A Simple Model of Offshore Outsourcing, Technology Upgrading and Welfare

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April 15, 2008

Abstract

We adapt Yeaple's (2005) heterogeneous agents framework to model firms in the North as making explicit offshore outsourcing decisions to cheap-labor economies. Globalization results from a lowering of the set-up costs incurred when engaging in offshore activities. We highlight how firms' technology transformations due to globalization will induce skill upgrading in the North, increase aggregate productivity, average wages and therefore total welfare at the cost of increased wage inequalities. We analytically derive mild conditions under which all consumers–including lower-skilled workers–will nevertheless gain from the surge of offshore outsourcing. A parameterized version of the model roughly calibrated on U.S. data is then numerically explored and confirms our positive welfare predictions.

Keywords: Offshore outsourcing; Globalization; Skill upgrading, Technology upgrading; Firm heterogeneity

JEL Classification: F16

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1 Introduction

Recent revolutionary advances in transportation and communication technologies coupled with institutional progress in many cheap labor countries have provided firms in the North with strong new incentives to extensively adopt offshore outsourcing strategies and transfer larger parts of their production activities to the South. Though the transferred activities are bound to be dominantly low-tech manufacturing shifting the demand for production workers at home, some low-skilled white collar jobs that were previously protected from foreign competition are now threatened by this new factor-cost savings prospect. This is a rather new phenomenon in international trade. For this reason, the prospect of massive offshoring in white collar services and its potential consequences on welfare in the North has surged as a major political issue in the previous US presidential campaign. As convincingly argued by Mankiw and Swagel (2006), the extent of outsourcing to low-wage countries is currently less than one might infer from media reports, and the idea that U.S. firms are shipping products back to the United States and disrupting the U.S. labor market simply does not line up with the data. But the phenomenon is recent, and possibly not yet perceptible in the data: in view of the new international environment, it is hard to exclude the possibility that firms in the North could massively turn multinational and switch to cost-saving offshore outsourcing practices, transferring large parts of their labor-intensive activities to the South. Assuming this does happen, and that U.S. firms start shipping products back to the United States, will that disrupt U.S. labor markets?

Addressing this issue, Mankiw and Swagel (2006) note that, though there exists a large theoretical literature on the positive aspects of offshore outsourcing focusing on the factors influencing firms' choices of organizational structure and location of production, relatively little normative analysis is available on the welfare impact of offshoring. Most existing papers tend to suggest that offshore outsourcing is a modern form of trade, and that it will therefore almost inevitably imply that there are winners and losers–the curse of Stolper-Samuelson–but that the gains from the first are large enough to compensate for the latter.[1] Our paper contributes to qualify this perception: offshoring need not lead to lower welfare for domestic factors competing with foreign factors. The argument is that,

[1] See Deardorff (2005, 2006) for an illuminating discussion on this.

by making profitable expensive-to-set-up but cheap-to-operate technologies, globalization induces domestic-only firms to turn multinational and switch to more efficient technologies and hence induces a potentially large subset of workers in the North to relocate to more productive activities. There is ample evidence that this mechanism is of empirical relevance. Indeed, it is well established that multinationals use better technologies and are therefore more efficient than their purely domestic competitors. Furthermore, Head and Ries (2002) have investigated the influence of offshore production by Japanese multinationals on domestic skill intensity, using firm-level data. They find that additional foreign affiliate employment in low income countries raises skill intensity at home, but that this effect falls as investment shifts towards high income countries. This is clearly consistent with vertical specialization, and provides evidence that vertical specialization by multinationals contributes to skill upgrading domestically.[2]

To model this mechanism, we adapt Yeaple (2005) to a North-South setting: workers are heterogeneous in their absolute and comparative advantages in different technologies and firms are ex ante identical but endogenously adopt different technologies. Two complementary activities within a firm, which we refer to as "repetitive" and "conceptual" enter in the production process, respectively of "intermediates" and "headquarter services"; these tasks may be separated geographically: conceptual tasks are exclusively performed in the North while the South can produce the intermediates at lower cost than the North. Headquarter services can be produced via a high fixed-cost low marginal-cost technology or from a low fixed-cost high marginal-cost technology. Workers sort into production activities in equilibrium. The ablest workers produce headquarter services and the less able intermediate goods. Among non-production workers employed in headquarter services, the most able use the high-fixed cost technology. Since offshoring involves a fixed cost, a firm must have sufficiently large sales volumes for this activity to increase profits. Hence, only those firms that choose the high fixed-cost low marginal-cost technology in-

[2] Hansson (2005) reaches similar conclusions on Swedish MNEs during the years 1990-97. The period is particularly interesting because it covers the years after the iron curtain was lifted: Swedish MNEs have extensively taken advantage of the large supply of cheap labor in the immediate neighborhood which the processes of transition in the CEECs has given rise to. He finds a non-trivial, significantly positive, impact on skill upgrading in Swedish MNE parents of the increased employment share in their affiliates in non-OECD countries.

vest abroad, substituting cheap foreign labor for domestic labor in the production of the intermediates. Globalization is interpreted as a reduction in the fixed cost of offshoring. We demonstrate that this inevitably induces some firms to adopt better technologies and some workers to skill upgrade, in particular among blue-collars, who move to less repetitive more efficient activities. This rise in the economy's global productivity can benefit the least paid factor owners. Furthermore, the consecutive market size increase makes a greater variety of products available to consumers, in particular to the less-skilled.[3] We show that, under mild conditions, real wages rise even at the low-end of the skill ladder. We next proceed to explore numerically a parameterized version of the model roughly calibrated on U.S. data and show that our theoretical results indeed bear some realism: globalization generates positive welfare gains for all.

We are obviously not the first to reach such a conclusion, though we use a very different approach. An early paper by Feenstra and Hanson (1996) develops a Heckscher-Ohlin type model without factor-price equalization. They then show that outsourcing leads to a productivity increase for firms which will lower the prices for final goods; this reduction in consumer prices, they stress, could exceed the fall in wages of the less-skilled workers. More recently, Grossman and Rossi-Hansberg (2006a, b) also demonstrate that, depending on demand parameters, productivity growth induced by increased offshoring opportunities can benefit the factor intensely used in the sector with decreasing offshoring costs. An innovative aspect of their analysis is to focus, in a perfectly competitive environment, on the nature of tasks performed on the job; this, they advocate, is more relevant for a job's propensity to be offshored than either the skill-intensity of the occupation or the education level of the worker. The conceptual shift may prove extremely important (in particular for empirical investigations, see e.g., Becker *et al.* (2008)) but complexifies the theoretical analysis.[4] In contrast with the previous authors, we acknowledge the role of increasing returns to scale and make imperfect competition an indispensable ingredient in the shaping of the new global economy.[5] Furthermore, we explicitly consider the effect of globalization

[3]See Broda and Weinstein (2006) for an empirical investigation of the gains from trade for the U.S. due to the worldwide expansion of available varieties of goods.

[4]The result also hinges on an assumption on technical progress that raises questions: see Taylor (2006).

[5]Even though we focus on offshore outsourcing, our model could be seen as closely related to the traditional vertical FDI literature. See Helpman (1984) and Markusen (2002, Ch.9) for modeling of vertical

on four firm-level decisions: entry, technology choice, whether or not to offshore outsource and the type of workers to employ so that we account for the observed fact that, to take advantage of the new low-cost opportunities, some firms upgrade technologically.[6] Our model remains nevertheless extremely simple and the results quite intuitive. As we shall argue in the paper, the highlighted characteristics of firms that engage in offshore outsourcing is consistent with empirical evidence.

The paper is organized as follows: the model is laid down in Section 2, and the effects of globalization are analyzed in Section 3. Numerical results are reported in Section 4 from a calibrated version of the model. The paper closes with a conclusion, followed by technical appendices.

2 The model

2.1 Households

Households have Dixit-Stiglitz preferences over a continuum of varieties:

$$X = \left[\int_{i \in N} x(i)^{\rho} di \right]^{\frac{1}{\rho}}, \ 0 < \rho < 1 \tag{1}$$

from which consumption demands are derived:

$$x(i) = \left(\frac{P_X}{p(i)} \right)^{\sigma} X \tag{2}$$

$$P_X = \left[\int_{i \in N} p(i)^{1-\sigma} di \right]^{\frac{1}{1-\sigma}} \tag{3}$$

with $\sigma = 1/(1-\rho)$.

Domestic households also supply labor from a continuum of workers with unit mass, differentiated by skill level z with cumulative distribution $G(z)$ on support $[0, \infty)$.

2.2 Firms

Each final-good variety is produced by a single firm. Output $x(i)$ of any variety requires combining two type of activities within a firm: we refer to the first as conceptual activities

MNEs under increasing returns to scale and imperfect competition.

[6] See e.g., Navaretti et al. (2006) for a discussion on technological upgrading related to firms switching from national to multinational.

associated with headquarter services, and to the second as repetitive tasks associated with the production of intermediate components, respectively in amount $y(i)$ and $m(i)$. These tasks may be separated geographically. We assume a Leontief production function with units chosen so that:

$$x(i) = y(i) = m(i). \tag{4}$$

Both activities are performed by workers using Ricardian technologies. Headquarter services can only be produced in the home country, the North, using a high- (H) or a low- (L) technology. Technology H is more expensive to set-up but cheaper to operate than L so that $F_L < F_H$ and $C_L > C_H$, where F_j and C_j denote respectively the set-up and marginal costs involved by the use of technology $j = L, H$. Though born identical, firms will sort in equilibrium between these two types: this is one source of endogenously generated firm heterogeneity.

Firms also choose where to produce their intermediate goods: domestically with an M technology, at marginal cost C_M, or in the South where unit production cost θC_M is lower: $\theta < 1$. Offshore outsourcing however involves specific set-up costs F_I so that only the most productive firms will turn multinational. There is considerable evidence that multinational (MN) firms use more productive technologies than non-MNs,[7] so we choose F_I and θ such that only firms using the H technology find it profitable to offshore outsource the production of their intermediate inputs. (The conditions for this to be satisfied will be given later.) We define for future use $\theta_j = 1, \theta$ for $j = L, H$.

Finally, firms differ from one another by the skill level of the domestic workers they hire. Let $\varphi_j(z)$ denote the productivity of a worker of skill z when working with technology $j \in \{M, L, H\}$. We assume $\varphi_j(z)$ continuous and increasing in z, so that, for any technology considered, a higher skilled worker is absolutely more productive than a less skilled one. We characterize comparative advantages as follows:

$$0 < \frac{\partial \varphi_M(z)}{\partial z} \frac{1}{\varphi_M(z)} < \frac{\partial \varphi_L(z)}{\partial z} \frac{1}{\varphi_L(z)} < \frac{\partial \varphi_H(z)}{\partial z} \frac{1}{\varphi_H(z)}, \tag{5}$$

[7] It is widely documented that affiliates of multinationals are more productive than national firms; see for example Doms and Jensen (1998), Conyon et al. (2002). In addition, Helpman et al. (2004) highlight also that MNEs are substantially more productive than non-MNE exporters which outperform significantly purely domestic ones.

with $\varphi_M(0) = \varphi_L(0) = \varphi_H(0) = 1$, so that a higher skilled worker is relatively more productive with more efficient technologies. In equilibrium, workers will sort between the three technology types according to their respective comparative advantage.[8] Let z_1 and z_2 be equilibrium skill thresholds with $0 < z_1 < z_2$. Then, the least skilled with $z \in [0, z_1]$ will be employed to perform repetitive tasks, whereas the intermediate (with $z \in [z_1, z_2]$) and most talented (with $z \in [z_2, \infty)$) workers will be hired to perform conceptual activities in headquarters, respectively with low- and high-tech. See Figure 1.[9]

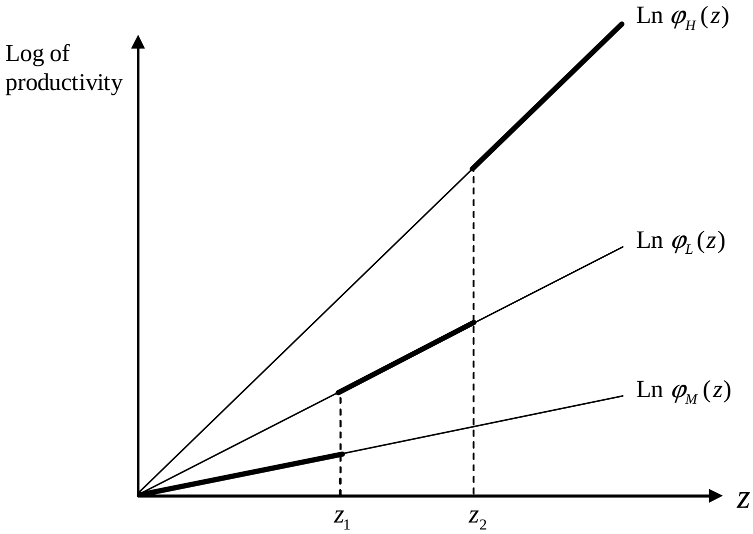

Figure 1: The technologies

In a competitive labor market, worker z earns a wage $w(z)$ that reflects both its talent and the technology of the firm that employs him. The competitive wage distribution will satisfy:

$$w(z) = \begin{cases} C_M \varphi_M(z) & 0 \leq z \leq z_1 \\ C_L \varphi_L(z) & z_1 \leq z \leq z_2 \\ C_H \varphi_H(z) & z_2 \leq z \end{cases} \tag{6}$$

[8] For ease of exposition, we assume in what follows that all three types of technologies are used in equilibrium.

[9] We assume in this figure a log-linear form for the productivity functions $\varphi_j(z)$, though this is not the only functional form that satisfies condition (5).

with the marginal skill owners being indifferent, so that

$$\begin{aligned} C_M\varphi_M(z_1) &= C_L\varphi_L(z_1) \\ C_L\varphi_L(z_2) &= C_H\varphi_H(z_2) \end{aligned} \tag{7}$$

as illustrated in Figure 2.

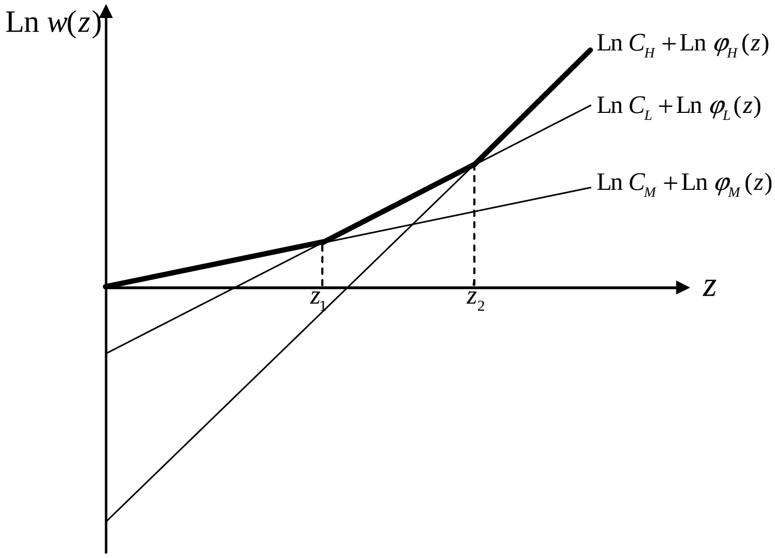

Figure 2: The wage distribution

C_M is chosen as numeraire; the two indifference conditions therefore pin down the variable unit costs in home country non-manufacturing activities:

$$\begin{aligned} C_M &= 1 \\ C_L &= C_M\frac{\varphi_M(z_1)}{\varphi_L(z_1)} \\ C_H &= C_L\frac{\varphi_L(z_2)}{\varphi_H(z_2)} \ . \end{aligned} \tag{8}$$

Observe from (5) that C_L and C_H are decreasing respectively in z_1 and z_2.

We are not interested in unrealistically extreme cost differences between North and South in manufacturing[10], and shall restrict our attention to cases where

$$C_H < C_L < \theta C_M < C_M. \tag{9}$$

[10] See I.L.O. (2007) for unit labor cost comparisons.

Empirical evidence on the level of the fixed costs is scarce but it seams reasonable to assume that the total fixed costs of a vertically fragmented firm is less than twice the fixed costs of a domestic firm:

$$(C_H + \theta C_M)(F_H + F_I) < 2(C_L + C_M)F_L \tag{10}$$

where for convenience, fixed costs take the form of unsold final goods.

Multinationals and non-multinationals compete on the output market. We assume monopolistic competition to prevail so that firms charge a constant mark-up rate over their marginal production costs:

$$p_j = \frac{\sigma}{\sigma - 1}(C_j + \theta_j C_M) \qquad j = L, H. \tag{11}$$

2.3 Equilibrium

All domestically performed repetitive tasks are done within low-tech firms, so that:

$$\int_0^{z_1} \varphi_M(z)dG(z) = \int_{z_1}^{z_2} \varphi_L(z)dG(z). \tag{12}$$

Free entry ensures zero profits for both firm types, so that mark-up revenues exactly cover fixed costs:

$$\frac{1}{\sigma}p_j x_j = (C_j + \theta_j C_M) \cdot (F_j + \delta_j F_I) \qquad j = L, H \tag{13}$$

with $\delta_j = \{0, 1\}$ for $j \in \{L, H\}$.

Finally, we ensure balance of payment equilibrium by conveniently assuming that labor costs in the South are paid by multinationals in units of the consumption basket (1). Incomes then follow from employment:

$$Inc = C_M \int_0^{z_1} \varphi_M(z)dG(z) + C_L \int_{z_1}^{z_2} \varphi_L(z)dG(z) + C_H \int_{z_2}^{\infty} \varphi_H(z)dG(z) \tag{14}$$

$$Inc^* = \theta C_M \int_{z_2}^{\infty} \varphi_H(z)dG(z) \tag{15}$$

with $P_X X = Inc + Inc^*$, which completes the model.[11]

[11] We have assumed that F_I and θ are such that only high-tech firms engage in offshore outsourcing. To exclude the possibility for a low-tech firm to turn multinational requires that the mark-up revenue it would then earn not be large enough to cover the set-up costs, that is:

$$\frac{1}{\sigma}p_L^* x_L^* < (C_L + \theta C_M) \cdot (F_L + F_I)$$

where $p_L^* = \frac{\sigma}{\sigma-1}(C_L + \theta C_M)$ and $x_L^* = \left[\frac{P_X}{p_L^*}\right]^\sigma X$, using respectively (11) and (2).

3 Globalization

We now analyze the effects on the home country of globalization which we shall quite naturally interpret as a fall in F_I, making offshore outsourcing increasingly attractive.

3.1 The wage distribution

We start by showing how the cut-off skill levels z_1 and z_2 are affected by globalization. Totally differentiating equilibrium condition (12), we get:

$$\frac{dz_1}{dz_2} = \frac{\varphi_L(z_2)dG(z_2)}{\varphi_M(z_1)dG(z_1) + \varphi_L(z_1)dG(z_1)}, \tag{16}$$

an expression that is unambiguously positive so that z_1 and z_2 move in the same direction.[12] The reason is transparent: less labor used domestically for repetitive tasks ($dz_1 < 0$) can only imply a contraction of aggregate activity by non multinationals ($dz_2 < 0$) and, therefore, an expansion of total employment in multinational firms. Consider next the revenue ratio between a MN and a non-MN firm: from equilibrium condition (13) we have:

$$\frac{p_H x_H}{p_L x_L} = \frac{(C_H + \theta C_M) \cdot (F_H + F_I)}{(C_L + C_M) \cdot F_L}$$

where prices and output can be substituted out with (11) and (2); rearranging, we get:

$$\left[\frac{C_H + \theta C_M}{C_L + C_M}\right] = \left[\frac{F_H + F_I}{F_L}\right]^{-1/\sigma}. \tag{17}$$

We learn from this equality that the equilibrium marginal-cost gap between MNs and non-MNs will narrow as F_I is reduced. Making use of (8) we obtain

$$\frac{\frac{\varphi_M(z_1)}{\varphi_L(z_1)}\frac{\varphi_L(z_2)}{\varphi_H(z_2)} + \theta}{\frac{\varphi_M(z_1)}{\varphi_L(z_1)} + 1} = \left[\frac{F_H + F_I}{F_L}\right]^{-1/\sigma}. \tag{18}$$

From our characterization (5) of technologies and the fact that, see (16), z_1 and z_2 move in the same direction, it is easy to check that the only possibility is for both C_H and C_L to increase, the first more than the second as the two cut-off skill levels move leftward. Globalization therefore affects the equilibrium wage distribution in this economy as illustrated in Figure 3.

[12] Observe that this is not the case in Yeaple (2005) when opening his economy to trade.

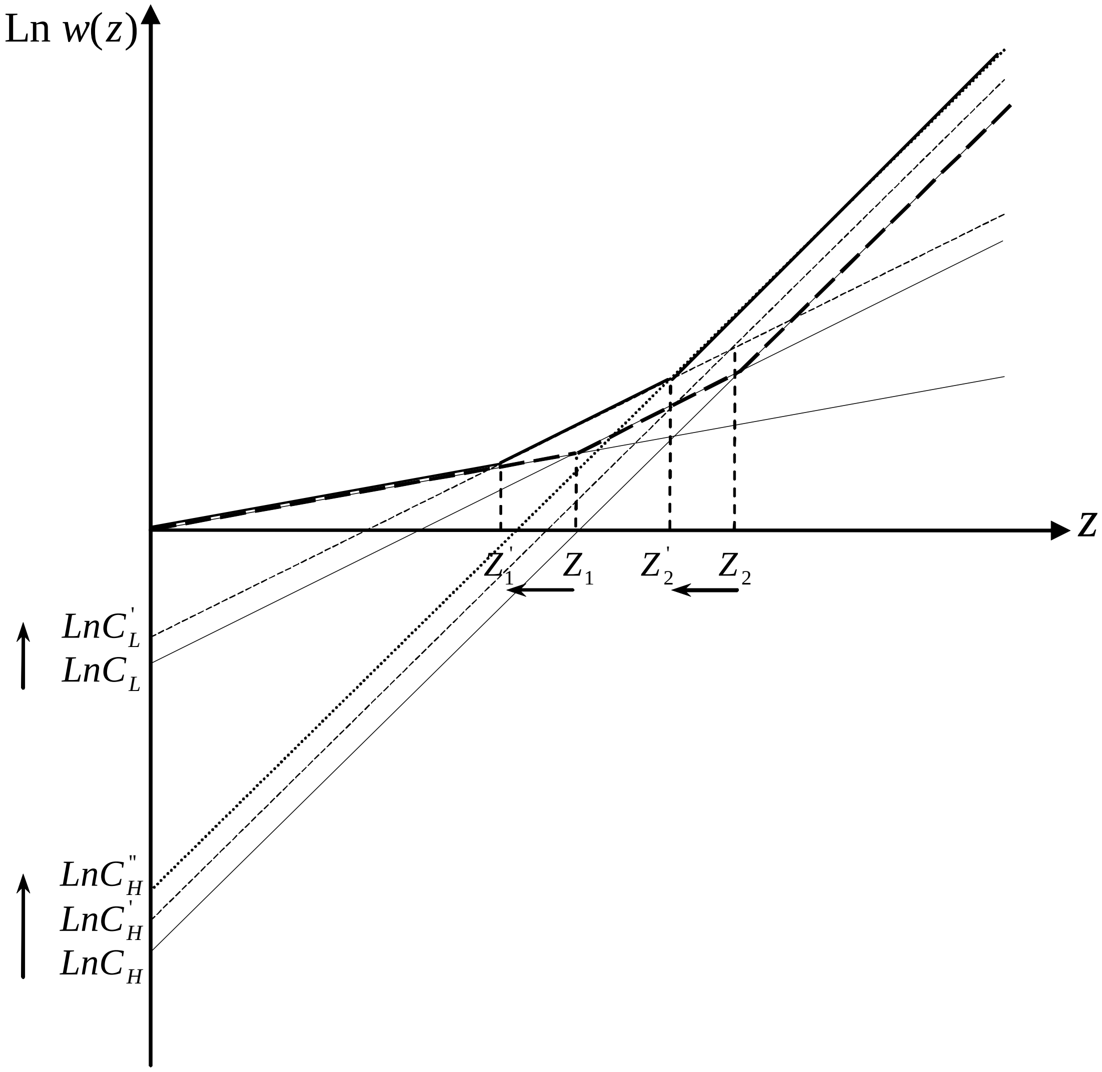

Figure 3: Wage distribution shift as F_I decreases

Two qualitatively different skill-upgrading mechanisms operate as aggregate employment in non-MNs contracts. Firstly, workers with abilities $z \in (z_1', z_1)$, initially employed by domestic-only firms at repetitive tasks are moved to more productive conceptual activities within the same firm type and therefore earn better wages. All the more talented domestic workers (those with $z > z_1$) benefit from this increased demand for skills and see their wages rise, as is apparent from the equal log-rise of marginal costs C_L and C_H (respectively to C_L' and C_H'). Secondly, the best workers in the non-MN firms–those with

$z \in (z_2', z_2)$–move to high-tech jobs within multinationals and earn more, their new wages matching their improved productivity. All those with talent levels above z_2 benefit from this, their skill premium rising equally as reflected by the log-increase of the marginal production costs within multinationals from C_H' to C_H''. In this economy, globalization unambiguously rises overall productivity, average wages, as well as wage inequalities.

Observe that, even though average wages decline in the low-skill activities, this is only a composition effect: for individual workers who remain in blue-collar jobs, wages remain unchanged in terms of the numeraire.

3.2 Individual firm behavior and industry concentration

We first consider non-multinational firms. It immediately follows from mark-up pricing (11) and free entry (13) that the individual non-MN's supply of final goods is proportional to fixed costs (expressed in real terms) and therefore remains constant: $x_L = (\sigma - 1) F_L$. We know from the leftward move of z_1, and from the technology, that aggregate blue-collar employment, and therefore aggregate output, of non-multinationals decrease. As one would have expected, fewer firms will survive to globalization without transferring their blue-collar activities to cheap labor countries. We know that those firms that survive do so by increasing the price of their output, skill upgrading some of their blue-collar workers to more conceptual tasks for which they earn better wages.

Consider next multinationals. We know from the previous discussion that the individual MN's output scale is unaffected by changes in marginal costs –since $x_H = (\sigma - 1)(F_H + F_I)$– and that smaller fixed costs reduce the equilibrium firm size. We also know that the skill threshold z_2 moves left which implies that the aggregate output of MNs increases. It therefore follows that the number of firms that outsource offshore has unambiguously increased. Clearly, globalization has induced a number of national firms to turn multinational, adopting the H-technology, skill upgrading their workers $z \in (z_2', z_2)$, operating at larger scale and selling final goods at cheaper prices than their purely domestic competitors.

Hence, globalization implies both creation and destruction of firms. We now show that the net effect on the total number of firms is positive. From (1) and our definition of fixed costs in units of the firm's unsold final good, we have:

$$\begin{aligned}\int_{z_2}^{\infty} \varphi_H(z)dG(z) &= N_H \ (x_H + F_H + F_I) \\ &= N_H \ \sigma \, (F_H + F_I) \\ \int_0^{z_1} \varphi_M(z)dG(z) &= N_L \ \sigma F_L \end{aligned} \tag{19}$$

where N_j denotes the equilibrium number of type-j firms. Totally differentiating $N = N_L + N_H$ and making use of (16) yields $\frac{dN}{dz_2} =$

$$\frac{\varphi_M(z_1)dG(z_1)}{\sigma F_L(F_H + F_I)} \frac{dz_1}{dz_2} \left[(F_H + F_I) - \frac{\varphi_H(z_2)}{\varphi_L(z_2)} F_L(1 + \frac{\varphi_L(z_1)}{\varphi_M(z_1)}) \right] \ ;$$

using (8) one then obtains:

$$\frac{dN}{dz_2} = \frac{\varphi_M(z_1)dG(z_1)}{\sigma F_L(F_H + F_I)} \frac{dz_1}{dz_2} \left[(F_H + F_I) - \frac{C_L + C_M}{C_H} F_L \right] . \tag{20}$$

Our assumptions (9) and (10) on technologies ensure that the term in brackets is always negative. We conclude that the number of product varieties available to consumers increases unambiguously.

3.3 Welfare

We know from Figure 4 that all workers see their wages increase in terms of the numeraire except those who remain attached to their blue-collar jobs within non-MN firms. It is shown in **Appendix 1** that the purchasing power of the average wage increases unambiguously, so that would be losers –the low-skilled– could always be compensated for by transfers from those who benefit from the new international environment.

We are more interested in the conditions under which lower-skilled workers will benefit from globalization even in absence of redistributive policies. For this purpose, we need focus our attention on the consumption price index (3) only. We have shown that, because of higher wages paid to workers with skill $z > z_1'$, $dC_H > dC_L > 0$ so that, from (11), both p_L and p_H increase: this "distribution effect" acts negatively on the welfare of those that remain in blue-collar activities.

A number of domestic firms, however, turn multinational and produce intermediates with cheaper labor: for this subset of firms, the total effect on output prices is uncertain given that $dC_H > 0$. It is easy to derive a sufficient condition for this price to fall. This will happen if $\frac{p_H^1}{p_L^0} = \frac{C_H^1+\theta C_M}{C_L^0+C_M} < 1$ where superscripts 0/1 refer to the firm's pre- and post-mutation variables respectively. Using (9), we know that $C_H^1 + \theta C_M < 2\theta$ so that $p_H^1 < p_L^0$ if $\theta < \frac{C_L^0+C_M}{2}$, that is, if international wage disparities of low-skilled labor is not too small, presumably the case that concerns us most. This "selection effect" works to everyone's benefit, in particular to the less-skilled.

Finally, globalization has a positive effect on the size of the market, which by making available a larger number of product varieties contributes positively to welfare. We infer from Krugman (1981) that the more final goods are differentiated, the more it is likely that market-size expansion gain will outweigh the distribution loss: the "selection effect" contributes to make this requirement on preferences less stringent, and the positive welfare outcome more likely: see **Appendix 2** for an expression that relates P_X to σ.

To conclude, we have shown that in this economy, the surge of offshore outsourcing needs not inevitably induce losers: even workers employed in activities that are most easily moved offshore may gain.[13] How realistic are the conditions for these welfare gains to materialize? We address this question in the next section by exploring numerically a parametrized version of the model roughly calibrated on US data.

[13] Our model abstracts from labor market adjustments in the South. Endogenizing wages in the South would only mitigate the welfare conclusions. To see this, consider the extreme case of inelastic labor supply abroad: as F_I decreases, wages in the South –and therefore θ– adjust upward constraining the aggregate volume of offshore production by MN firms to remain constant. z_1 and z_2 remain unchanged: there is no skill upgrading and no "selection effect" on welfare. From (11) we know that $dp_H > 0$ and from (19) that $dN_H > 0$: we have nothing more than the standard opposition between a "distribution loss" and a "market-size expansion gain". In this specific case, it is easy to see that the net effect is always positive. For this, rewrite (3) as $P_x = \left[p_L^{1-\sigma} N_L + p_H^{1-\sigma} N_H\right]^{\frac{1}{1-\sigma}}$; make use of (19) to substitute out N_L, N_H and then substitute out $F_H + F_I$ using (17); it follows that: $P_X = \frac{\sigma}{\sigma-1}\left[\frac{1}{\sigma F_L}\int_0^{z_1}\varphi_M(z)dG(z)\left[C_L + C_M\right]^{1-\sigma} + \frac{1}{\sigma F_L}\int_{z_2}^{\infty}\varphi_H(z)dG(z)\left[C_L + C_M\right]^{-\sigma}\left[C_H + \theta C_M\right]\right]^{\frac{1}{1-\sigma}}$. As F_I is reduced, everything remains constant in the RHS except θ that rises: P_X therefore unambiguously falls.

4 A numerical appraisal

4.1 Calibration

In this section, we use a calibrated version of the model to assess some orders of magnitude and sensitivity with respect to key parameters.

I.L.O. (2007) provides us with unit labor costs (relative to U.S.) in manufacturing for a number of cheap labor countries, from which we choose

$$\theta = 0.82 \; , \tag{21}$$

a value between those of Mexico and of the new EU Member States (Czech Republic, Hungary and Poland) in year 2002.

From Industry Statistics published by the U.S. Census Bureau (2002, Table 5, p.54) we choose

$$z_1 = 70\% \; , \tag{22}$$

as the ratio of the number of production workers to the total number of employees in Manufacturing in year 2002; from the same source, we pick the share of non-production activities in total value added from labor as:

$$\frac{C_L \int_{z_1}^{z_2} \varphi_L(z)dG(z) + C_H \int_{z_2}^{\infty} \varphi_H(z)dG(z)}{C_M \int_0^{z_1} \varphi_M(z)dG(z) + C_L \int_{z_1}^{z_2} \varphi_L(z)dG(z) + C_H \int_{z_2}^{\infty} \varphi_H(z)dG(z)} = 42\% \; ; \tag{23}$$

we approximate the share of total production that is due to MN firms as the output share of establishments with 2500 or more employees:

$$\frac{\int_{z_2}^{\infty} \varphi_H(z)dG(z)}{\int_{z_1}^{z_2} \varphi_L(z)dG(z) + \int_{z_2}^{\infty} \varphi_H(z)dG(z)} = 14\% \; . \tag{24}$$

We have little guidance from empirical evidence on the fixed costs, which we choose somewhat arbitrarily within the ranges consistent with the constraints:[14]

$$F_L = 1.0; \; F_H = 1.186; \; F_I = 0.75 \; . \tag{25}$$

[14] In addition to constraints mentioned in a previous footnote, the theoretical consistency of the model imposes that: (a) some L-type firms exist, so that $\frac{1}{\sigma} p_L x_L \geq (C_L + C_M) F_L$; (b) all H-type firms adopt offshore outsourcing strategies so that $\frac{1}{\sigma} p_H x_H \geq (C_H + \theta C_M)(F_H + F_I)$ and $\frac{1}{\sigma} p_H^* x_H^* \leq (C_H + C_M) F_H$ where $p_H^* = \frac{\sigma}{\sigma - 1}(C_H + C_M)$ and $x_H^* = \left[\frac{P_X}{p_H^*}\right]^\sigma X$, using respectively (11) and (2). The value of F_H is actually chosen so that, at the initial equilibrium, $\frac{1}{\sigma} p_H^* x_H^* = (C_H + C_M) F_H$.

We assume log-linear technologies (consistently with our graphical representations in previous sections) and a uniform distribution of talents $G(z)$. Finally, we set

$$\sigma = 4 \tag{26}$$

as the benchmark value for the differentiation elasticity in preferences.

With this set of functional forms and parameter values, it is straightforward to calibrate the model: Figure 4 displays the three calibrated technologies.[15]

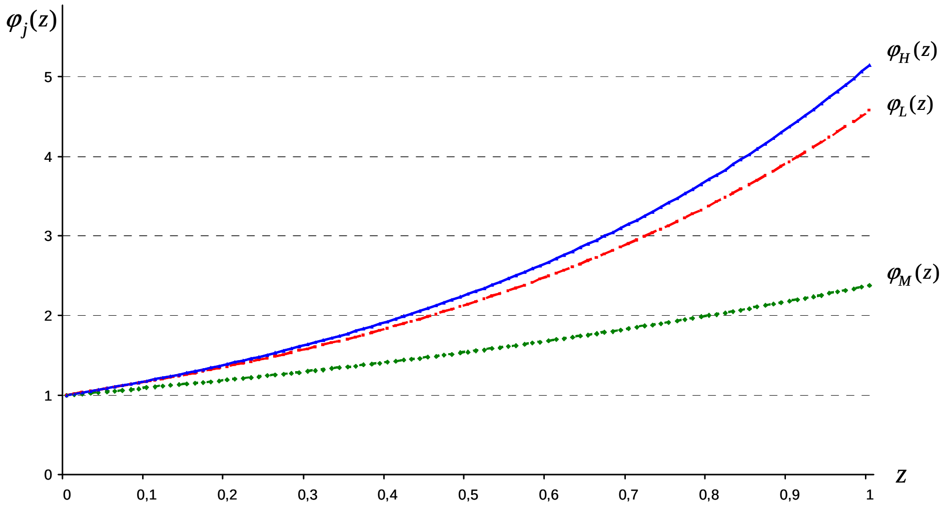

Figure 4: The three techologies

4.2 Welfare effects of globalization for alternative values of σ

Figure 5 reports the effect of globalization –measured on the horizontal axis by the level of the fixed cost of offshoring F_I– on the consumption price index P_X. Computations are reported for various values of the differentiation elasticity σ, and confirm our theoretical analysis.[16] We see that for realistic values of σ (i.e. for values not too different from 4)

[15] **Appendix 3** reports the calibrated benchmark equilibrium values.

[16] Changing the values of σ obviously implies recalibrating the model. Doing this, we maintain conditions (22) to (24) and the values of F_L and F_I unchanged so as to keep z_2 and the marginal costs C_M, C_L, C_H unchanged; the two cost parameters that are affected are θ and F_H. To $\sigma \in [3, 8]$ are associated the calibrated values of $\theta \in [.757, .919]$ and $F_H \in [1.136, 1.407]$. F_H is recalibrated so that $\frac{1}{\sigma} p_H^* x_H^* = (C_H + C_M) F_H$, as explained in footnote (14). See Appendix 3 for more information on which of the equilibrium variables are unaffected by changes in σ.

globalization comes with positive welfare gains even at the low-end of the skill ladder.[17]

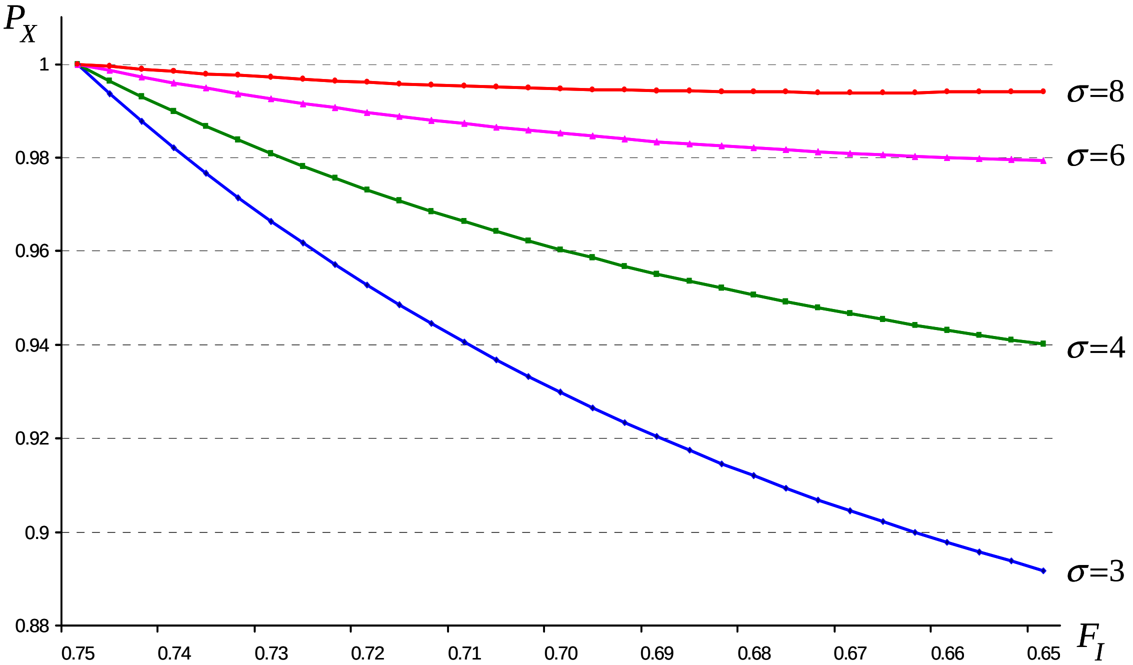

Figure 5: Impact of globalization on P_X (sensitivity w.r.t. to σ)

[17]How much of these results is due to the selection effect, and how much to the market-size expansion effect? We can get a rough idea of this by computing from (19) the impact on N_H of a reduction of F_I keeping z_2 constant, and comparing this with the equilibrium number of new MNs. In all the performed simulations, this ratio is below 10%.

5 Conclusion

It is widely believed both in academic and in policy circles, that globalization and massive offshore outsourcing to cheap labor countries will benefit some—mainly high-skilled—workers within the North, at the expense of the others. Yet, up to now, empirical investigation fails to provide evidence in support of this view.[18] Furthermore, in a country—Japan—where offshore outsourcing has been extensively practiced for decades, there seems to be strong evidence that vertical specialization by local multinationals has induced skill upgrading domestically (Head and Ries, 2002) with blue-collar workers being moved to more productive white-collar jobs within the same firms. This observed efficiency-improving reallocation of factors suggests that globalization need not be associated with falling real wages at the low-end of the skill ladder. Based on Yeaple (2005), we have developed a simple general equilibrium model with endogenously induced heterogeneity of firms from exogenously heterogeneous labor; these firms make explicit decisions on whether or not to fragment geographically their production so as to take advantage of favorable cost-conditions offshore. As globalization proceeds, making increasingly profitable the displacement of manufacturing activities to low-cost countries, workers in the North are endogenously moved to less repetitive more productive tasks. We have shown analytically that, under mild conditions, real wages will rise even at the low-end of the skill ladder. Numerical exploration of the model roughly calibrated on U.S. data confirms that those conditions are far from being unrealistic. The basic mechanism, technology upgrading at the individual firm level and skill upgrading of workers, is simple enough to be plain to, and deemed reasonable by, any citizen. Yet, the implications are unlikely to be easily understood by non economists because they hinge on general equilibrium effects that are far more abstract. We believe that the simplicity of the model will render those powerful GE effects transparent enough so that our paper will contribute to change the perception that globalization is a threat rather than an opportunity for all.

Needless to say, the model abstracts from important elements of the real world such

[18] There is ample evidence highlighting how globalization has increased wage inequality between skilled and unskilled workers; see Feenstra and Hanson (2003) for an excellent survey on this literature. However, as Feenstra (2007) argues, so far there is no evidence that real wages of unskilled (production) workers are negatively impacted by outsourcing.

as labor market imperfections: introducing rigidities could presumably inverse the conclusions.[19] But then the policy implication would clearly be that government action has to aim at reducing those imperfections, not at opposing to globalization as is often suggested:[20] more rigid labor markets can only enhance the attractiveness to firms of offshore options. Rather than thwarting adjustment, public action should aim at protecting workers rather than jobs: this, in particular, calls for extensive and flexible re-training programs that could indeed be costly to set-up. But it is clear that such public action would in any case stand as a top priority even in absence of globalization, in view of the ongoing aging of populations in the North.

[19] See Davidson et al. (2008) for an analysis that includes heterogeneous labor and search; they reach a very different conclusion.

[20] During his run for U.S. president, John Kerry, for instance, forcefully suggested changing the U.S. tax code to discourage offshore outsourcing practices by U.S. firms!

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Appendix 1:
Effect of globalization on the average wage

Let $\overline{w}$ be the average wage per worker; from (6) and (8):

$$\overline{w} = C_M \int_0^{z_1} \varphi_M(z)dG(z) + C_L \int_{z_1}^{z_2} \varphi_L(z)dG(z) + C_H \int_{z_2}^{\infty} \varphi_H(z)dG(z) \ ; \tag{27}$$

making use of (12), $\overline{w}$ becomes:

$$\overline{w} = (C_M + C_L) \int_0^{z_1} \varphi_M(z)dG(z) + C_H \int_{z_2}^{\infty} \varphi_H(z)dG(z) \ . \tag{28}$$

The consumption price index (3) can we written as:

$$P_X = \frac{1}{\rho} \left[N_L(C_L + C_M)^{1-\sigma} + N_H(C_H + \theta C_M)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{29}$$

so that, making use of (19) and rearranging, we get:

$$\begin{aligned} \left(\frac{\overline{w}}{\rho P_X}\right)^{\sigma-1} = & \left[(C_L + C_M) \int_0^{z_1} \varphi_M(z)dG(z) + C_H \int_{z_2}^{\infty} \varphi_H(z)dG(z) \right]^{\sigma-1} \cdot \\ & \left[\frac{1}{\sigma F_L} \int_0^{z_1} \varphi_M(z)dG(z)(C_L + C_M)^{1-\sigma} + \frac{1}{\sigma(F_H+F_I)} \int_{z_2}^{\infty} \varphi_H(z)dG(z)(C_H + \theta C_M)^{1-\sigma} \right] . \end{aligned} \tag{30}$$

Differentiating the RHS of this expression with respect to z_2, and making use of (8), (16), (17) and (19) yields:

$$\begin{aligned} \frac{dRHS(30)}{dz_2} = \ & \overline{w}^{\sigma-2} \cdot \theta C_M \cdot \\ & \left\{ (\sigma - 1) \ N_H \ \frac{(F_H+F_I)}{F_L} \frac{(C_L+C_M)^{-\sigma}}{C_L} (\overline{w} - N_L \sigma F_L) \frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1} \frac{dz_1}{dz_2} \right. \\ & + \ (\sigma - 1) \ N_H^2 \ \sigma C_L \ (F_H + F_I)(C_H + \theta C_M)^{-\sigma} \frac{d(\frac{\varphi_L(z_2)}{\varphi_H(z_2)})}{dz_2} \\ & \left. - \ \frac{1}{\sigma(F_H+F_I)} (C_H + \theta C_M)^{-\sigma} \varphi_H(z_2) dG(z_2) \overline{w} \right\} , \end{aligned} \tag{31}$$

an expression that is unambiguously negative since $\overline{w} - N_L \sigma F_L > 0$ from (27) and (19), $\frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1} < 0$, $\frac{d(\frac{\varphi_L(z_2)}{\varphi_H(z_2)})}{dz_2} < 0$ and $\frac{dz_1}{dz_2} > 0$. We have therefore shown that $\frac{d(\frac{\overline{w}}{P_X})}{dz_2} < 0$ that is, globalization unambiguously improves aggregate welfare.

Appendix 2:
Effect of globalization on price of aggregate consumption P_X

From (29) and making use of (19), we have :

$$[\rho P_X]^{1-\sigma} = \left[\frac{1}{\sigma F_L}\int_0^{z_1}\varphi_M(z)dG(z)(C_L+C_M)^{1-\sigma} + \frac{1}{\sigma(F_H+F_I)}\int_{z_2}^{\infty}\varphi_H(z)dG(z)(C_H+\theta C_M)^{1-\sigma}\right]. \tag{32}$$

Totally differentiating the RHS of (32) with respect to z_2 and making use of (8), we obtain:

$$\begin{aligned}\frac{dRHS(32)}{dz_2} = {} & (1-\sigma)\left[\frac{1}{\sigma F_L}\int_0^{z_1}\varphi_M(z)dG(z)(C_L+C_M)^{-\sigma}\frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1}\right. \\ & \left. + \frac{1}{\sigma(F_H+F_I)}\int_{z_2}^{\infty}\varphi_H(z)dG(z)(C_H+\theta C_M)^{-\sigma}\frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1}\frac{\varphi_L(z_2)}{\varphi_H(z_2)}\right]\frac{dz_1}{dz_2} \\ & + \left[\frac{1}{\sigma F_L}\varphi_M(z_1)dG(z_1)(C_L+C_M)^{1-\sigma}\frac{dz_1}{dz_2} - \frac{1}{\sigma(F_H+F_I)}\varphi_H(z_2)dG(z_2)(C_H+\theta C_M)^{1-\sigma}\right] \\ & +(1-\sigma)\frac{1}{\sigma(F_H+F_I)}\int_{z_2}^{\infty}\varphi_H(z)dG(z)(C_H+\theta C_M)^{-\sigma}\frac{\varphi_M(z_1)}{\varphi_L(z_1)}\frac{d(\frac{\varphi_L(z_2)}{\varphi_H(z_2)})}{dz_2}.\end{aligned} \tag{33}$$

With (19) and (8) , the first bracket-term simplifies to:

$$(1-\sigma)(C_L+C_M)^{-\sigma}\left[N_L + N_H\left(\frac{C_H+\theta C_M}{C_L+C_M}\right)^{-\sigma}\frac{C_H}{C_L}\right]\frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1}\frac{dz_1}{dz_2}$$

which, making use of (17) simplifies further to:

$$(1-\sigma)(C_L+C_M)^{-\sigma}\left[N_L + N_H\frac{F_H+F_I}{F_L}\frac{C_H}{C_L}\right]\frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1}\frac{dz_1}{dz_2}\ . \tag{34}$$

From (16) and (8), $\frac{dz_1}{dz_2}$ can be written as:

$$\frac{dz_1}{dz_2} = \frac{C_H}{C_L}\frac{C_M}{C_L+C_M}\frac{\varphi_H(z_2)dG(z_2)}{\varphi_L(z_1)dG(z_1)}\ ;$$

substitution in the second bracket-term of (33) yields:

$$\frac{1}{\sigma F_L}(C_L+C_M)^{1-\sigma}\left[\frac{C_H}{C_L}\frac{C_M}{C_L+C_M}\frac{\varphi_M(z_1)}{\varphi_L(z_1)} - \frac{F_L}{F_H+F_I}\left(\frac{C_H+\theta C_M}{C_L+C_M}\right)^{1-\sigma}\right]\ \varphi_H(z_2)\ dG(z_2),$$

which, from (8) and (17), simplifies to:

$$-\theta C_M\frac{1}{\sigma F_L}(C_L+C_M)^{-\sigma}\varphi_H(z_2)dG(z_2). \tag{35}$$

Making use of (17) and (8), the third bracket-term of (33) can be written as:

$$(1-\sigma)\ \frac{1}{\sigma F_L}\ (C_L + C_M)^{-\sigma} \int_{z_2}^{\infty} \varphi_H(z) dG(z)\ \frac{C_L}{C_M}\ \frac{d(\frac{\varphi_L(z_2)}{\varphi_H(z_2)})}{dz_2}\ . \tag{36}$$

Finally, making use of (34), (35) and (36) to rearrange (33), we obtain:

$$\begin{aligned} \frac{dRHS(32)}{dz_2} = &\ (1-\sigma)(C_L + C_M)^{-\sigma} \left[N_L + N_H \frac{F_H + F_I}{F_L} \frac{C_H}{C_L} \right] \frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1} \frac{dz_1}{dz_2} \\ &+ \frac{(C_L + C_M)^{-\sigma}}{\sigma F_L} \left[(1-\sigma) \int_{z_2}^{\infty} \varphi_H(z) dG(z)\ \frac{C_L}{C_M}\ \frac{d(\frac{\varphi_L(z_2)}{\varphi_H(z_2)})}{dz_2} - \theta C_M\ \varphi_H(z_2) dG(z_2) \right] . \end{aligned}$$

Given that $\frac{d(\frac{\varphi_M(z_1)}{\varphi_L(z_1)})}{dz_1} < 0$ and that $\frac{dz_1}{dz_2} > 0$, the first term is unambiguously positive; given that $\frac{d(\frac{\varphi_L(z_2)}{\varphi_H(z_2)})}{dz_2} < 0$, the second term will be negative if σ is not too large. The impact of globalization on P_X will therefore be negative only if there is enough product differentiation, that is, if σ is small enough.

Appendix 3:
Calibrated initial equilibrium (for alternative values of σ)
and simulated effects of globalization

Benchmark case

$\sigma = 4$	F_I				
	0.750	0.727	0.704	0.681	0.657
θ	0.820	0.820	0.820	0.820	0.820
F_H	1.186	1.186	1.186	1.186	1.186
F_L	1.000	1.000	1.000	1.000	1.000
z_1	0.700	0.655	0.612	0.569	0.528
z_2	0.969	0.920	0.871	0.823	0.776
C_M	1.000	1.000	1.000	1.000	1.000
C_L	0.632	0.651	0.670	0.689	0.708
C_H	0.564	0.584	0.605	0.625	0.646
p_L	2.176	2.202	2.227	2.252	2.277
p_H	1.845	1.872	1.899	1.927	1.954
x_L	3.000	3.000	3.000	3.000	3.000
x_H	5.808	5.739	5.669	5.600	5.530
N_L	0.241	0.220	0.202	0.184	0.168
N_H	0.020	0.051	0.079	0.106	0.131
Inc	1.659	1.682	1.708	1.737	1.768
P_X	3.352	3.279	3.225	3.186	3.158

$\sigma = 3$	F_I				
	0.750	0.727	0.704	0.681	0.657
θ	0.757	0.757	0.757	0.757	0.757
F_H	1.136	1.136	1.136	1.136	1.136
F_L	1.000	1.000	1.000	1.000	1.000
z_1	0.700	0.650	0.601	0.554	0.509
z_2	0.969	0.914	0.860	0.806	0.752
C_M	1.000	1.000	1.000	1.000	1.000
C_L	0.632	0.653	0.675	0.696	0.717
C_H	0.564	0.587	0.610	0.633	0.656
p_L	2.448	2.480	2.512	2.543	2.575
p_H	1.982	2.015	2.050	2.084	2.119
x_L	2.000	2.000	2.000	2.000	2.000
x_H	3.773	3.727	3.680	3.634	3.588
N_L	0.321	0.291	0.263	0.237	0.213
N_H	0.028	0.074	0.117	0.157	0.195
Inc	1.659	1.685	1.714	1.748	1.784
P_X	4.064	3.908	3.793	3.706	3.640

$\sigma = 6$	F_I				
	0.750	0.727	0.704	0.681	0.657
θ	0.885	0.885	0.885	0.885	0.885
F_H	1.292	1.292	1.292	1.292	1.292
F_L	1.000	1.000	1.000	1.000	1.000
z_1	0.700	0.664	0.628	0.594	0.561
z_2	0.969	0.929	0.890	0.851	0.813
C_M	1.000	1.000	1.000	1.000	1.000
C_L	0.632	0.648	0.663	0.678	0.693
C_H	0.564	0.581	0.597	0.613	0.629
p_L	1.959	1.977	1.995	2.013	2.031
p_H	1.739	1.759	1.778	1.798	1.817
x_L	5.000	5.000	5.000	5.000	5.000
x_H	10.208	10.092	9.976	9.861	9.745
N_L	0.160	0.149	0.139	0.129	0.120
N_H	0.013	0.029	0.043	0.057	0.071
Inc	1.659	1.677	1.697	1.719	1.743
P_X	2.749	2.726	2.711	2.700	2.694

$\sigma = 8$	F_I				
	0.750	0.727	0.704	0.681	0.657
θ	0.919	0.919	0.919	0.919	0.919
F_H	1.407	1.407	1.407	1.407	1.407
F_L	1.000	1.000	1.000	1.000	1.000
z_1	0.700	0.670	0.641	0.613	0.585
z_2	0.969	0.936	0.904	0.872	0.841
C_M	1.000	1.000	1.000	1.000	1.000
C_L	0.632	0.645	0.657	0.670	0.682
C_H	0.564	0.578	0.591	0.604	0.618
p_L	1.866	1.880	1.894	1.908	1.922
p_H	1.695	1.710	1.725	1.740	1.756
x_L	7.000	7.000	7.000	7.000	7.000
x_H	15.096	14.934	14.772	14.610	14.448
N_L	0.120	0.114	0.107	0.101	0.095
N_H	0.009	0.018	0.027	0.036	0.044
Inc	1.659	1.674	1.690	1.707	1.725
P_X	2.475	2.467	2.463	2.461	2.461