Globalization: Intensive versus Extensive Margin*

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Abstract

There is empirical evidence that globalization leads to higher income inequality within a country. However, in the economic literature no much attention is paid to the fact that globalization may influence inequality through the consumption channel. As different groups of consumers consume different sets of goods and in different amounts, globalization can change consumption patterns and increase or decrease welfare inequality among the groups. In this paper, I look at two components of globalization, namely trade liberalization and a rise in the number of trading partners, and explore their impact on the economic well-being of different population groups through the consumption channel. I consider a general equilibrium model of monopolistic competition with free entry and trade between symmetric countries in the presence of not only firm heterogeneity, but also consumer heterogeneity. In the paper, there are two types of consumers, rich and poor, that share identical but non-homothetic preferences, so that globalization affects different types of consumers differently. I argue that the impact of globalization on the relative welfare of the rich with respect to the poor depends on the type of globalization. In particular, the relative welfare of the rich has an inverted U shape as a function of transportation costs. As for a rise in the number of trading partners, the rich always gain more than the poor. Moreover, in some cases the rich can be even worse off from trade liberalization, while welfare of the poor and aggregate welfare both increase.

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1 Introduction

It is well known that different groups of consumers (for instance, the rich or the middle class) consume different bundles of goods and in different amounts: while the rich can afford to buy Mercedes, the poor are constrained by buying Nissan or Toyota. Thus, gains or losses from globalization are not equally distributed across consumers. Some consumers gain or lose more, some of them less. During the nineties in Russia, the government imposed high tariffs on imported cars to protect the domestic industry. While rich consumers continued buying cars at higher prices, some of poorer consumers had to do without any car at all. Whereas the rich lost from higher prices, the poor lost from incapability to buy a car. A natural question arises: who lost more? In this paper, I analyze the effects of globalization on relative welfare of the rich with respect to the poor.

There is a large empirical and theoretical literature that examines the impact of world globalization on income inequality within a country[1]. However, in economic literature there is not much attention paid to the fact that globalization may influence inequality through consumption: globalization can change consumption patterns and increase or decrease welfare inequality among the groups. To my best knowledge, there is only one study that examines the implications of globalization on welfare inequality not only through the income channel, but also through the consumption channel. In his paper, Porto (2006) empirically explores the impact of Argentinean trade reform, namely entry into Mercosur, on the distribution of welfare. He examines two possible effects caused by the trade reform: price changes and income changes. Given the structure of Mercosur, the prices of such goods as food and beverages increased, while the prices of nontradable goods such as health and education decreased. Food and beverages have a larger share in the consumption of the poor than that of the rich; health and education are mostly consumed by the rich. Thus, one of the effects of Mercosur is an increase in inequality through consumption. Even though Porto (2006) argues that the income channel dominates over the consumption channel, the consumption channel seems to play an important role in the analysis of globalization and inequality and needs to be explored further.

The goal of this paper is to construct a model that establishes a link between globalization and inequality through the consumption channel. I develop a general equilibrium trade model of monopolistic competition with heterogenous firms and consumers. Consumer heterogeneity in the model is introduced by assuming that consumers differ according to the efficiency units of labor they are endowed with. I assume that all consumers share identical but non-homothetic preferences. In traditional models of monopolistic competition and trade, there are two standard preference assumptions: consumer preferences are identical and homothetic, or identical and quasi-linear. In both cases, it is

[1] See Goldberg and Pavcnik (2007) for a literature review.

well understood that the presence of consumer heterogeneity does not affect equilibrium. In the case of homothetic preferences, only aggregate income matters; while in the case of quasi-linear preferences, the presence of a numeraire good eliminates the influence of consumer heterogeneity on equilibrium outcomes. In these models, any price change has the same (not relative to income) impact on all consumers. In the present model, non-homothetic preferences and income heterogeneity imply that price changes (caused by globalization) affect different population groups differently.

I adopt the preference structure in Murphy, Shleifer and Vishny (1989) and Matsuyama (2000). The basic idea is that goods are indivisible, and potential consumers want to buy only a single unit of each good. This implies that given prices, goods can be arranged so that consumers choose what to buy by moving down a certain list. For example, in developing countries, consumers first buy food, then clothing, then move up the chain of durables from kerosene stoves to refrigerators, to cars. Notice that the consumer utility can only be increased by the consumption of a greater number of goods. Moreover, consumers with high income consume the same set of goods as consumers with low income, plus some others. Goods differ in terms of the valuations that consumers attach to them. By the valuation of a good, I mean the utility derived by consumers from the consumption of one unit of this good. Such differences between goods generate ex-post heterogeneity across firms, as firms enter the market before the valuations placed on their goods are realized[2]. There is free entry in the market. To enter the market firms have to make costly sunk investments. Once firms enter, they learn about the valuations attached to their goods. Depending on the valuation drawn, firms choose whether to exit or to stay. Firms that decide to stay engage in price competition with other firms. Hence, the model incorporates two key features: imperfect competition and non-homothetic preferences, which permit to analyze the impact of globalization on mark-ups charged on different goods and on the welfare of different groups of consumers.

The heart of the paper focuses on the case of two types of consumers: rich and poor, which are distinguished only by income (associated with productivity). Given the preferences, all goods consumed by the poor are also consumed by the rich. In equilibrium, domestic and importing firms choose between selling to everybody at a lower price and selling only to the rich at a higher price. As a result, firms with relatively high valuations decide to sell to everybody, while firms with relatively low valuations choose to sell only to the rich. Thus, potentially available goods in each country can

[2] This structure of consumer preferences has enough flexibility to be applied as to the whole economy as to a certain industry where goods differ in quality. On the one hand, each good can be interpreted as a distinct good sold in the market. In this case, the structure describes the whole economy. On the other hand, one can think that firms sell not distinct goods but some characteristics of a good produced by a certain industry. For instance, consider a car industry. Each good can be treated as some characteristic of a car. The poor purchase some main characteristics associated with a car, while the rich buy the same characteristics as the poor plus some additional luxury characteristics. That is, both groups of consumers buy the same good but of different quality.

be divided into three groups: the "common" group includes goods that are consumed by both types of consumers; the "exclusive" group includes goods that are consumed by the rich only; finally, there is the group of goods that are consumed by no one.

In the analysis, I focus on the two components of globalization: trade liberalization and a rise in the number of trading partners[3]. I show that the effect of globalization on welfare inequality depends on the component of globalization considered. While the rich always gain more from a rise in the number of trading partners than the poor, the impact of trade liberalization on relative welfare depends on transportation costs. If transportation costs are low enough then the poor compared to the rich gain more out of trade liberalization; otherwise, the opposite is true.

The intuition behind these results is as follows. Consider separately two submarkets: one for the "common" goods and one for the "exclusive" goods. Since the rich consume the same set of goods as the poor plus goods from the "exclusive" group, then changes in the relative welfare of the rich are determined by changes in the relative prices of "exclusive" goods with respect to "common" goods. If the transportation costs are sufficiently low then both types of consumers buy imported goods. In this case, an increase in transportation costs leads to exit of some importing firms from both submarkets: firms that used to sell their goods to the rich stop exporting; firms sold to everybody start selling only to the rich. This limits the scope of competition in the submarkets and drives up prices. However, as firms that switched from the submarket for "common" goods to the submarket for "exclusive" goods induce more competition, prices in this submarket rise by less than prices in the submarket for "common" goods. This implies that the rich lose less from an increase in transportation costs than the poor. Moreover, I show that depending on the exogenous parameters of the model, the rich may be better off from an increase in transportation costs, while welfare of the poor and aggregate welfare both fall. If the transportation costs are high enough then the prices of imported goods are relatively high, and only the rich can afford to buy them. In this case, it becomes that the rich lose more from an increase in transportation costs than the poor. The results regarding the expansion of the number of trading partners are based on the similar logic. If transportation costs are high enough then only the rich purchase imported goods. In this case, they gain more from a rise in the number of trading partners than the poor. If transportation costs are such that both types of consumers buy imported goods then a rise in the number of trading partners leads to higher competition in both submarkets forcing some domestic and importing firms to exit. At the same time, firms that leave

[3] While lower transportation costs are the main consequence of globalization, the connection of globalization with a rise in the number of trading partners is not so straightforward. One can think that globalization leads to changes in the set of goods produced in a country: firms start producing goods that have potential to be sold in the world market. Thus, the number of countries trading with each other increases. Another example is related to trade blocs: a rise in the number of trading partners can be interpreted as the expansion of a trade bloc.

the submarket for the "common" goods enter the submarket for the "exclusive" goods inducing even higher competition and lower prices in this submarket. Hence, the rich gain more from a rise in the number of trading partners than the poor irrespective of the transportation costs.

The related literature in this area can be divided into three strands. First, there are papers considering monopolistic competition and trade models with firm heterogeneity, but assuming homothetic or quasilinear preferences. Melitz (2003) develops a general equilibrium model with firm heterogeneity and Dixit-Stiglitz preferences, which imply constant mark-ups. Melitz and Ottaviano (2005) examine a similar framework, but incorporate variable mark-ups by considering a linear demand system. In both studies, the impact of globalization is the same for all consumers. In contrast, the model presented here includes all the key features of the papers mentioned, while analyzing in addition the impact of globalization on different population groups.

The second group of papers explores the implications of non-homothetic preferences in a perfectly competitive environment for open economies. Flam and Helpman (1987), Stokey (1991), and Matsuyama (2000) develop a Ricardian model of North-South trade with non-homothetic preferences. They examine the impact of technical progress, population growth, and redistribution policy on the patterns of specialization and welfare. Stibora and Vaal (2005) extend the model in Matsuyama (2000) by studying the effects of trade liberalization. They show that South loses in terms of trade from unilateral trade liberalization, while North may gain by liberalizing its trade. Krishna and Yavas (2005) investigate the impact of trade in the presence of labor market distortions and indivisibilities in consumption. However, due to their perfectly competitive framework, some important economic mechanisms (such as entry and exit of firms) related to pricing, market structure, and welfare are beyond the scope of these papers. Fieler (2007) modifies Eaton and Kortum (2002) by introducing non-homothetic preferences and technology distribution across sectors. This modification allows separating the effects of income per capita and country size on trade patterns.

The third group of papers deals with both monopolistic competition and non-homothetic preferences. Markusen (1986) extends the Krugman type model of trade with monopolistic competition by adding non-homothetic demand. He examines the role of income per capita in interindustry and intra-industry trade. Mitra and Trindade (2005) focus on the implications of asset inequality on trade flows and patterns. While they consider a model of monopolistic competition with non-homothetic preferences, the way they introduce non-homotheticity has the shortcoming that the share of income spent on a particular good is exogenous and depends on personal income. There are two papers written by Foellmi and Zweimueller that are similar to the closed economy case of the model presented in this paper. Foellmi and Zweimueller (2004) develop a general equilibrium model with an exogenous mass of identical firms. They show that, depending on the parameters of the model, an increase in income inequality has either no impact on firm mark-ups or increases them. In contrast, I consider heterogenous firms and free entry in the market, which in turn implies endogeneity of the mass of potential producers in equilibrium. Foellmi and Zweimueller (2006) examine a dynamic variation of Murphy, Shleifer, and Vishny (1989). Assuming learning by R&D, they focus their analysis on the link between possible growth and inequality. Finally, Tarasov (2007) considers the closed economy case of the model in the paper and studies the impact of income distribution on individual welfare, in particular, welfare of the poor.

The rest of the paper is organized as follows. Section 2 introduces the basic concepts for the closed economy case of the model. Section 3 extends the analysis to the open economy case with $N+1$ identical countries and derives the implications of globalization on prices, market structure, and consumer welfare. Section 4 concludes.

2 Closed Economy

In this section, I briefly describe the closed economy version of the model. The structure of the model is adopted from Tarasov (2007).

2.1 Production

The timing of the model is as follows: firms choose whether to incur sunk costs f_e or not. If a firm incurs the costs then it obtains a draw b of the valuation of its good from the distribution $G(b)$ on $[0, A]$. This captures the idea that before entry, firms do not know how well they will end up doing due to uncertainty in valuations of their products. I assume that $G'(b) = g(b)$ exists. The valuation b can be interpreted as the utility derived by consumers from the consumption of one unit of the good. Such differences between goods generate ex-post heterogeneity across firms. Depending on the valuation drawn, firms choose whether to leave the market or to stay. Firms that decide to stay engage in price competition with other firms. The only factor of production is labor. I assume that marginal cost of production is the same for all firms and equals to c, i.e., it takes c effective units of labor (which are paid a wage of unity) to produce a unit of any good.

Consumers differ in the number of efficiency units of labor they are endowed with. I assume that there are two types of consumers, indexed by L and H. A consumer of type $i \in \{L, H\}$ is endowed with I_i efficiency units of labor, and $I_H > I_L$. Let α_H be the fraction of type H consumers in the aggregate mass L of consumers. Thus, the total labor supply in the economy in efficiency units is $L(\alpha_H I_H + (1 - \alpha_H) I_L)$.

2.2 Consumption

All consumers have the same non-homothetic preferences given by utility function

$$U = \int_{\omega \in \Omega} b(\omega) x(\omega) d\omega, \tag{1}$$

where Ω is the set of available goods in the economy, $b(\omega)$ is the valuation of good ω, and $x(\omega) \in \{0, 1\}$ is the consumption of good ω. Each consumer owns a balanced portfolio of shares of all firms. To simplify the notation, I assume that consumers have equal shares of all firms[4]. This means that all consumers have the same wealth, while their labor incomes vary with their productivity. Let π be the total profits of all firms in the economy. For given prices, a type i consumer maximizes (1) subject to the budget constraint

$$\int_{\omega \in \Omega} p(\omega) x(\omega) d\omega \leq I_i + \frac{\pi}{L},$$

where $p(\omega)$ is the price of good ω. It is clear that utility maximization merely involves moving down the list of products ordered by their valuation to price ratio, $\frac{b(\omega)}{p(\omega)}$, until all income is exhausted.

2.3 Equilibrium

Given preferences, all goods consumed by less productive consumers are also consumed by more productive ones. Thus, goods in the economy can be divided into three groups: the "common" group includes goods that are consumed by both types of consumers; the "exclusive" group includes goods that are consumed by more productive type only; finally, there is the group of goods that are never consumed. Hereafter, by the rich and the poor, I mean consumers of type H and L, respectively.

A firm that produces a good ω obtains a profit of $(p(\omega) - c)Q(\omega)$, where $Q(\omega)$ is the demand for good ω. If all consumers buy the good then the demand is L. If only the rich buy it, the demand is $\alpha_H L$. Thus, $Q(\omega) \in \{L, \alpha_H L, 0\}$.

Each firm takes the valuation to price ratios of all other firms as given and maximizes its profit. The following proposition holds.

Proposition 1 *Even though all goods have different valuation to marginal cost ratios, goods from the same group have the same valuation to price ratio in the equilibrium.*

Proof. Suppose the opposite is true. Then, there exists some group, in which there are at least two goods with different $\frac{b(\omega)}{p(\omega)}$ ratios. Since both goods belong to the same group, the firm that produces

[4] Due to free entry, the total profits of all firms are equal to zero in the equilibrium. This implies that the value of any balanced portfolio is equal to zero.

its good with higher $\frac{b(\omega)}{p(\omega)}$ can raise its $p(\omega)$ without affecting the demand. This in turn would increase its profit. ■

Define V_C as the valuation to price ratio of goods from the "common" group and V_E as valuation to price ratio of goods from the "exclusive" group in the equilibrium. Here V_C and V_E are endogenous parameters and $V_C > V_E$ in the equilibrium[5]. Thus, if a firm with valuation $b(\omega)$ sells to all consumers then its price is equal to $\frac{b(\omega)}{V_C}$ and its profit is given by

$$(p(\omega) - c)\, L = \left(\frac{b(\omega)}{V_C} - c\right) L,$$

while if the firm sells only to the rich, its profit is given by

$$(p(\omega) - c)\alpha_H L = \left(\frac{b(\omega)}{V_E} - c\right) \alpha_H L.$$

As $V_C > V_E$, the firm chooses between selling to more people at a lower price and selling to fewer of them, but at a higher price. Hence, the firm chooses $p(\omega) \in \{\frac{b(\omega)}{V_C}, \frac{b(\omega)}{V_E}\}$ to maximize its profit, taking V_C and V_E as given. Note that in the equilibrium the price of good ω depends only on $b(\omega)$. Therefore, hereafter I omit the notation of ω and consider prices as a function of b.

Let b_M be the unique solution of the equation

$$\left(\frac{b}{V_C} - c\right) L = \left(\frac{b}{V_E} - c\right) \alpha_H L. \tag{2}$$

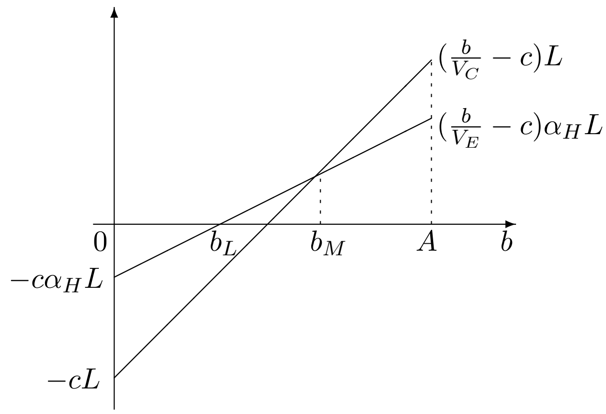
In the equilibrium, the condition $\frac{\alpha_H}{V_E} < \frac{1}{V_C}$ is satisfied (otherwise $\left(\frac{b}{V_E} - c\right) \alpha_H L > \left(\frac{b}{V_C} - c\right) L$ for any $b \geq 0$ and all firms would choose to sell only to high income consumers, which is impossible in the equilibrium). This condition guarantees that

$$\begin{aligned}
\left(\frac{b}{V_C} - c\right) L &\geq \left(\frac{b}{V_E} - c\right) \alpha_H L, \quad \text{if } b \geq b_M, \\
\left(\frac{b}{V_C} - c\right) L &< \left(\frac{b}{V_E} - c\right) \alpha_H L, \quad \text{otherwise.}
\end{aligned}$$

Thus, if a firm draws $b \geq b_M$ then in the equilibrium it sells to both types of consumers, otherwise it sells only to the rich or exits. A firm with valuation b_M of its good is indifferent between selling to all consumers or only to the rich (see *Figure 1*). Thus, even in the presence of market power, products have a natural hierarchy: consumers first buy goods with higher b. Notice that firms with valuations $b < b_L \equiv cV_E$ have to exit, otherwise they would have negative profits.

[5] Notice that by definition, $V_C \geq V_E$. Moreover, if $V_C = V_E$, then all available goods have the same valuation to price ratios. In this case, the equilibrium concept implies that the high income consumers buy all goods, while the poor buy only some part (for instance, this part can be randomly determined). This means that expected demand for a certain good is strictly less than L. Thus, firms can increase their profits by slightly decreasing their prices and acquiring greater demand share. Therefore, if $V_C = V_E$, equilibrium does not exist.

Figure 1: Profit Functions



Let M_e be the mass of firms that enter the market[6]. In the equilibrium, several conditions should be satisfied. First, due to free entry, the expected profits of firms have to be equal to zero. Second, the goods market clears. Since the poor consume only goods from the "common" group, the aggregate cost of the bundle of goods from the "common" group should be equal to the income of a poor consumer. Similarly, the aggregate cost of the bundle of all available goods in the economy should be equal to the income of a rich consumer.

Definition 1 *The equilibrium in the model is defined by the price function $p(b)$ on $b \geq b_L$, the cutoff level b_L, b_M, M_e, and the valuation to price ratios V_C and V_E such that*

1) The expected profits of firms are equal to zero;

2) The goods market clears.

Now I derive the equations that satisfy conditions mentioned above and prove that the equilibrium in the model always exists and is unique. Let $\pi(b)$ be the variable profit of a firm with valuation b. To find the equilibrium, I rewrite $\pi(b)$ and $p(b)$ as functions of b, b_L, b_M, and exogenous parameters. Recall that firms with valuation b_L have zero profits, i.e., $b_L = cV_E$ or $V_E = \frac{b_L}{c}$. From (2) one can easily find V_C as a function of b_L and b_M. Thus, the following lemma holds.

Lemma 1 *In equilibrium*

$$p(b) = \begin{cases} \frac{b}{V_C} = cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right), & \text{if } b \geq b_M, \\ \frac{b}{V_E} = cb\frac{1}{b_L}, & \text{if } b \in [b_L, b_M), \end{cases}$$

[6] One can think of M_e as that there are $M_e g(b)$ different firms with a particular valuation b.

$$\pi(b) = \begin{cases} \left(cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right) - c\right)L, & if \;\; b \geq b_M, \\ \left(cb\frac{1}{b_L} - c\right)\alpha_H L, & if \;\; b \in [b_L, b_M). \end{cases}$$

The ex-ante profits of firms are equal to zero in the equilibrium. Using the results from *Lemma 1* and taking into account that firms with $b < b_L$ exit, I obtain

$$\begin{aligned} f_e &= (1 - G(b_M))\left(\int_{b_M}^{A}\left(ct\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right) - c\right)LdG_1(t)\right) \\ &\quad + (G(b_M) - G(b_L))\left(\int_{b_L}^{b_M}\left(ct\frac{1}{b_L} - c\right)\alpha_H LdG_2(t)\right), \end{aligned}$$

where $G_1(t) = \frac{G(t)}{1-G(b_M)}$ and $G_2(t) = \frac{G(t)}{G(b_M)-G(b_L)}$. This equation can be rewritten as follows:

$$\frac{f_e}{cL} + 1 = \alpha_H H(b_L) + (1-\alpha_H)H(b_M), \tag{3}$$

where $H(x) = G(x) + \frac{\int_x^A tdG(t)}{x}$. The goods market clearing condition implies that

$$\begin{cases} I_L + \frac{\pi}{L} = M_e \int_{b_M}^{A} p(t)dG(t), \\ I_H + \frac{\pi}{L} = M_e \int_{b_L}^{A} p(t)dG(t). \end{cases} \tag{4}$$

At the same time, free entry in the market means that $\pi = 0$. Thus, dividing the second line by the first one and using *Lemma 1*, I obtain

$$\frac{\int_{b_L}^{b_M} tdG(t)}{\int_{b_M}^{A} tdG(t)} = \left(\frac{I_H}{I_L} - 1\right)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right).$$

Hence, given the exogenous parameters I_H, I_L, α_H, f_e, c, L, and the distribution of draws $G(\cdot)$, one can find endogenous b_M and b_L from the system of equations:

$$\begin{cases} \frac{\int_{b_L}^{b_M} tdG(t)}{\int_{b_M}^{A} tdG(t)} = \left(\frac{I_H}{I_L} - 1\right)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right), \\ \frac{f_e}{cL} + 1 = \alpha_H H(b_L) + (1-\alpha_H)H(b_M). \end{cases} \tag{5}$$

The detailed analysis of the existence and uniqueness of the equilibrium and comparative statics is presented in Tarasov (2007).

3 Open Economy

In this section, I analyze the open economy extension of the model. I assume that there are $N + 1$ symmetric countries, i.e., every country has $N \geq 1$ trade partners. The symmetry assumption leads to the same wage across countries, which is normalized to unity. I assume that markets are segmented. There is an iceberg transportation costs $\tau \geq 1$ of serving a foreign market[7]. The presence of transportation costs implies that there are firms that serve only their domestic market. Thus, given the valuation b of its good, a firm has three options: to exit, to serve only its domestic market, or to serve all existing markets. To simplify the model, I assume that there are no fixed costs of exporting.

3.1 Equilibrium

Let $\pi_D(b) \geq 0$ and $\pi_F(b) \geq 0$ be the variable profits of a firm with valuation b from selling at home and at a foreign country, respectively. Then, as there are N trade partners,

$$\pi(b) = \begin{cases} 0, & \text{if the firm exits,} \\ \pi_D(b), & \text{if the firm serves only domestic market,} \\ \pi_D(b) + N\pi_F(b), & \text{if the firm serves all existing markets.} \end{cases}$$

In every country the existing goods are divided into three groups: the "common" group, the "exclusive" group, and the "no one" group. Because the markets are segmented, valuation to price ratios of goods from the same group are the same. Define V_C^i and V_E^i as valuation to price ratios of goods from the "common" and "exclusive" groups in country i, respectively. As all countries are identical, $V_C^i = V_C$ and $V_E^i = V_E$ for all $i = 1..N+1$. From *Figure 2*, one can see that

$$\pi_D(b) = \begin{cases} \left(\frac{b}{V_C} - c\right) L, & \text{if } b \geq b_M, \\ \left(\frac{b}{V_E} - c\right) \alpha_H L, & \text{if } b \in [b_L, b_M), \end{cases}$$

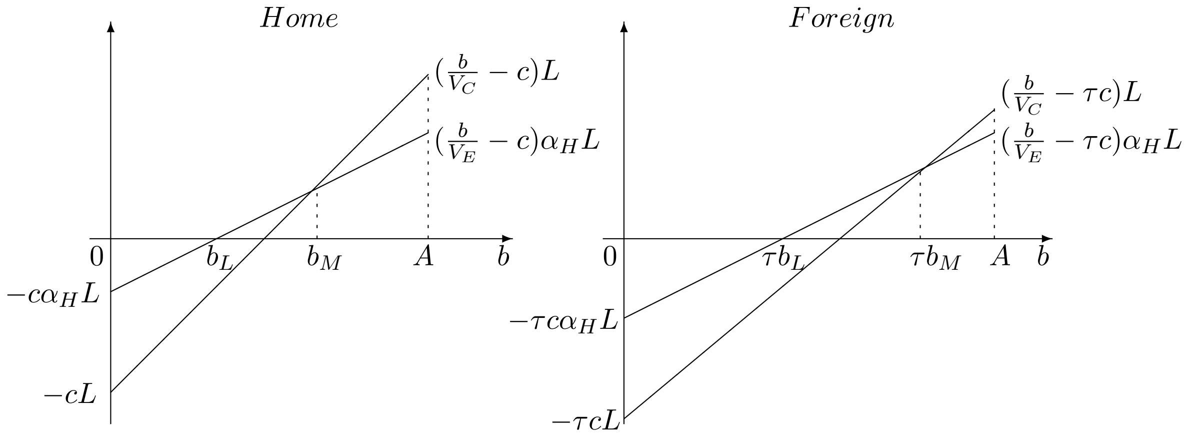
where b_M solves $\frac{b}{V_C} - c = \left(\frac{b}{V_E} - c\right) \alpha_H$ and $b_L = cV_E$. Similarly, since the markets are segmented,

$$\pi_F(b) = \begin{cases} \left(\frac{b}{V_C} - \tau c\right) L, & \text{if } b \geq b_M^*, \\ \left(\frac{b}{V_E} - \tau c\right) \alpha_H L, & \text{if } b \in [b_L^*, b_M^*), \end{cases}$$

where b_M^* solves $\frac{b}{V_C} - \tau c = \left(\frac{b}{V_E} - \tau c\right) \alpha_H$ and $b_L^* = \tau c V_E$. Obviously, $b_M^* = \tau b_M$ and $b_L^* = \tau b_L$. Thus, firms with $b < b_L$ exit, firms with $b \in [b_L, \tau b_L)$ serve only domestic market, and firms with $b \geq \tau b_L$ sell to all existing markets. Due to transportation costs, there are goods in every country, which are available to consumers of type i at home but not available to consumers of the same type abroad. For instance, goods with valuations $b \in [b_M, \tau b_M)$ are sold to everybody at home but exported only to the rich at the foreign countries. Hence, the model provides a clear intuition why some imported goods are available to the rich and not available to the poor.

[7] In the analysis below, to avoid the possibility of arbitrage opportunities that can arise due to market segmentation, I assume that τ is sufficiently high.

Figure 2: Profit Functions: Open Economy



If transportation costs τ are such that $\tau b_M \geq A$ in the equilibrium then in every country only the rich consume imported goods[8]. Moreover, given sufficiently high transportation costs[9], there is no trade among the countries. Hereafter, I assume that all consumers can afford to buy imported goods, i.e., τ is not so high and $\tau b_M < A$ in the equilibrium.

Let M_e^i be the mass of firms entering the market in country i. Due to the symmetry assumption, $M_e^i = M_e$ for any $i = 1..N+1$. Let $p_D(b)$ and $p_F(b)$ be the prices of goods with valuation b charged to the consumers at home and abroad, respectively. Notice that $p_D(b)$ is not necessarily equal to $p_F(b)$, since the markets are segmented.

Definition 2 *The equilibrium in the model is defined by the price functions $p_D(b)$ and $p_F(b)$ on $b \geq b_L$ and $b \geq \tau b_L$, respectively, the cutoff level b_L, b_M, M_e, and the valuation to price ratios V_C and V_E such that*

1) The expected profits of firms in every country are equal to zero;

2) The goods markets clear in every country.

As in the closed economy case, to find the equilibrium, I rewrite $\pi_D(b)$, $\pi_F(b)$, $p_D(b)$, and $p_F(b)$ as functions of b, b_L, b_M and exogenous parameters. The following lemma holds.

Lemma 2 *In the equilibrium*

[8] I will show later that this case ($\tau b_M \geq A$) is possible in general.

[9] τ is such that $\tau b_L > A$.

$$p_D(b) = \begin{cases} \frac{b}{V_C} = cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right), & \text{if } b \geq b_M, \\ \frac{b}{V_E} = cb\frac{1}{b_L}, & \text{if } b \in [b_L, b_M), \end{cases}$$

$$p_F(b) = \begin{cases} \frac{b}{V_C} = cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right), & \text{if } b \geq \tau b_M, \\ \frac{b}{V_E} = cb\frac{1}{b_L}, & \text{if } b \in [\tau b_L, \tau b_M), \end{cases}$$

$$\pi_D(b) = \begin{cases} \left(cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right) - c\right)L, & \text{if } b \geq b_M, \\ \left(cb\frac{1}{b_L} - c\right)\alpha_H L, & \text{if } b \in [b_L, b_M), \end{cases}$$

$$\pi_F(b) = \begin{cases} \left(cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right) - \tau c\right)L, & \text{if } b \geq \tau b_M, \\ \left(cb\frac{1}{b_L} - \tau c\right)\alpha_H L, & \text{if } b \in [\tau b_L, \tau b_M). \end{cases}$$

Lemma 2 implies that the prices of goods with relatively high and low valuations[10] are the same at home and abroad, i.e., $p_D(b) = p_F(b)$. Hence, firms that produce these goods receive the same revenues from exporting to a foreign country as from selling at home, but due to the presence of transportation costs the profits are lower[11]. Firms that produce goods with valuation $b \in [b_M, \tau b_M)$ sell to all consumers at home, but only to the rich at the foreign countries. For these goods,

$$\begin{aligned} p_D(b) &= cb\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right), \\ p_F(b) &= cb\frac{1}{b_L}, \end{aligned}$$

i.e., $p_F(b) > p_D(b)$. However, due to differences in quantities demanded and transportation costs, these firms have higher revenues from selling at home than from exporting to a foreign country.

What about arbitrage opportunities? No arbitrage condition means that it is not profitable for the third party to buy a good in one country and resell it in another one, i.e., $p_D(b)$ should be less or equal than $\tau p_F(b)$ and greater or equal than $\frac{p_F(b)}{\tau}$. In our case, no arbitrage condition holds for goods with $b \in [\tau b_L, b_M) \cup [\tau b_M, A]$ and does not necessarily hold for goods with $b \in [b_M, \tau b_M)$, since for these goods, $p_F(b) > p_D(b)$ for any $\tau > 1$. No arbitrage condition for the goods with $b \in [b_M, \tau b_M)$ is given by $\frac{p_F(b)}{p_D(b)} \leq \tau$. Recall that these goods are sold to all consumers at home, but only to the rich abroad. Given the assumption about market segmentation, $\frac{p_F(b)}{p_D(b)}$ positively depends on the relative income of the rich with respect to the poor $\frac{I_H}{I_L}$ (see details in Tarasov (2007)). Thus, for some values of $\frac{I_H}{I_L}$ and τ, it might be the case that $\frac{p_F(b)}{p_D(b)} > \tau$ implying arbitrage opportunities for the set of goods considered above. In detail,

$$\frac{p_F(b)}{p_D(b)} \leq \tau \iff \tau\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right) \geq \frac{1}{b_L} \iff \frac{b_L}{b_M} \geq \frac{1-\alpha_H\tau}{(1-\alpha_H)\tau}. \tag{6}$$

[10] That is, goods with $b \in [\tau b_L, b_M) \cup [\tau b_M, A]$.

[11] Here the symmetry assumption matters. In general, V_C^i and V_E^i can differ across countries. This in turn may result in the different home and foreign prices of any particular good.

Recall that $\frac{b_L}{b_M}$ is always strictly less than one. Thus, if transportation costs are sufficiently low: τ is close to one, then $\frac{b_L}{b_M} < \frac{1-\alpha_H \tau}{(1-\alpha_H)\tau}$. At the same time, $\frac{1-\alpha_H \tau}{(1-\alpha_H)\tau}$ is decreasing in τ and equal to zero at $\tau = \frac{1}{\alpha_H}$, and as I will show later, $\left(\frac{b_L}{b_M}\right)'_\tau > 0$. This implies that there exists τ^* such that for $\tau \geq \tau^*$, inequality (6) holds. In the subsequent analysis, I assume that $\tau \geq \tau^*$ and $\tau^* b_M(\tau^*) < A$[12].

In the next section, I derive equilibrium conditions and show the existence and uniqueness of the equilibrium in the model.

3.1.1 Equilibrium Conditions

The ex-ante profits of firms is equal to zero in the equilibrium. This can be written as follows:

$$f_e = E\left(\pi_D(b)|b \geq b_L\right) + NE\left(\pi_F(b)|b \geq \tau b_L\right).$$

Using the results from *Lemma 2*, I obtain

$$\begin{aligned} f_e \;=\; & (1-G(b_M))\left(\int_{b_M}^{A}\left(ct\left(\frac{\alpha_H}{b_L}+\frac{(1-\alpha_H)}{b_M}\right)-c\right)LdG_1(t)\right) \\ & +(G(b_M)-G(b_L))\left(\int_{b_L}^{b_M}\left(ct\frac{1}{b_L}-c\right)\alpha_H LdG_2(t)\right) \\ & +N(1-G(\tau b_M))\left(\int_{\tau b_M}^{A}\left(ct\left(\frac{\alpha_H}{b_L}+\frac{(1-\alpha_H)}{b_M}\right)-\tau c\right)LdG_3(t)\right) \\ & +N(G(\tau b_M)-G(\tau b_L))\left(\int_{\tau b_L}^{\tau b_M}\left(ct\frac{1}{b_L}-\tau c\right)\alpha_H LdG_4(t)\right), \end{aligned}$$

where $G_1(t) = \frac{G(t)}{1-G(b_M)}$, $G_2(t) = \frac{G(t)}{G(b_M)-G(b_L)}$, $G_3(t) = \frac{G(t)}{1-G(\tau b_M)}$, and $G_4(t) = \frac{G(t)}{G(\tau b_M)-G(\tau b_L)}$. Simple algebra shows that this equation can be rewritten as follows:

$$\frac{f_e}{cL} + 1 + N\tau = \alpha_H\left(H(b_L) + N\tau H(\tau b_L)\right) + (1-\alpha_H)\left(H(b_M) + N\tau H(\tau b_M)\right),$$

where $H(x) = G(x) + \frac{\int_x^A t dG(t)}{x}$.

The goods market clearing condition implies that

$$\begin{cases} I_L + \frac{\pi}{L} = M_e\left(\int_{b_M}^{A} p_D(t)dG(t) + N\int_{\tau b_M}^{A} p_F(t)dG(t)\right), \\ I_H + \frac{\pi}{L} = M_e\left(\int_{b_L}^{A} p_D(t)dG(t) + N\int_{\tau b_L}^{A} p_F(t)dG(t)\right). \end{cases} \tag{7}$$

[12] Notice that τ^* is strictly less than $\frac{1}{\alpha_H}$. To give a reader an idea about the possible values of τ^*, I consider the following numerical exercise. I take $\frac{L}{f_e} = c = 1$, $\alpha_H = 0.45$, $\frac{I_H}{I_L} = 3$, $N = 10$, and $G(b) = b$ on $[0, 1]$. As a range for τ, I take an interval $(1, \frac{1}{\alpha_H})$ with step 0.03. That is, $\tau = 1.03$, 1.06 and so on. For any τ from the range and the other parameters, I find the equilibrium values of b_L and b_M. Recall that τ^* can be found from $\frac{b_L(\tau^*)}{b_M(\tau^*)} = \frac{1-\alpha_H\tau^*}{(1-\alpha_H)\tau^*}$. Given the values of the exogenous parameters considered above, $\tau^* \approx 1.24$. Moreover, changes in $\frac{L}{f_e}$, c, and N do not significantly alter τ^*. Thus, the assumption that $\tau \geq \tau^*$ is not so strong.

Recall that free entry in the market means that $\pi = 0$. Thus, dividing the second line by the first one and using *Lemma 2*, I obtain

$$\frac{\int_{b_L}^{b_M} tdG(t) + N\int_{\tau b_L}^{\tau b_M} tdG(t)}{\int_{b_M}^{A} tdG(t) + N\int_{\tau b_M}^{A} tdG(t)} = \left(\frac{I_H}{I_L} - 1\right)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right).$$

Hence, given the exogenous parameters I_H, I_L, α_H, f_e, c, L, τ, N, and the distribution of draws $G(\cdot)$, one can find endogenous b_M and b_L from the following system of equations:

$$\begin{cases} \frac{\int_{b_L}^{b_M} tdG(t)+N\int_{\tau b_L}^{\tau b_M} tdG(t)}{\int_{b_M}^{A} tdG(t)+N\int_{\tau b_M}^{A} tdG(t)} = \left(\frac{I_H}{I_L} - 1\right)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right), \\ \frac{f_e}{cL} + 1 + N\tau = \alpha_H\left(H(b_L) + N\tau H(\tau b_L)\right) + (1-\alpha_H)\left(H(b_M) + N\tau H(\tau b_M)\right). \end{cases} \quad (8)$$

Using the same technique as in Tarasov (2007), it is possible to prove the existence and uniqueness of the equilibrium. Once b_M and b_L are found, V_C and V_E can be derived from *Lemma 2.* Finally, the mass of firms entering the market, M_e, can be found from (7).

Before describing the comparative statics of the model, I look at consumer welfare.

3.2 Welfare

Welfare of a poor consumer is equal to $M_e\left(\int_{b_M}^{A} tdG(t) + N\int_{\tau b_M}^{A} tdG(t)\right)$. At the same time, from (7) $M_e = \frac{I_L}{\int_{b_M}^{A} p_D(t)dG(t)+N\int_{\tau b_M}^{A} p_F(t)dG(t)}$. This implies that

$$W_p = I_L V_C.$$

Welfare of a poor consumer naturally rises with an increase in either her income or the valuation to price ratio of goods she consumes. Similarly, welfare of a rich consumer is given by

$$W_r = I_L V_C + (I_H - I_L)V_E.$$

As the rich consume the same bundle of goods as the poor plus some others, welfare of the rich is equal to welfare of the poor plus additional welfare from consumption of goods from the "exclusive" group, which is in turn equal to income spent on these goods multiplied by their valuation to price ratio. Aggregate welfare per capita, W_a, is equal to $(1-\alpha_H)W_p + \alpha_H W_r$, which is equivalent to

$$W_a = I_L V_C + \alpha_H(I_H - I_L)V_E.$$

Finally, relative welfare of the rich with respect to the poor is given by

$$\frac{W_r}{W_p} = 1 + \left(\frac{I_H}{I_L} - 1\right)\frac{V_E}{V_C} = 1 + \frac{I_H - I_L}{I_L}\left(\alpha_H + (1-\alpha_H)\frac{b_L}{b_M}\right).$$

Given changes in τ or N, $\frac{W_r}{W_p}$ moves in the same direction as $\frac{b_L}{b_M}$ does.

Notice that all changes in individual welfare can be decomposed into two components: an income effect and a price effect. The price effect is determined by changes in V_C and V_E, which depend on the level of competition within the groups of goods. The income effect is determined by changes in exogenous I_C and I_R.

In the next section, I investigate the effects of the changes in the level of globalization, which are caused by changes in τ and N, on the market structure, trade patterns, and individual welfare in a country.

3.3 Comparative Statics

One of the main goals of this section is to analyze the relationship between globalization and relative welfare of the rich with respect to the poor $\frac{W_r}{W_p}$. Recall that any changes in τ and N affect $\frac{W_r}{W_p}$ through $\frac{b_L}{b_M}$. Hence, to examine the impact of changes in τ and N on $\frac{W_r}{W_p}$, it is sufficient to determine the signs of $\left(\frac{b_L}{b_M}\right)'_\tau$ and $\left(\frac{b_L}{b_M}\right)'_N$. In general, the signs of $\left(\frac{b_L}{b_M}\right)'_\tau$ and $\left(\frac{b_L}{b_M}\right)'_N$ depend on the exogenous parameters of the model and can go in either direction. To avoid the ambiguity in the signs, I limit the analysis of the comparative statics to the case when the distribution of draws $G(b)$ is such that $b^2 g(b)$ is increasing and convex in b[13]. The last condition has a strong economic interpretation. It implies that $g(b)$ does not decrease too fast, i.e., the probability of getting higher values of b does not decrease too fast with b. Moreover, the aggregate utility from the consumption of goods with a particular valuation b is equal to $M_e g(b) b$. Thus, the condition also guarantees that the aggregate utility from the consumption of more valuable goods does not decrease too fast. The convexity of $b^2 g(b)$ is rather a technical condition: it helps to simplify some proofs.

To better understand the intuition, which is behind the changes in τ and N, I separately consider two submarkets: the submarket for goods from the "common" group and the submarket for goods from the "exclusive" group. Each of these submarkets is characterized by its equilibrium valuation to price ratio: V_C and V_E. Since the poor consume only goods from the "common" group, changes in τ and N affect their welfare through changes in V_C, whereas welfare of the rich is affected by changes in both V_C and V_E, as the rich consume all available goods.

One can think of V_C and V_E as some measures of the level of competition in the submarkets. The higher the level of competition is in the submarket for "common" goods or for "exclusive" goods, the higher is V_C or V_E. Changes in τ and N induce some firms to exit and some firms to enter a certain submarket. If firms exit then the level of competition decreases, while if firms enter the level of competition rises. Thus, the impact of changes in τ and N can be divided into two effects: "exiting"

[13] For instance, the set of power distributions with $G(b) = \left(\frac{b}{A}\right)^k$, $k > 0$, satisfies this assumption.

and "entering" effects. In the next subsections, the intuition is built on these two effects.

3.3.1 Changes in Transportation Costs

First, I discuss the consequences of changes in transportation costs. Consider the impact of higher transportation costs τ on the submarket for goods from the "common" group. Higher transportation costs lead to exit of some importing firms from the submarket (the "exiting" effect). As a result, τb_M increases. Due to lower competition, firms that stay increase their prices. Some domestic firms that used to sell their goods only to rich consumers now find it more profitable to sell to all consumers (the "entering" effect). This leads to a decrease in b_M. In the short run, the "exiting" effect dominates the "entering" one[14]. To analyze the long run effect, one needs to take into account changes in M_e. On the one hand, an increase in τ reduces the profits from exporting. On the other hand, an increase in τ can raise the profits from selling domestically due to lower competition. The overall effect on the expected profits and, therefore, on M_e is ambiguous. I show that, whatever changes in M_e are, τb_M rises, b_M falls, and the "exiting" effect still dominates the "entering" effect in the long run. Thus, an increase in τ results in lower level of competition in the submarket for goods from the "common" group.

A quite different situation is observed in the submarket for goods from the "exclusive" group. Again, higher transportation costs lead to the exit of some importers from the submarket: τb_L increases. Moreover, some domestic firms move to the submarket for the goods from the "common" group. These two effects result in lower competition. At the same time, higher transportation costs imply that some importing firms that sold their goods to all consumers now find it more profitable to sell only to the rich. These firms in turn induce tougher competition. In this case, it is unclear which effect ("exiting" or "entering") is stronger. Thus, the impact of an increase in τ on b_L and, hence, on the price level in the submarket might be ambiguous both in short and long run cases. The following lemma summarizes the findings above.

Lemma 3 *In the long run, higher transportation costs raise τb_L and τb_M, decrease b_M, and have an ambiguous impact on b_L.*

Proof. The proof is in Part A of the Appendix. ■

Recall that $\frac{W_r}{W_p} = 1 + \left(\frac{I_H}{I_L} - 1\right)\frac{V_E}{V_C}$. Since the "exiting" effect is stronger than the "entering" effect in the submarket for "common" goods, the prices in the submarket rise, reducing V_C. At the same

[14] By the short run, I mean the case when the number of entrants M_e is fixed and not affected by the changes in transportation costs, while in the long run, M_e changes.

time, the impact of an increase in τ on b_L and, thereby, on V_E is ambiguous[15]. In the Appendix, I show that depending on the exogenous parameters, V_E can either increase or decrease. I prove that an increase in τ raises the ratio $\frac{V_E}{V_C}$, i.e., the rich lose less from higher transportation costs than the poor (or the poor gain more from trade liberalization than the rich)[16].

Remember that I consider the case when $\tau b_M < A$, that is, transportation costs are not significantly high. However, if $\tau b_M \geq A$ in the equilibrium then the rich gain more than the poor from trade liberalization. The intuition is quite straightforward. If $\tau b_M \geq A$ then the poor do not consume imported goods at all. Therefore, trade liberalization does not have a direct impact on their welfare. The following proposition summarizes the above results.

Proposition 2 *If transportation costs are low enough (high enough) then the poor gain more (less) from trade liberalization than the rich.*

Proof. The proof is in Parts A and B of the Appendix. ■

Thus, relative welfare of the rich with respect to the poor has an inverted U shape as a function of transportation costs.

3.3.2 Changes in the Number of Trading Partners

In this section, I turn to analyzing the effects of changes in the number of trading partners. An increase in the number of trading partners N leads to higher competition in both submarkets. As a result, some domestic and importing firms leave the submarkets, and in the short run, b_L and b_M rise. Firms that leave the submarket for the "common" goods enter the submarket for the "exclusive"

[15] Recall that $V_E = \frac{b_L}{c}$.

[16] Since the "exiting" effect dominates the "entering" effect in the submarket for goods from the "common" group, welfare of the poor falls. As the rich consume goods from both groups and the impact of higher transportation cost on the submarket for "exclusive" goods is ambiguous, the impact of an increase in τ on welfare of the rich is ambiguous: the rich may gain from an increase in τ. Thus, trade liberalization results in higher welfare of the poor and may result in either higher or lower welfare of the rich. I also show that trade liberalization positively affects aggregate welfare per capita in the economy.

In what cases does welfare of the rich decrease or increase? In the Appendix, I demonstrate that if the fraction of the rich is high enough or the income of the rich is close to that of the poor then given an increase in τ, b_L is likely to fall and welfare of the rich decreases. While if the fraction of the rich is close to zero and the income difference between the rich and the poor is high enough, then b_L is more likely to rise and welfare of the rich may increase. The intuition is as follows. Recall that $\frac{V_E}{V_C} = \alpha_H + \frac{b_L(1-\alpha_H)}{b_M}$. Thus, if α_H or $\frac{I_H}{I_L}$ is close to one, then $\frac{V_E}{V_C}$ is close to one. That is, there is no much difference between selling only to the rich and selling to everybody. In this case, the "exiting" effect dominates the "entering" effect and welfare of the rich decreases. While if α_H is close to zero and $\frac{I_H}{I_L}$ is high enough, then the difference between selling only to the rich and selling to everybody is significant and the "entering" effect prevails the "exiting" one. Welfare of the rich may increase. See the proofs in Part A of the Appendix.

In traditional literature, for instance, in Melitz (2003), bilateral trade liberalization is beneficial for all consumers. In this paper, I show that it is not necessarily the case. While the whole economy benefits from lower transportation costs, the rich consumers may be worse off from trade liberalization. Moreover, lower transportation costs have different impacts on firm mark-ups. After bilateral trade liberalization mark-ups of some firms may rise, while in traditional literature mark-ups of all firms stay the same or fall.

goods. This additional "entering" effect induces even higher competition in this submarket raising b_L. Thus, one can expect that in the short run, b_L increases by more than b_M, that is, $\frac{b_L}{b_M}$ rises. In the long run, the impact of an increase in N on b_L and b_M also depends on changes in M_e: lower entry causes b_L and b_M to fall. On the one hand, higher N implies that firms import their goods to more markets than before; this raises the profits of importing firms and results in higher M_e. On the other hand, higher N intensifies competition in each market and, consequently, reduces the profits. This in turn results in lower entry rate. A number of simulations I conduct for a wide range of parameters shows that M_e falls, while NM_e rises[17]. I demonstrate that in the long run, b_L keeps increasing, while b_M may either rise or fall. A possible fall in b_M is caused by a decrease in M_e. Finally, $\frac{b_L}{b_M}$ also rises in the long run. The following lemma summarizes the results above.

Lemma 4 *In the long run, a higher number of trading partners raises b_L and $\frac{b_L}{b_M}$, and has an ambiguous impact on b_M.*

Proof. The proof is in Part A of the Appendix. ■

Remember that $\frac{W_r}{W_p} = 1 + \frac{I_H - I_L}{I_L}\left(\alpha_H + (1-\alpha_H)\frac{b_L}{b_M}\right)$. Given an increase in N, $\frac{b_L}{b_M}$ and, thereby, $\frac{W_r}{W_p}$ increase. Thus, if $\tau b_M < A$ in the equilibrium then the rich gain more from a rise in the number of trading partners than the poor. The main reason for this result is that firms that leave the submarket for the "common" goods enter the submarket for the "exclusive" goods inducing tougher competition and lower prices. If transportation costs are high enough and $\tau b_M \geq A$ in the equilibrium then again, the rich gain more than the poor. The intuition is exactly the same as in the case with an increase in τ. The following proposition formulates these findings.

Proposition 3 *For any transportation costs the rich gain more than the poor from an increase in the number of trading partners.*

Proof. The part of the proof follows from *Lemma 4* and the rest of the proof is in Part B of the Appendix. ■

4 Conclusion

In the present paper, I construct a general equilibrium trade model of monopolistic competition with heterogenous firms and consumers, which establishes a link between different components of globalization and welfare inequality through the consumption channel. The model is based on two key assumptions: imperfect competition and non-homothetic preferences. Given these assumptions, the

[17] It is rather complicated to show analytically that M_e falls and NM_e rises.

model allows to analyze the impact of globalization on mark-ups charged on different goods and on the welfare of different groups of consumers. The main analysis is focused on the case with two types of consumers: rich and poor.

I argue that the impact of globalization on relative welfare of the rich with respect to the poor depends on the component of globalization considered. Changes in relative welfare of the rich are determined by changes in the relative prices of "exclusive" goods (consumed only by the rich) with respect to "common" goods (consumed by everybody). These relative prices in turn depend on the level of competition inside the submarkets for "exclusive" and "common" goods. Due to non-homothetic preferences, greater globalization affects the submarkets differently, therefore, changing relative welfare. I show that while the rich always gain more from a rise in the number of trading partners than the poor, the impact of trade liberalization on relative welfare depends on transportation costs. If transportation costs are low enough then the poor compared to the rich gain more out of trade liberalization; otherwise, the opposite is true. I also show that depending on the exogenous parameters of the model, the rich may be even worse off from trade liberalization, while welfare of the poor and the aggregate welfare rise.

I would like to mention two plausible ways, which allow extending the present model. First, it would be interesting to consider a similar model of trade between two countries with different income distributions and examine the way this difference affects the distribution of gains from greater globalization across the countries. Second, it might be sensible to develop a model where income distribution is endogenous and, for instance, influenced by the level of openness. These issues are left for future research.

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5 Appendix

In this Appendix, I determine the effects of changes in τ and N on the endogenous parameters of the model such as b_L, b_M, $\frac{b_L}{b_M}$, and consumer welfare. Therefore, the algebra in the Appendix is mainly based on the differentiation of implicit functions. As the intuition of this exercise (the differentiation of implicit functions) is straightforward, I present only the most important details and omit unnecessary ones.

In this section, I introduce a simplifying notation: $\int_x^y$ means $\int_x^y t dG(t)$.

5.1 Part A

Let

$$J_1 = \alpha_H \left(H(b_L) + N\tau H(\tau b_L)\right) + (1-\alpha_H)\left(H(b_M) + N\tau H(\tau b_M)\right) - \frac{f_e}{cL} - 1 - N\tau \quad (9)$$

$$J_2 = I_L \left(\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}\right) - (I_H - I_L)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right)\left(\int_{b_M}^{A} + N\int_{\tau b_M}^{A}\right). \quad (10)$$

Then, simple algebra shows[18]

$$\frac{\partial J_1}{\partial b_M} = -\frac{(1-\alpha_H)}{b_M^2}\left(\int_{b_M}^{A} + N\int_{\tau b_M}^{A}\right) < 0,\ \frac{\partial J_1}{\partial b_L} = -\frac{\alpha_H}{b_L^2}\left(\int_{b_L}^{A} + N\int_{\tau b_L}^{A}\right) < 0,$$

$$\frac{\partial J_1}{\partial \tau} = N\left(\alpha_H G(\tau b_L) + (1-\alpha_H)G(\tau b_M) - 1\right) < 0,\ \frac{\partial J_1}{\partial N} = \tau\left(\alpha_H H(\tau b_L) + (1-\alpha_H)H(\tau b_M) - 1\right) > 0,$$

$$\frac{\partial J_2}{\partial b_M} = I_L b_M\left(g(b_M) + N\tau^2 g(\tau b_M)\right)\left(\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\right) + I_L\frac{b_L(1-\alpha_H)}{b_M^2}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} > 0,$$

$$\frac{\partial J_2}{\partial b_L} = -I_L b_L\left(g(b_L) + N\tau^2 g(\tau b_L)\right) - I_L\frac{(1-\alpha_H)}{b_M}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} < 0,$$

$$\frac{\partial J_2}{\partial \tau} = I_L N\tau\left(b_M^2 g(\tau b_M)\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}} - b_L^2 g(\tau b_L)\right) > 0,\ \frac{\partial J_2}{\partial N} = I_L\left(\frac{\int_{\tau b_L}^{\tau b_M}\int_{b_M}^{A} - \int_{b_L}^{b_M}\int_{\tau b_M}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\right) > 0.$$

5.1.1 Changes in Transportation Costs

From (9) and (10),

$$\frac{\partial J_1}{\partial b_M}\frac{\partial b_M}{\partial \tau} + \frac{\partial J_1}{\partial b_L}\frac{\partial b_L}{\partial \tau} = -\frac{\partial J_1}{\partial \tau} \text{ and } \frac{\partial J_2}{\partial b_M}\frac{\partial b_M}{\partial \tau} + \frac{\partial J_2}{\partial b_L}\frac{\partial b_L}{\partial \tau} = -\frac{\partial J_2}{\partial \tau}.$$

Define D as $\frac{\partial J_1}{\partial b_M}\frac{\partial J_2}{\partial b_L} - \frac{\partial J_2}{\partial b_M}\frac{\partial J_1}{\partial b_L}$. Notice that $D > 0$. Then,

$$\frac{\partial b_M}{\partial \tau} = \frac{-\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_L}}{D} \text{ and } \frac{\partial b_L}{\partial \tau} = \frac{-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M}}{D}.$$

[18] Remember that $b^2 g(b)$ is increasing in b.

Proof of Lemma 3 Consider $(\tau b_M)'_\tau = b_M + \tau \frac{\partial b_M}{\partial \tau}$. This can be rewritten as

$$(\tau b_M)'_\tau = \frac{b_M D + \tau \left(-\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_L} \right)}{D}.$$

Since $D > 0$, one needs to determine the sign of the numerator:

$$b_M D + \tau \left(-\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_L} \right) = \frac{\partial J_2}{\partial b_L}\left(b_M \frac{\partial J_1}{\partial b_M} - \tau \frac{\partial J_1}{\partial \tau} \right) + \frac{\partial J_1}{\partial b_L}\left(\tau \frac{\partial J_2}{\partial \tau} - b_M \frac{\partial J_2}{\partial b_M} \right).$$

Using the expressions for $\frac{\partial J_i}{\partial b_L}$, $\frac{\partial J_i}{\partial b_M}$, and $\frac{\partial J_i}{\partial \tau}$, it is possible to show

$$\begin{aligned} b_M \frac{\partial J_1}{\partial b_M} - \tau \frac{\partial J_1}{\partial \tau} &= -(1-\alpha_H)\left(N\tau H(\tau b_M) + \frac{\int_{b_M}^A}{b_M} \right) + N\tau\left(1 - \alpha_H G(\tau b_L)\right), \\ \tau \frac{\partial J_2}{\partial \tau} - b_M \frac{\partial J_2}{\partial b_M} &= -I_L \left(N\tau^2 b_L^2 g(\tau b_L) + b_M^2 g(b_M) \left(\frac{\int_{b_L}^A + N \int_{\tau b_L}^A}{\int_{b_M}^A + N \int_{\tau b_M}^A} \right) + \frac{b_L(1-\alpha_H)}{b_M} \frac{\int_{b_L}^{b_M} + N \int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} \right). \end{aligned}$$

Plugging this into the numerator and using the expressions for $\frac{\partial J_1}{\partial b_L}$ and $\frac{\partial J_2}{\partial b_L}$, I obtain that the numerator is equal to

$$\begin{aligned} & I_L \frac{(1-\alpha_H)}{b_M} \frac{\int_{b_L}^{b_M} + N \int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} \left(\frac{\alpha_H \int_{b_L}^A}{b_L} + \frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + N\tau\left(\alpha_H H(\tau b_L) + (1-\alpha_H) H(\tau b_M) - 1\right) \right) \\ & + I_L N \tau^2 b_L g(\tau b_L) \left(\frac{\alpha_H \int_{b_L}^A}{b_L} + \frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + N\tau\left(\alpha_H H(\tau b_L) + (1-\alpha_H) H(\tau b_M) - 1\right) \right) \\ & + I_L \frac{\alpha_H b_M^2 g(b_M)}{b_L^2} \frac{\left(\int_{b_L}^A + N \int_{\tau b_L}^A \right)^2}{\int_{b_M}^A + N \int_{\tau b_M}^A} - I_L b_L g(b_L) \left(-(1-\alpha_H)\left(N\tau H(\tau b_M) + \frac{\int_{b_M}^A}{b_M} \right) + N\tau\left(1 - \alpha_H G(\tau b_L)\right) \right). \end{aligned}$$

Remember that $H(x) = G(x) + \frac{\int_x^A}{x} \geq 1$ for any $x \in [0, A]$. This means that $\alpha_H H(\tau b_L) + (1 - \alpha_H) H(\tau b_M) - 1 > 0$. Recall that $b_L < b_M$. Hence, the assumption that $b^2 g(b)$ is increasing in b implies that $b_M^2 g(b_M) > b_L^2 g(b_L)$. Moreover, $\frac{\int_{b_L}^A + N \int_{\tau b_L}^A}{\int_{b_M}^A + N \int_{\tau b_M}^A} > 1$. As a result,

$$\begin{aligned} & I_L \frac{\alpha_H b_M^2 g(b_M)}{b_L^2} \frac{\left(\int_{b_L}^A + N \int_{\tau b_L}^A \right)^2}{\int_{b_M}^A + N \int_{\tau b_M}^A} - I_L b_L g(b_L) \left(-(1-\alpha_H)\left(N\tau H(\tau b_M) + \frac{\int_{b_M}^A}{b_M} \right) + N\tau\left(1 - \alpha_H G(\tau b_L)\right) \right) \\ > \; & I_L g(b_L) b_L \left(\frac{\alpha_H \left(\int_{b_L}^A + N \int_{\tau b_L}^A \right)}{b_L} + (1-\alpha_H)\left(N\tau H(\tau b_M) + \frac{\int_{b_M}^A}{b_M} \right) - N\tau\left(1 - \alpha_H G(\tau b_L)\right) \right) > 0. \end{aligned}$$

Hence, $b_M D + \tau \left(-\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_L} \right) > 0$, which in turn implies that $(\tau b_M)'_\tau > 0$.

Similarly,

$$(\tau b_L)'_\tau = \frac{b_L D + \tau \left(-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M} \right)}{D}.$$

Again, it is necessary to determine the sign of

$$b_L D + \tau \left(-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M} \right) = \frac{\partial J_1}{\partial b_M}\left(b_L \frac{\partial J_2}{\partial b_L} - \tau \frac{\partial J_2}{\partial \tau} \right) + \frac{\partial J_2}{\partial b_M}\left(\tau \frac{\partial J_1}{\partial \tau} - b_L \frac{\partial J_1}{\partial b_L} \right).$$

Using the same technique as before, one can show that $b_L D + \tau \left(-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M} \right)$ equals to

$$\begin{aligned}
& I_L \frac{b_L(1-\alpha_H)}{b_M^2} \frac{\int_{b_L}^{b_M} + N \int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} \left(\frac{(1-\alpha_H)\int_{b_M}^{A}}{b_M} + \alpha_H \frac{\int_{b_L}^{A}}{b_L} + N\tau \left((1-\alpha_H)H(\tau b_M) + \alpha_H H(\tau b_L) - 1 \right) \right) \\
& + I_L N \tau^2 b_M g(\tau b_M) \frac{\int_{b_L}^{A} + N \int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N \int_{\tau b_M}^{A}} \left(\frac{(1-\alpha_H)\int_{b_M}^{A}}{b_M} + \alpha_H \frac{\int_{b_L}^{A}}{b_L} + N\tau \left((1-\alpha_H)H(\tau b_M) + \alpha_H H(\tau b_L) - 1 \right) \right) \\
& + \frac{I_L(1-\alpha_H)\left(\int_{b_M}^{A} + N \int_{\tau b_M}^{A} \right)}{b_M^2} b_L^2 g(b_L) \\
& + I_L b_M g(b_M) \frac{\int_{b_L}^{A} + N \int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N \int_{\tau b_M}^{A}} \left(\alpha_H N \tau H(\tau b_L) + \alpha_H \frac{\int_{b_L}^{A}}{b_L} - N\tau \left(1 - (1-\alpha_H) G(\tau b_M) \right) \right).
\end{aligned}$$

Taking into account that $(\tau b_M)^2 g(\tau b_M) \geq b_M^2 g(b_M)$, one can derive

$$\begin{aligned}
& I_L N \tau^2 b_M g(\tau b_M) \frac{\int_{b_L}^{A} + N \int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N \int_{\tau b_M}^{A}} \left(\frac{(1-\alpha_H)\int_{b_M}^{A}}{b_M} + \alpha_H \frac{\int_{b_L}^{A}}{b_L} + N\tau \left((1-\alpha_H)H(\tau b_M) + \alpha_H H(\tau b_L) - 1 \right) \right) \\
& + I_L b_M g(b_M) \frac{\int_{b_L}^{A} + N \int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N \int_{\tau b_M}^{A}} \left(\alpha_H N \tau H(\tau b_L) + \alpha_H \frac{\int_{b_L}^{A}}{b_L} - N\tau \left(1 - (1-\alpha_H) G(\tau b_M) \right) \right) \\
\geq \; & I_L N b_M g(b_M) \frac{\int_{b_L}^{A} + N \int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N \int_{\tau b_M}^{A}} \left(\frac{(1-\alpha_H)\int_{b_M}^{A}}{b_M} + \alpha_H \frac{\int_{b_L}^{A}}{b_L} + N\tau \left((1-\alpha_H)H(\tau b_M) + \alpha_H H(\tau b_L) - 1 \right) \right) \\
& + I_L b_M g(b_M) \frac{\int_{b_L}^{A} + N \int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N \int_{\tau b_M}^{A}} \left(\alpha_H N \tau H(\tau b_L) + \alpha_H \frac{\int_{b_L}^{A}}{b_L} - N\tau \left(1 - (1-\alpha_H) G(\tau b_M) \right) \right).
\end{aligned}$$

Note that

$$\begin{aligned}
0 \; < \; & N \left(\frac{(1-\alpha_H)\int_{b_M}^{A}}{b_M} + \alpha_H \frac{\int_{b_L}^{A}}{b_L} + N\tau \left((1-\alpha_H)H(\tau b_M) + \alpha_H H(\tau b_L) - 1 \right) \right) \\
& + \alpha_H N \tau H(\tau b_L) + \alpha_H \frac{\int_{b_L}^{A}}{b_L} - N\tau \left(1 - (1-\alpha_H) G(\tau b_M) \right).
\end{aligned}$$

Thus, I show that $b_L D + \tau \left(-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M} \right) > 0$.

Recall that $\frac{\partial b_M}{\partial \tau} = \frac{-\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_L}}{D}$. From the expressions for $\frac{\partial J_i}{\partial b_L}$ and $\frac{\partial J_i}{\partial \tau}$, $\frac{\partial J_1}{\partial \tau} < 0$, $\frac{\partial J_2}{\partial b_L} < 0$, $\frac{\partial J_2}{\partial \tau} > 0$, and $\frac{\partial J_1}{\partial b_L} < 0$. This results in the negative sign of $\frac{\partial b_M}{\partial \tau}$, i.e., given an increase in τ, b_M falls.

At the same time, the impact of an increase in τ on b_L is ambiguous. Remember that $\frac{\partial b_L}{\partial \tau} = \frac{-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M}+\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M}}{D}$. Consider the numerator of the expression:

$$\begin{aligned}
& -\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M} \\
= \; & I_L N \frac{\tau(1-\alpha_H)}{b_M^2}\left(b_M^2 g(\tau b_M)\left(\int_{b_L}^{A} + N\int_{\tau b_L}^{A}\right) - b_L^2 g(\tau b_L)\left(\int_{b_M}^{A} + N\int_{\tau b_M}^{A}\right)\right) \\
& - I_L N \frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\left(1-\alpha_H G(\tau b_L) - (1-\alpha_H)G(\tau b_M)\right)\left(b_M g(b_M) + N\tau^2 b_M g(\tau b_M)\right) \\
& - I_L N \frac{b_L(1-\alpha_H)}{b_M^2}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}}\left(1-\alpha_H G(\tau b_L) - (1-\alpha_H)G(\tau b_M)\right).
\end{aligned}$$

In general, $-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M}+\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M}$ can be positive or negative. If α_H is close to one then $-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M}+\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M}$ is close to

$$-I_L N \frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\left(1-G(\tau b_L)\right)\left(b_M g(b_M) + N\tau^2 b_M g(\tau b_M)\right) < 0.$$

If α_H is close to zero then $-\frac{\partial J_2}{\partial \tau}\frac{\partial J_1}{\partial b_M}+\frac{\partial J_1}{\partial \tau}\frac{\partial J_2}{\partial b_M}$ is close to

$$\begin{aligned}
& I_L N \frac{\tau}{b_M^2}\left(b_M^2 g(\tau b_M)\left(\int_{b_L}^{A} + N\int_{\tau b_L}^{A}\right) - b_L^2 g(\tau b_L)\left(\int_{b_M}^{A} + N\int_{\tau b_M}^{A}\right)\right) \\
& - I_L N \left(1-G(\tau b_M)\right)\left(\left(b_M g(b_M) + N\tau^2 b_M g(\tau b_M)\right)\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}} + \frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{b_M}\right).
\end{aligned}$$

The sign of last expression is not determined in general. For example, if τ is high enough (τb_M is close to A)then it is positive, while if τ is close to one then it can be negative. Thus, given sufficiently low α_H, b_L has a U shape or increasing as a function of τ, while given sufficiently high α_H, b_L is always decreasing. A number of simulations I conduct for a wide range of parameters confirm the findings above.

Proof of Proposition 2 To examine the sign of $\left(\frac{W_r}{W_p}\right)'_\tau$, one needs to analyze the sign of $\left(\frac{b_L}{b_M}\right)'_\tau = \frac{\frac{\partial b_L}{\partial \tau}b_M - \frac{\partial b_M}{\partial \tau}b_L}{b_M^2}$. Simple algebra shows that the sign of $\frac{\partial b_L}{\partial \tau}b_M - \frac{\partial b_M}{\partial \tau}b_L$ is the same as the sign of $\frac{\partial J_1}{\partial \tau}\left(\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L\right) - \frac{\partial J_2}{\partial \tau}\left(\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L\right)$. Using the expressions for $\frac{\partial J_i}{\partial \tau}$, $\frac{\partial J_i}{\partial b_M}$, and $\frac{\partial J_i}{\partial b_L}$, I derive

$$\begin{aligned}
\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L &= I_L\left(\left(b_M^2 g(b_M) + \tau^2 b_M^2 g(\tau b_M)\right)\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}} - b_L^2 g(b_L) - \tau^2 b_L^2 g(\tau b_L)\right) \\
\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L &= -\frac{(1-\alpha_H)\left(\int_{b_M}^{A} + N\int_{\tau b_M}^{A}\right)}{b_M} - \frac{\alpha_H\left(\int_{b_L}^{A} + N\int_{\tau b_L}^{A}\right)}{b_L}.
\end{aligned}$$

Thus, one needs to examine the sign of

$$\begin{aligned}
&I_L N\left(\tau b_M^2 g(\tau b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A + N\int_{\tau b_M}^A} - \tau b_L^2 g(\tau b_L)\right)\tau\left(\alpha_H G(\tau b_L) + (1-\alpha_H)G(\tau b_M) - 1\right) \\
&+ I_L N\left(\tau b_M^2 g(\tau b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A + N\int_{\tau b_M}^A} - \tau b_L^2 g(\tau b_L)\right)\left(\frac{(1-\alpha_H)\left(\int_{b_M}^A + N\int_{\tau b_M}^A\right)}{b_M} + \frac{\alpha_H\left(\int_{b_L}^A + N\int_{\tau b_L}^A\right)}{b_L}\right) \\
&- I_L N\left(1 - \alpha_H G(\tau b_L) - (1-\alpha_H)G(\tau b_M)\right)\left(b_M^2 g(b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A + N\int_{\tau b_M}^A} - b_L^2 g(b_L)\right).
\end{aligned}$$

Remember that $b^2 g(b)$ is increasing and convex in b. As $\tau b_M^2 g(\tau b_M) - b_M^2 g(b_M) > 0$,

$$\begin{aligned}
& \frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A + N\int_{\tau b_M}^A}\left(\tau b_M^2 g(\tau b_M) - b_M^2 g(b_M)\right) - \left(\tau b_L^2 g(\tau b_L) - b_L^2 g(b_L)\right) \\
> \;& \left(\tau b_M^2 g(\tau b_M) - b_M^2 g(b_M)\right) - \left(\tau b_L^2 g(\tau b_L) - b_L^2 g(b_L)\right) > 0.
\end{aligned}$$

Since $N \geq 1$,

$$\begin{aligned}
& \tau\left(\alpha_H G(\tau b_L) + (1-\alpha_H)G(\tau b_M) - 1\right) + \frac{(1-\alpha_H)\left(\int_{b_M}^A + N\int_{\tau b_M}^A\right)}{b_M} + \frac{\alpha_H\left(\int_{b_L}^A + N\int_{\tau b_L}^A\right)}{b_L} \\
> \;& \tau\left(\alpha_H H(\tau b_L) + (1-\alpha_H)H(\tau b_M) - 1\right) + \frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + \frac{\alpha_H\int_{b_L}^A}{b_L} \\
> \;& \frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + \frac{\alpha_H\int_{b_L}^A}{b_L} > 1 - \alpha_H G(\tau b_L) - (1-\alpha_H)G(\tau b_M).
\end{aligned}$$

Thus, $\left(\frac{b_L}{b_M}\right)'_\tau > 0$.

Welfare Issues (the proofs for footnote 16) Consider the following expression: $\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}$. I prove that $\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right)'_\tau > 0$. This in turn implies that $(W_p)'_\tau < 0$.

$$\begin{aligned}
\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right)'_\tau &= -\frac{\alpha_H}{b_L^2}\frac{\partial b_L}{\partial \tau} - \frac{(1-\alpha_H)}{b_M^2}\frac{\partial b_M}{\partial \tau} \\
&= \frac{\frac{\partial J_1}{\partial \tau}\left(\frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_2}{\partial b_L} - \frac{\alpha_H}{b_L^2}\frac{\partial J_2}{\partial b_M}\right) + \frac{\partial J_2}{\partial \tau}\left(\frac{\alpha_H}{b_L^2}\frac{\partial J_1}{\partial b_M} - \frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_1}{\partial b_L}\right)}{D}.
\end{aligned}$$

Note that $\frac{\alpha_H}{b_L^2}\frac{\partial J_1}{\partial b_M} - \frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_1}{\partial b_L} > 0$. Since $\frac{\partial J_1}{\partial \tau} < 0$, $\frac{\partial J_2}{\partial \tau} > 0$, $\frac{\partial J_2}{\partial b_L} < 0$, and $\frac{\partial J_2}{\partial b_M} > 0$, $\left(\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right)'_\tau > 0$. Thus, $(W_p)'_\tau < 0$.

Aggregate welfare per capita in a country is given by $W_a = \alpha_H W_r + (1-\alpha_H)W_p = W_p + \alpha_H(I_H - I_L)V_E$. This can be rewritten as

$$W_a = \frac{1}{c}\left(\frac{I_L}{\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}} + \alpha_H(I_H - I_L)b_L\right), \text{ and}$$

$$(W_a)'_\tau = \frac{I_L\left(\frac{\partial J_1}{\partial \tau}\left(P_1\frac{\alpha_H}{b_L^2}\frac{\partial J_2}{\partial b_M} - \frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_2}{\partial b_L}\right) + \frac{\partial J_2}{\partial \tau}\left(\frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_1}{\partial b_L} - P_1\frac{\alpha_H}{b_L^2}\frac{\partial J_1}{\partial b_M}\right)\right)}{cD\left(\frac{\alpha_H}{b_L}+\frac{(1-\alpha_H)}{b_M}\right)^2},$$

where $P_1 = 1 + \frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\left(\alpha_H + \frac{(1-\alpha_H)b_L}{b_M}\right)$. I show that $\frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_1}{\partial b_L} - P_1\frac{\alpha_H}{b_L^2}\frac{\partial J_1}{\partial b_M} < 0$. This implies that $(W_a)'_\tau < 0$. Aggregate welfare per capita falls with higher τ.

What about the welfare of the rich? $W_r = W_p + (I_H - I_L)V_E = \frac{1}{c}\left(\frac{I_L}{\frac{\alpha_H}{b_L}+\frac{(1-\alpha_H)}{b_M}} + (I_H - I_L)\,b_L\right)$, and

$$(W_r)'_\tau = \frac{I_L\left(\frac{\partial J_1}{\partial \tau}\left(P_2\frac{\alpha_H}{b_L^2}\frac{\partial J_2}{\partial b_M} - \frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_2}{\partial b_L}\right) + \frac{\partial J_2}{\partial \tau}\left(\frac{(1-\alpha_H)}{b_M^2}\frac{\partial J_1}{\partial b_L} - P_2\frac{\alpha_H}{b_L^2}\frac{\partial J_1}{\partial b_M}\right)\right)}{cD\left(\frac{\alpha_H}{b_L}+\frac{(1-\alpha_H)}{b_M}\right)^2}, \tag{11}$$

where $P_2 = 1 + \frac{1}{\alpha_H}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\left(\alpha_H + \frac{(1-\alpha_H)b_L}{b_M}\right)$. The impact of an increase in τ on W_r is ambiguous. To show this, I plug the expressions for $\frac{\partial J_i}{\partial \tau}$, $\frac{\partial J_i}{\partial b_M}$, and $\frac{\partial J_i}{\partial b_L}$ into (11). After some simplifications, I show that the sign of the numerator in (11) is the same as the sign of the following expression:

$$\begin{aligned}
&(\alpha_H G(\tau b_L) + (1-\alpha_H)G(\tau b_M) - 1)\left(b_M g(b_M) + N\tau^2 b_M g(\tau b_M)\right) P_2 \frac{\alpha_H}{b_L^2}\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}} \\
&+ (\alpha_H G(\tau b_L) + (1-\alpha_H)G(\tau b_M) - 1)\left(b_L g(b_L) + N\tau^2 b_L g(\tau b_L)\right)\frac{(1-\alpha_H)}{b_M^2} \\
&+ (\alpha_H G(\tau b_L) + (1-\alpha_H)G(\tau b_M) - 1)\frac{(1-\alpha_H)}{b_M^2}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}}\left(P_2\frac{\alpha_H}{b_L} + \frac{(1-\alpha_H)}{b_M}\right) \\
&+ \left(\tau b_M^2 g(\tau b_M)\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}} - \tau b_L^2 g(\tau b_L)\right)\frac{(1-\alpha_H)^2\left(\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}\right)}{b_M^3 b_L}.
\end{aligned}$$

In general, the sign of this expression can be either positive or negative. If α_H is close to one or incomes of the poor and the rich are close to each other then the sign is negative[19]. However, if α_H is close to zero and the difference between incomes of the poor and the rich is significant enough then the sign can be positive[20]. A number of simulations I conduct for a wide range of parameters support these results.

5.1.2 Changes in the Number of Trading Partners

Proof of Lemma 4 Similarly to the previous analysis,

$$\frac{\partial b_M}{\partial N} = \frac{-\frac{\partial J_1}{\partial N}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial N}\frac{\partial J_1}{\partial b_L}}{D} \text{ and } \frac{\partial b_L}{\partial N} = \frac{-\frac{\partial J_2}{\partial N}\frac{\partial J_1}{\partial b_M} + \frac{\partial J_1}{\partial N}\frac{\partial J_2}{\partial b_M}}{D}.$$

[19] This implies that b_L is close to b_M.

[20] This condition guarantees that $\frac{I_H}{I_L}$ is high enough. This implies that τb_M is close to one (see Tarasov (2007) for details).

Note that $\frac{\partial b_L}{\partial N} > 0$. Consider the sign of $-\frac{\partial J_1}{\partial N}\frac{\partial J_2}{\partial b_L} + \frac{\partial J_2}{\partial N}\frac{\partial J_1}{\partial b_L}$, which is the same as the sign of

$$I_L\tau\left(\alpha_H H(\tau b_L) + (1-\alpha_H)H(\tau b_M) - 1\right)\left(b_L g(b_L) + N\tau^2 b_L g(\tau b_L) + \frac{(1-\alpha_H)}{b_M}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{\tau b_M}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}}\right)$$
$$-I_L\left(\frac{\int_{\tau b_L}^{\tau b_M}\int_{b_M}^{A} - \int_{b_L}^{b_M}\int_{\tau b_M}^{A}}{\int_{b_M}^{A} + N\int_{\tau b_M}^{A}}\right)\frac{\alpha_H}{b_L^2}\left(\int_{b_L}^{A} + N\int_{\tau b_L}^{A}\right).$$

If α_H is close to zero then $\frac{\partial b_M}{\partial N}$ is likely to be greater than zero. However, if α_H is close to one then it is possible that $\frac{\partial b_M}{\partial N} < 0$. For instance, if b_L is close to zero and α_H is close to one then $\frac{\partial b_M}{\partial N} < 0$.

Finally, the sign of $\left(\frac{b_L}{b_M}\right)'_N$ is the same as the sign of $\frac{\partial J_1}{\partial N}\left(\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L\right) - \frac{\partial J_2}{\partial N}\left(\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L\right)$. Since $\frac{\partial J_i}{\partial N} > 0$, $\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L > 0$, and $\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L < 0$, $\left(\frac{b_L}{b_M}\right)'_N > 0$.

5.2 Part B

Here I consider the case when $\tau b_M \geq A$ in the equilibrium. Then,

$$\begin{cases} \frac{\int_{b_L}^{b_M} tdG(t) + N\int_{\tau b_L}^{A} tdG(t)}{\int_{b_M}^{A} tdG(t))} = \left(\frac{I_H}{I_L} - 1\right)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right), \\ \frac{f_e}{cL} + 1 + \alpha_H N\tau = \alpha_H\left(H(b_L) + N\tau H(\tau b_L)\right) + (1-\alpha_H)H(b_M). \end{cases}$$

Again, let

$$\begin{aligned} J_1 &= \alpha_H\left(H(b_L) + N\tau H(\tau b_L)\right) + (1-\alpha_H)H(b_M) - \frac{f_e}{cL} - 1 - \alpha_H N\tau, \\ J_2 &= I_L\left(\int_{b_L}^{b_M} + N\int_{\tau b_L}^{A}\right) - (I_H - I_L)\left(\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}\right)\int_{b_M}^{A}. \end{aligned}$$

Then, algebra shows

$$\begin{aligned} \frac{\partial J_1}{\partial b_M} &= -\frac{(1-\alpha_H)}{b_M^2}\int_{b_M}^{A} < 0,\ \frac{\partial J_1}{\partial b_L} = -\frac{\alpha_H}{b_L^2}\left(\int_{b_L}^{A} + N\int_{\tau b_L}^{A}\right) < 0, \\ \frac{\partial J_1}{\partial \tau} &= N\alpha_H\left(G(\tau b_L) - 1\right) < 0,\ \frac{\partial J_1}{\partial N} = \tau\alpha_H\left(H(\tau b_L) - 1\right) > 0, \\ \frac{\partial J_2}{\partial b_M} &= I_L b_M g(b_M)\frac{\int_{b_L}^{A} + N\int_{\tau b_L}^{A}}{\int_{b_M}^{A}} + I_L\frac{b_L(1-\alpha_H)}{b_M^2}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{A}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} > 0 \\ \frac{\partial J_2}{\partial b_L} &= -I_L b_L\left(g(b_L) + N\tau^2 g(\tau b_L)\right) - I_L\frac{(1-\alpha_H)}{b_M}\frac{\int_{b_L}^{b_M} + N\int_{\tau b_L}^{A}}{\alpha_H + \frac{b_L(1-\alpha_H)}{b_M}} < 0 \\ \frac{\partial J_2}{\partial \tau} &= -I_L N\tau b_L^2 g(\tau b_L) < 0,\ \frac{\partial J_2}{\partial N} = I_L\int_{\tau b_L}^{A} > 0. \end{aligned}$$

5.2.1 Changes in Transportation Costs

Proof of Proposition 2 From Part A of the Appendix the sign of $\left(\frac{W_r}{W_p}\right)'_\tau$ is the same as that of $\frac{\partial J_1}{\partial \tau}\left(\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L\right) - \frac{\partial J_2}{\partial \tau}\left(\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L\right)$. Using the expressions for $\frac{\partial J_i}{\partial \tau}$, $\frac{\partial J_i}{\partial b_M}$, and $\frac{\partial J_i}{\partial b_L}$,

$$\begin{aligned}
\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L &= I_L\left(b_M^2 g(b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A} - b_L^2 g(b_L) - N\tau^2 b_L^2 g(\tau b_L)\right), \\
\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L &= -\frac{(1-\alpha_H)\int_{b_M}^A}{b_M} - \frac{\alpha_H\left(\int_{b_L}^A + N\int_{\tau b_L}^A\right)}{b_L}.
\end{aligned}$$

Thus, one needs to examine the sign of

$$\begin{aligned}
& I_L\left(b_M^2 g(b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A} - b_L^2 g(b_L) - N\tau^2 b_L^2 g(\tau b_L)\right) N\alpha_H\left(G(\tau b_L) - 1\right) \\
& -I_L N\tau b_L^2 g(\tau b_L)\left(\frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + \frac{\alpha_H\left(\int_{b_L}^A + N\int_{\tau b_L}^A\right)}{b_L}\right) \\
= \; & I_L N\alpha_H\left(b_M^2 g(b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A} - b_L^2 g(b_L)\right)\left(G(\tau b_L) - 1\right) \\
& + I_L N\tau b_L^2 g(\tau b_L)\left(\alpha_H N\tau\left(1 - H(\tau b_L)\right) - \frac{(1-\alpha_H)\int_{b_M}^A}{b_M} - \frac{\alpha_H\int_{b_L}^A}{b_L}\right) < 0.
\end{aligned}$$

Thus, $\left(\frac{W_r}{W_p}\right)'_\tau < 0$, and the rich lose more than the poor from higher τ.

5.2.2 Changes in the Number of Trading Partners

Proof of Proposition 3 As in Part A of the Appendix, the sign of $\left(\frac{W_r}{W_p}\right)'_N$ is the same as the sign of $\frac{\partial J_1}{\partial N}\left(\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L\right) - \frac{\partial J_2}{\partial N}\left(\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L\right)$. Using the expressions for $\frac{\partial J_i}{\partial N}$, $\frac{\partial J_2}{\partial b_M}b_M + \frac{\partial J_2}{\partial b_L}b_L$, and $\frac{\partial J_1}{\partial b_M}b_M + \frac{\partial J_1}{\partial b_L}b_L$, one needs to examine the sign of

$$\begin{aligned}
& I_L\tau\alpha_H\left(H(\tau b_L) - 1\right)\left(b_M^2 g(b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A} - b_L^2 g(b_L) - N\tau^2 b_L^2 g(\tau b_L)\right) \\
& + I_L\int_{\tau b_L}^A\left(\frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + \frac{\alpha_H\left(\int_{b_L}^A + N\int_{\tau b_L}^A\right)}{b_L}\right) \\
= \; & I_L\tau\alpha_H\left(H(\tau b_L) - 1\right)\left(b_M^2 g(b_M)\frac{\int_{b_L}^A + N\int_{\tau b_L}^A}{\int_{b_M}^A} - b_L^2 g(b_L)\right) + I_L\int_{\tau b_L}^A\left(\frac{(1-\alpha_H)\int_{b_M}^A}{b_M} + \frac{\alpha_H\int_{b_L}^A}{b_L}\right) \\
& + I_L\alpha_H N\tau\left(\frac{\left(\int_{\tau b_L}^A\right)^2}{\tau b_L} - \left(H(\tau b_L) - 1\right)\tau^2 b_L^2 g(\tau b_L)\right).
\end{aligned}$$

Consider the function $K(x) = \frac{\left(\int_x^A\right)^2}{x} - (H(x)-1)\, x^2 g(x)$. I show that

$$K'(x) = \frac{-x^2 g(x) \int_x^A - \left(\int_x^A\right)^2}{x^2} - (H(x)-1)\left(2xg(x) + x^2 g'(x)\right).$$

Since $x^2 g(x)$ is increasing, $K'(x) < 0$. Moreover, $K(A) = 0$, so that $K(x) \geq 0$ for any $x \in [0, A]$. Thus, the sign of $\left(\frac{W_r}{W_p}\right)'_N$ is positive. The rich gain more than the poor from an increase in N.