases.

If the total Type 3 income is sufficiently high, then the change in $(s_3\ ln\overline{w} - ln\overline{W})$ from the autarky to outward FDI can be approximated by the change in $(ln\overline{w} - ln\overline{W})$. The change in $(ln\overline{w} - ln\overline{W})$ from autarky to outward FDI can be expressed as $\Delta(ln\overline{w} - ln\overline{W}) = ln\left\{1 + \lambda_2\left[\frac{\lambda_1}{\lambda_2}\left(Y_i^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}} - 1\right)\rho^{z-\beta(1-k/\delta)/\Gamma} + \frac{1}{\lambda_2}\left(Y_i^{\frac{(1-\beta)k}{\delta\Gamma}} - 1\right)\rho^{z-\frac{\beta k}{\delta\Gamma}} + \frac{\lambda_1}{\lambda_2}\left(Y_i^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}} - 1\right)\left(Y_i^{\frac{(1-\beta)k}{\delta\Gamma}} - 1\right)\rho^{2z-\frac{\beta}{\Gamma}}\right]\right\} - ln\left\{1 + \lambda_2\left[\left(Y_i^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}} - 1\right)\rho^{z-\beta(1-k/\delta)/\Gamma} + \left(Y_i^{\frac{(1-\beta)k}{\delta\Gamma}} - 1\right)\rho^{z-\frac{\beta k}{\delta\Gamma}} + \left(Y_i^{\frac{(1-\beta)(1-k/\delta)}{\Gamma}} - 1\right)\left(Y_i^{\frac{(1-\beta)k}{\delta\Gamma}} - 1\right)\rho^{2z-\frac{\beta}{\Gamma}}\right]\right\}$, where $\lambda_1 \equiv \frac{\frac{z\theta^z}{z-\frac{\beta(1-k/\delta)}{\Gamma}}h_d \theta_d^{-z}}{\mu G_1(1)\overline{L}+(1-\mu)G_2(\widetilde{w})\widetilde{L}+\frac{z\theta^z}{z-\frac{\beta(1-k/\delta)}{\Gamma}}h_d \theta_d^{-z}}$, $\lambda_2 \equiv \frac{\frac{z^2\theta^{2z}}{\left(z-\frac{\beta k}{\delta\Gamma}\right)\left(z-\frac{\beta(1-k/\delta)}{\Gamma}\right)}h_d w_d \theta_d^{-2z}}{\mu G_1(1)\overline{L}+(1-\mu)G_2(\widetilde{w})\widetilde{L}\widetilde{w}+\frac{z^2\theta^{2z}}{\left(z-\frac{\beta k}{\delta\Gamma}\right)\left(z-\frac{\beta(1-k/\delta)}{\Gamma}\right)}h_d w_d \theta_d^{-2z}}$, and Δ represents the difference between outward FDI and autarky. With $\underline{\theta}$ sufficiently close to 0, we have $\frac{z\underline{\theta}^z}{z-\frac{\beta k}{\delta\Gamma}}w_d \theta_d^{-z} \leq \widetilde{w}$. Consequently, we have $\frac{\lambda_1}{\lambda_2} \geq 1$. Since $\lambda_2 < 1$, we have $\Delta(ln\overline{w} - ln\overline{W}) > 0$. Therefore, $(s_3\ ln\overline{w} - ln\overline{W})$ increases from the autarky to outward FDI. We summarize this finding in Proposition 2:

Proposition 2. *Outward FDI unequivocally exacerbates the within component of the Theil index. Moreover, under the conditions of* (*i*) $\underline{\theta}$ *sufficiently close to* 0, (*ii*) *Type* 3 *income share sufficiently high, and* (*iii*) *a sufficiently higher endowment of unskilled production workers* ($0 < \mu < 1/2$) *with the first-order stochastic dominance of* (*skilled*) *Type* 1 *over* (*unskilled*) *Type* 2 *reservation wage, the between component of the Theil index increases from autarky to outward FDI, resulting in an overall increase in the Theil index.*

A number of discussions are warranted here. First, our model features three types of workers, where Types 1 and 2 production workers do not have wage bargaining power. We note it is important to have two types of production workers who do not have wage bargaining power, where the wage rate of one type of the production workers is chosen as the numeraire (i.e., normalized to 1). Doing so allows us to isolate the effect of wage bargaining power on wage income inequality.

[5] Note that Types 1 and 2 workers are worse off relative to Type 3 workers, and this disparity worsens after firms invest overseas.

From autarky to outward FDI, Type 3 workers' wage income increases, due to wage bargaining. The increase of wage income results in an increase in product demand. Firms then expand domestic production to meet the demand increase, which in turn requires hiring more production workers. Due to the substitution between Types 1 and 2 production workers and Type 1 wage rate normalized to 1, the equilibrium Type 2 wage rate does not change. If the equilibrium Type 2 wage rate were to increase, then firms substitute away from Types 2 to 1 workers (i.e., the relative demand decreases), putting a downward pressure on Type 2 wage rate, and vice versa.

Second, we assume the production workers do not have wage bargaining power. While this seems to be the case in real life, one may wonder what will happen if production workers form a union to bargain collectively with their employers. In such a case, it is likely production workers will also receive a share of benefits from outward FDI. Nevertheless, the generics of skills and availability of substitute workers limits the scope of wage bargaining.

Third, note the important role of wage bargaining power in determining whether a type of workers will receive benefit from outward FDI or not. A profit-maximizing firm will not automatically pass over the profits from outward FDI to workers if it does not have to. Besides, despite we do not particularly focus on wage bargaining dynamics, we implicitly assume a same wage bargaining dynamics between firms with and without outward FDI. The institutions that govern the wage bargaining process is the same for all firms, since they operate in the same domestic market. That said, it can be possible that more productive firms, which is more likely to invest overseas, are more efficient in wage bargaining. In such a case, they will be more efficient in hiring Type 3 workers, resulting in an even bigger advantage than less productive firms. Nevertheless, this seems not to change our results.

5. Concluding remarks

As an economy opens up, productive firms engage in the foreign market through export and/or outward FDI, while less productive firms focus on the domestic market—a sorting pattern observed in various studies (see, for example, Helpman et al., 2004). In the home country, whether benefits from foreign expansion extend to workers in the local labor market is not guaranteed.

Helpman et al. (2010) model the local labor market in the context of globalization via export, using the standard Diamond–Mortensen–Pissarides search and match approach with Melitz-type heterogeneous firms. Firms post vacancies, and workers search for jobs in the labor market. Upon matching, firms and workers engage in strategic bargaining to set wages, resulting in higher wages for more productive firms and, subsequently, wage income inequality. From autarky to globalization (via export), wage bargaining allows workers in exporting firms to share benefits, increasing wages relative to non-exporting firms. If not all firms export, this exacerbates inequality from autarky to export. The driving force behind this change in inequality is firm heterogeneity combined with wage bargaining.

Acknowledging the importance of wage bargaining, we extend the HIR (Helpman et al., 2010) model by introducing workers with no wage bargaining power. Due to the lack of bargaining power, these workers are unequivocally worse off from autarky to globalization (via outward FDI), as they do not benefit from firms' foreign expansion. Wage inequality between workers with and without bargaining power unambiguously increases from autarky to outward FDI, growing further as the intensity of outward FDI increases. This wage inequality contributes to an overall increase in wage income inequality in the economy, measured by the Theil index, under certain conditions. Our analysis emphasizes the role of (lack of) wage bargaining power in driving changes in inequality from autarky to globalization—an additional mechanism not captured in the HIR model.

Our analysis on the role of wage bargaining power is at an extensive margin, namely we focus on a comparison between workers with and without wage bargaining power. In addition, one may conjecture that workers with greater bargaining power benefit more from globalization, which can be a direction for future research.

While our analysis focuses on outward FDI, which aligns with our goal of highlighting the mechanism of (lack of) wage bargaining power in driving changes in wage income inequality post-globalization, it is worth noting that one can allow firms to choose between export and outward FDI, as seen in Helpman et al. (2004). This results in a sorting pattern where less productive firms serve the domestic market, more productive firms export, and the most productive firms invest in the foreign market. In such a case, workers with bargaining power continue to share the benefits of foreign expansion, while workers with no bargaining power do not. Thus, the mechanism we investigate remains applicable. As a suggestion for future research, one might consider allowing firms to choose between export and outward FDI, particularly when bringing the model to data.

From a policy perspective, as workers with no wage bargaining power are unequivocally worse off from autarky to globalization, policymakers aiming to address the worsening income inequality due to globalization can design and implement policies targeting this group of workers, such as through tax or transfer payments. However, it is important to note that the analysis of the welfare implications of such policies is beyond the scope of this study and serves as a direction for future research.[6]

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[6] For example, one may consider implanting progressive income tax policies, as discussed in Carbonell-Nicolau and Llavador (2018). Such policies could be designed to mitigate the widening income inequality experienced by workers with no wage bargaining power, thus addressing the adverse effects of globalization on income inequality.

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Data availability

No data was used for the research described in the article.

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