Globalization, Wage Volatility and the Welfare of Workers

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Abstract

We address the impact of globalization on the volatility of factor returns, when volatility arises from domestic, sector-specific productivity shocks. We show that, because factor returns in tradables are more volatile than in non-tradables, an increase in the terms-of-trade may reduce wages and the welfare of workers. We analyze also the impact of protectionism on the income and welfare of capitalists and workers.

Keywords: income distribution, trade and wages, wage volatility, globalization.

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1 Introduction

This paper looks the role of 'globalization' in explaining (a) the decline in real wages and (b) the increase in earnings volatility, which characterize labor markets in the United States and other industrialized countries, for the last two decades[1]. The main contributions are to uncover how 'globalization' expands the volatility of factor returns, and to show that, in the absence of insurance markets, the increase in volatility brings down wage-levels and the welfare of workers and improves the return to capitalists, because the latter can hedge risk through diversi…cation. Hence we establish that: not only when it arises due to a country's relative capital abundance, does international trade increase the gap between capitalists and workers[2].

Globalization increases the volatility of factor returns by expanding the share of factors (capital and labor) allocated to the goods in the tradable sector, because returns in tradables are more volatile than in non-tradables. In our setting, volatility arises from independent and identically distributed good- and country-speci…c productivity shocks. Taking markets to be competitive, this yields that the factor-demand, given by the value of the marginal product, is stochastic. Now, in a tradable good, the impact of a productivity shock on the marginal product is fully transmitted onto factor-demand, since international competition makes the good's price unchangeable. In contrast, in a non-tradable good, the impact on factor-demand is smaller than the shock to marginal productivity, because the absence of foreign substitutes creates a con‡icting e¤ect on the price of the good. When the cost of reallocating capital and labor across goods is prohibitive, a smoother impact of productivity shocks on factor-demand in non-tradable goods yields a higher volatility of factor returns in the tradable sector. Hence we link the size of the tradable sector and the average volatility of an individual worker's wage[3].

[1] For a survey of the empirical studies documenting the decline in real wages, see Cline (1997). For evidence on the increase in the short-term volatility of wages, see Gottschalk and Mo¢t (1994, 1997): between one-third and one-half on the widening wage distribution from the 1970's to the 1980's can be attributed to the increase in the short-term variance of earnings.

[2] Unlike the Stolper-Samuelson theorem, from the neoclassical model of comparative advantage, the impact of volatility addressed here bene…ts capital and hurts labor regardless of their relative scarcity. The volatility e¤ect of 'globalization' on (the level of) factor returns works independently of, and in addition to, the Stolper-Samuelson e¤ect.

[3] Rodrik (1997) argues that the increase in foreign competition increases the elasticity of demand (for goods), ‡attening the labor demand curve, which yields that shocks to

The main assumption in this paper is that there is a difference in the ability of capitalists and workers to allocate their endowments across different goods, which hinges on their ability to hedge risk. On the one hand, workers, who own one indivisible unit of labor, must allocate it entirely to the same good. On the other, capital is perfectly divisible and a capitalist's endowment can be spread across different goods, as she builds a diversified portfolio. Since productivity shocks are independent across goods, diversification enables capitalists to hedge against risk, while workers have to endure the uncertainty of the wage in the industry they have chosen. Thus, in the absence of insurance markets for income risk, even if risk-aversion is similar across individuals, the shadow price of the volatility of returns is higher for workers than for capitalists[4]. Consequently, workers disfavor the tradable sector due to the uncertainty of returns, which has two important consequences: (a) the tradable sector is more capital intensive than the non-tradable sector, and (b) expected wages are higher in the tradable sector, to compensate for volatility[5].

To understand the impact of globalization on workers and capitalists, we analyze the consequences of an increase in the terms-of-trade. By increasing the profitability in the tradable sector, an increase in the terms-of-trade attracts workers and capitalists to this sector (thus globalization). And since the tradable sector is more capital intensive, 'globalization' yields a decline in capital intensity in each good, in order to preserve full-employment[6]. Hence,

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productivity imply stronger shifts in employment and earnings (p. 20). Rodrik suggests also that an important part of the volatility of income arises from external risk associated with the terms-of-trade volatility (p. 55). In our setting, taking income risk to arise also from the terms-of-trade would expand further the volatility of returns in the tradable sector (relative to non-tradables), thus strenghtening our results.

[4] The hypothesis that workers do not hedge risk by acquiring skills and accepting part-time jobs in different sectors, might be due to the presence of economies of scale in on-the-job learning - see Matusz (1985) and Fernandez (1992). On the other hand, since risk is idiosyncratic, the volatility of a worker's income could be hedged against by insurance markets. However, we assume away the presence of such markets, given the informational and contractual difficulties involved (e.g. hidden actions, adverse selection).

[5] Gourrinchas (1998) shows that the tradable sector is, on average, more capital intensive than the non-tradable sector. Looking specifically at the exportable sector, Bernard and Jensen (1995) argue that it is more capital intensive and pays a higher average wage.

[6] The impact of the expansion of the tradable sector on capital intensity, is similar to an expansion of the capital-intensive sector in the neo-classical model. In our model, the ranking of the capital intensity of tradables and non-tradables is endogenously determined by volatility, while in the neo-classical model the raking of the exportable and the

there are two effects of the terms-of-trade increase: first, the income effect, due to the increase in purchasing power of exports, works to expand the wage and the rate-of-return on capital; second, the volatility effect, capturing the impact of the decline in capital intensity on the marginal product, works to lower the wage and expand the return on capital. If the degree of openness is sufficiently low, the volatility effect dominates the income effect, and an increase in the terms-of-trade brings down the wage and reduces the welfare of workers.

These results shed new light on the stylized facts mentioned at the start. On one hand, the expansion of the tradable sector, where wage volatility is higher, justifies the expansion in earnings volatility documented in Gottschalk and Moffitt (1994, 1997). On the other, the predicted decline in real wages fits well the evidence of a decline in wages in industrialized countries during the last twenty years. Recently, a consensus has emerged that downplays the role of trade with developing countries, normally a chief suspect due to the Stolper-Samuelson theorem, - with the blame falling, by default, on technological change (for a survey of the literature, see Cline, 1997). Our results suggest that 'globalization' has contributed to the wage decline also through its impact on volatility. Remarkably, the feeble degree of openness to trade in the United States and other industrialized economies, which undermines the explanatory power of factor content theories, increases the likelihood that the volatility effect has played an important role in the wage decline.

Finally, we look at the scope for policy intervention. Government policies that reduce the volatility of disposable income, through ex-post redistributive policies, or the volatility of factor returns, through state-contingent price interventions (e.g. contingent protection) constitute second best solutions to the absence of insurance markets[7]. However, as Dixit (1987, 1989a and 1989b) argues, the same market failures that bring down insurance markets, can undermine the case for these policies, and an appropriate analysis should model explicitly the reason for the break down of insurance markets.

With this caveat in mind, we address the impact of protectionism by looking at the implications of an across the board tariff on imports, whose

importable sector is given exogenously by technology.

[7] Eaton and Grossman (1985) show that contingent protection can enhance welfare by hedging external risk from terms-of-trade volatility, in the absence of insurance markets. Rodrik (1997) suggests that a widely used mechanism to provide insurance against external risk is the expansion of safe government jobs.

revenues are distributed lump-sum[8]. From a redistributive standpoint, protectionism reduces inequality, bringing down the gap between capitalists and workers, since the volatility effect of the ensuing expansion of the non-tradable sector implies an increase in wages and a decline in the return to capital. However, protectionism is ineffective to correct the lack of insurance markets, and reduces aggregate welfare.

The next section presents the model. Section three looks at the effect of globalization, under complete markets. Section four analyzes the case where workers cannot insure against income risk. Section five studies the impact of trade policy, and section six concludes.

2 The model

Take an economy composed of three sectors: the non-tradable (n), the importable (i) and the exportable (x). Each sector contains a continuum of measure one of goods. Only the goods in the first two sectors are consumed domestically, and only those in the non-tradable and exportable sectors are produced domestically. We denote goods by: $z_{j\in n}$ if it is non-tradable, by $z_{j\in i}$ if it is importable, and by $z_{j\in x}$ if exportable. The output of tradable (exportable) and non-tradable goods is stochastic, due to good specific productivity shocks.

The economy is composed by a continuum of measure one of capitalists and a continuum of measure one of workers. Each capitalist owns one unit of capital, and each worker one unit of labor, which implies that the total amount of labor and capital in the economy is normalized to one. We set up a static model, assuming the absence of a market for intertemporal securities, i.e. there are no savings.

[8] Here, a tariff is seen as protectionism because it expands the non-tradable sector, thus reducing the economy's degree of openness, without influencing the volatility of income or factor returns. Our main goal is to analyze wether governments should hinder the speed of 'globalization', in response to the demand from political groups concerned with the deterioration of the welfare of workers. See, for example, "Sharing Prosperity", the cover story in Business Week, September 1, 1997.

2.1 Product Markets

2.1.1 Demand

Preferences are identical for workers and capitalists, given by the CRRA utility function,

$$V \equiv C^{1-\rho} \tag{1}$$
$$C \equiv \left(\int z_{j\in n}^{\frac{\varepsilon-1}{\varepsilon}} + \int z_{j\in i}^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad \varepsilon > 1$$

where ρ is the coefficient of relative risk aversion, and ε is the elasticity-of-substitution.

Assuming a small open economy, the relative prices among tradable goods are given from abroad. We assume that they are not random. Furthermore, and without loss of generality, we assume that (a) the relative price between any two importables is unitary, (b) the relative price between any two exportables is also unitary, and (c) the relative price between an exportable and an importable is given by τ, which we address as the terms of trade. Taking aggregate nominal expenditure as the numeraire, we use p_x to denote the price of each and every exportable good, while $\tau^{-1}p_x$ denotes the price of each and every importable good.

Letting $p_{j\in n}$ denote the price of non-tradable good j, in terms of the numeraire, we define the CPI (Π), i.e. the consumer price index, as:

$$\Pi \equiv \left[\pi_n^{1-\varepsilon} + \tau^{\varepsilon-1} p_x^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{2}$$
$$\pi_n \equiv \left(\int_0^1 p_{j\in n}^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}}$$

where π_n captures the price index for non-tradables.

Now, since there are no savings, a consumer's expenditure is her income. Therefore, the welfare of a consumer with income I is given by

$$V_I = (I/\Pi)^{1-\rho} \tag{3}$$

while her demand for a non-tradable and an importable good are given, respectively, by $z^d_{Ij\in n} = p_{j\in n}^{-\varepsilon} \Pi^{\varepsilon-1} I$ and $z^d_{Ij\in i} = \tau^{\varepsilon} p_x^{-\varepsilon} \Pi^{\varepsilon-1} I$. Since preferences are homothetic and aggregate expenditure is the numeraire, we obtain

$$z^d_{j\in n} = \frac{p_{j\in n}^{-\varepsilon}}{\Pi^{1-\varepsilon}}; \qquad z^d_{j\in i} = \frac{\tau^{\varepsilon} p_x^{-\varepsilon}}{\Pi^{1-\varepsilon}} \tag{4}$$

where $z^d_{j\in n}$ and $z^d_{j\in i}$ are the aggregate demand for a non-tradable and an importable, respectively.

2.1.2 Supply

If we assume for a moment that there is no international market for state-dependent securities, then trade is balanced in all states of nature[9]. Given that the quantity consumed of each importable is identical (see 4), we obtain: $z_i = \tau \int z_{j\in x}$, where z_i is the quantity consumed of each and every importable. Meanwhile, by definition, the demand for each non-tradable good has to be satisfied by domestic production of the same good. Now, from (2) and (4), these equilibrium conditions in product markets for the tradable sector and for each non-tradable good yield, respectively,

$$
\begin{aligned}
p_x &= \tau^{\frac{\varepsilon-1}{\varepsilon}} \left(\int z_{j\in x}\right)^{-\frac{1}{\varepsilon}} \lambda^{\frac{\varepsilon-1}{\varepsilon}} \\
\pi_n &= \left(\int z_{j\in n}^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{1}{1-\varepsilon}} \lambda^{\frac{\varepsilon-1}{\varepsilon}}
\end{aligned}
\tag{5}
$$

where $z_{j\in n}$ and $z_{j\in n}$ denote, respectively, the domestic output of a non-tradable good and an exportable good j. Finally, using (2) to substitute for λ in (5), we obtain

$$
\lambda = \left[\int z_{j\in n}^{\frac{\varepsilon-1}{\varepsilon}} + \tau^{\frac{\varepsilon-1}{\varepsilon}} \left(\int z_{j\in x}\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{1-\varepsilon}} \tag{6}
$$

2.2 Factor Markets

The income of capitalists and workers arises from the returns obtained by the factors in the production of non-tradable and exportable goods.

[9] This assumption corresponds to the absence of an international insurance market for income risk, and can be justified at two levels. On one hand, in the presence of domestic insurance markets, international markets are redundant, since, as we will see, all risk in this model is idiosyncratic and diversifiable domestically. On the other hand, in the absence of domestic insurance, it can be argued that the market failures that lead to the break down of domestic insurance markets undermine also the potential for insurance contracts with foreign providers, in particular to insure a worker's income. Hence, our assumption does not entail much loss of generality, and is useful mostly for expository purposes.

2.2.1 Technology

Technologies are similar for all goods produced domestically, whether exportable or non-tradable. In particular, the production function for good j, in the non-tradable or the exportable sector, is given by:

$$z_j = A_j l_j^{\alpha} k_j^{1-\alpha} \qquad j \in n \cup x \tag{7}$$

where A_j is the productivity parameter, l_j is the amount of labor and k_j is the amount of capital. The productivity parameter A_j is a random variable, independent across goods, with $E(A_j) = 1$ and $Var(A_j) = \sigma^2$. Hence σ^2 measures the dispersion of the distribution of A_j, capturing the exogenous uncertainty in the model.

2.2.2 Allocation

Labor and capital are allocated to each good before the realization of A_j, and cannot be reallocated across goods afterwards, due to the presence of an entry cost (e.g. the accumulation of good specific human capital, or the installation of good specific equipment).

Nevertheless, both capital and labor can move between different firms producing the same good. Assuming a large number of firms producing each good, inter-firm mobility implies that product and factor markets for each good are perfectly competitive, with factor returns given by the value of the marginal product. Since productivity shocks are good specific, factor returns are random and independent across goods. To set notation, let r_j and w_j denote respectively, the rate-of-return and the wage in good j (in the non-tradable or exportable sector) in terms of the numeraire. Then, from (7), they are given by

$$w_j = \alpha \frac{p_j z_j}{l_j}; \qquad r_j = (1-\alpha)\frac{p_j z_j}{k_j} \qquad j \in n \cup x \tag{8}$$

The only and crucial difference between capitalists and workers in this paper is in their ability to spread the allocation of their endowments across different goods, which hinges on their ability, as risk-averse agents, to diversify away risk. On the one hand, each worker owns one indivisible unit of labor, which he must allocate entirely to a single good. On the other, capital is perfectly divisible and a capitalist can spread her endowment between different goods, as she builds a diversified portfolio.

2.2.3 A capitalist's portfolio

For the representative capitalist, the allocation of capital arises through the maximization of the expected utility from the return to her portfolio: $E(V_r)$, which given (3), is given by:

$$E(V_r) \equiv \max_{t_j} E\left(\int t_j \frac{r_j}{\Pi}\right)^{1-\rho} \quad st \quad \int t_j = 1 \qquad j \in n \cup x$$

where t_j is the share of capital to allocate to each good, while $\int t_j r_j$ denotes the return to the portfolio. The capitalist takes as given the rate of return for any given asset, as in (8), and the price level, as in (6), to obtain the optimal portfolio. Given that each good is infinitesimal in a capitalist's consumption basket, the rate of return in any good is not correlated with Π, i.e. the return on any asset is not correlated with the marginal utility of consumption. Since the rate-of-return in any asset is independent of other assets and the number of assets is infinite, a capitalist can obtain a risk-free portfolio by fully diversifying her holdings. Consequently, the equilibrium implies that the expected rates-of-return have to be identical across goods:

$$E(r_j) = E(r_{j'}) \qquad \forall j; j' \in n \cup x \tag{9}$$

Moreover, full diversification to minimize risk implies that each capitalist will span her assets across all goods, exportable or non-tradable, yielding that $t_j > 0; \forall j \in n \cup x$. Since all capitalists choose the same (optimal) risk-free portfolio, the income (I_r) and the expected utility of a representative capitalist are given, respectively, by

$$\begin{aligned} I_r &= E(r_j) \quad \text{for any } j \in n \cup x \\ E(V_r) &= (I_r/E(\Pi))^{1-\rho} \end{aligned} \tag{10}$$

2.2.4 Labor

Workers, who cannot diversify, have different wages, depending on the productivity shock in the good they choose to work on, thus bearing risky returns. The volatility of their consumption depends on the existence of an insurance market for income risk or of state-dependent securities. Letting I_{wj} denote the income of a worker who has chosen good j in either sector, we have that: in the absence of insurance markets, the income corresponds to the wage, $I_{wj} = w_j$; otherwise, it depends on the insurance contracts offered. Finally, since workers are identical ex-ante, in equilibrium they must be indifferent between committing into the production of any good. Letting $E(V_w)$ denote the expected utility of the representative worker in equilibrium (see 3), the labor market equilibrium condition yields:

$$E\left(I_{wj}/\pi\right)^{1-\rho} = E\left[\left(I_{wj'}/\pi\right)^{1-\rho}\right] \equiv E(V_w) \qquad \forall j; j' \in n \cup x \tag{11}$$

2.2.5 Symmetry

Given (8), it is straightforward to see that if two goods j and j' in the same sector (e.g. non-tradables, exportables) employ the same amount of capital and labor, then conditions (9) and (11) hold between these two goods. Hence, the class of allocations that is symmetric within each sector, i.e. where the amount of capital and labor is identical for all goods in the same sector, satisfies the conditions of the competitive equilibria. We restrict our analysis to this subset of allocations.

To set notation, henceforth, we take l_x and k_x to denote the amount of labor and capital, respectively, employed in each and every exportable good. Since the exportable sector is a continuum of measure one of exportable goods, we obtain that l_x and k_x capture also the total amount of labor and capital, respectively, in the exportable sector.

Similarly, letting l_n and k_n denote the amount of labor and capital, respectively, employed in each and every non-tradable good, they denote the total amount of labor and capital in the non-tradable sector. Moreover, since the endowments of labor and capital in the economy are normalized at one, we can write: $l_n = (1 - l_x)$ and $k_n = (1 - k_x)$.

Thus, l_x and k_x, capturing the total amount of labor and capital in the exportable sector, fully characterize the allocation, with the output in an exportable and a non-tradable good given, respectively, by:

$$z_{j\in x} = A_j l_x^{\alpha} k_x^{1-\alpha}; \qquad z_{j\in n} = A_j (1 - l_x)^{\alpha} (1 - k_x)^{1-\alpha} \tag{12}$$

To ensure that l_x and k_x describe an equilibrium, we must verify that (9) and (11) are satisfied when two goods are in different sectors. This implies that a worker in (any of) the exportable goods has the same ex-ante utility as his counterpart in the non-tradable sector, and that goods in the non-tradable and the exportable sectors have the same expected rate-of-return, i.e.

$$
\begin{aligned}
E\left(l_{wj\in x}/\Pi\right)^{1-\rho} &= E\left[\left(l_{wj\in n}/\Pi\right)^{1-\rho}\right] \\
E\left(r_{j\in x}\right) &= E\left(r_{j\in n}\right)
\end{aligned}
\tag{13}
$$

2.2.6 Aggregate risk

Now, given (12), the output of the each good depends only on the sector it is in and on the realization of the i.i.d. productivity shock. Hence, since there is a continuum of goods in each sector, the law of large numbers implies that sectoral output in non-tradables and tradables is constant, and there is no aggregate risk. Following Judd (1985), the law-of-large-numbers yields that if A_j is a continuum of measure one of i.i.d. random variables $\int A_j^q = E(A_j^q)$, which, substituting (12) in (6), implies

$$
\Pi = \left[\Psi^{\frac{\varepsilon-1}{\varepsilon}}(1-k_x)^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}}(1-l_x)^{\alpha\frac{\varepsilon-1}{\varepsilon}} + \tau^{\frac{\varepsilon-1}{\varepsilon}}k_x^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}}l_x^{\alpha\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{1-\varepsilon}} \tag{14}
$$

where

$$
\Psi \equiv E\left(A_j^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{15}
$$

captures the expected marginal profitability for a good in the non-tradable sector, - taking into account the impact in the price. Hence we obtain:

Lemma 1 There is no aggregate or sectoral consumption risk in the economy; i.e. Π, p_x and π_n are non-stochastic.

Proof. Equation (14) shows that Π does not depend on the realization of the productivity shocks. Using (12) to substitute for $\int z_{j\in x}$ and $\int z_{j\in n}^{\frac{\varepsilon-1}{\varepsilon}}$ in (5), it is immediate that if Π is non-stochastic, the law-of-large numbers yields also that π_n and p_x are non-stochastic ■

The ratio π_n/p_x can be seen as the real exchange rate. Since p_x and π_n are not random, the real exchange rate is also not random. In non-tradables, the price index is constant because, even if productivity shocks can make the price of individual goods variable, the law-of-large-numbers implies that this volatility disappears on aggregate. For the tradable sector, if a given exportable good were large relative to the economy, a positive shock in its productivity would imply a decline in p_x, to induce a surge in imports that would keep trade balanced. However, this volatility disappears here, because each good is a small part of the economy and productivity shocks are good specific.

2.2.7 Factor returns

Finally, we obtain the expression for factor returns in each sector. Substituting (5) and (12) in (8), and taking Π as given in (14), the wage and rate-of-return in an exportable good, denoted respectively by $w_{j\in x}$ and $r_{j\in x}$, are given by:

$$
\begin{aligned}
w_{j\in x} &= \alpha\tau^{\frac{\varepsilon-1}{\varepsilon}} A_j l_x^{\alpha\frac{\varepsilon-1}{\varepsilon}-1} k_x^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}} \Pi^{\frac{\varepsilon-1}{\varepsilon}} \\
r_{j\in x} &= (1-\alpha)\tau^{\frac{\varepsilon-1}{\varepsilon}} A_j\, l_x^{\alpha\frac{\varepsilon-1}{\varepsilon}} k_x^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}-1} \Pi^{\frac{\varepsilon-1}{\varepsilon}}
\end{aligned}
\tag{16}
$$

On the other hand, from (4) we have $p_{j\in n}z_{j\in n} = z_{j\in n}^{\frac{\varepsilon-1}{\varepsilon}} \Pi^{\frac{\varepsilon-1}{\varepsilon}}$, which given (12) implies that the wage and rate-of-return for a non-tradable good, respectively $w_{j\in n}$ and $r_{j\in n}$, are given by

$$
\begin{aligned}
w_{j\in n} &= \alpha A_j^{\frac{\varepsilon-1}{\varepsilon}} (1-l_x)^{\alpha\frac{\varepsilon-1}{\varepsilon}-1} (1-k_x)^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}} \Pi^{\frac{\varepsilon-1}{\varepsilon}} \\
r_{j\in n} &= (1-\alpha)A_j^{\frac{\varepsilon-1}{\varepsilon}} (1-l_x)^{\alpha\frac{\varepsilon-1}{\varepsilon}} (1-k_x)^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}-1} \Pi^{\frac{\varepsilon-1}{\varepsilon}}
\end{aligned}
\tag{17}
$$

Comparing (16) and (17), and since $\varepsilon > 1$, a striking feature is that the exponent of the random productivity parameter is lower in the case of a non-tradable good. This implies that the volatility of factor returns is lower for the goods in the non-tradable sector.

The volatility of factor returns differs between the two sectors because the effect of the productivity shock on the price of the good is different in tradable and non-tradable goods. In a tradable good, the productivity shock does not affect the relative prices price because the relative price with respect to other tradables is given from abroad, and the good constitutes too small a part of the tradable sector to affect the real exchange rate (see equation 5). Hence, the productivity shock affects factor returns in a tradable good to the full extent of its impact on marginal productivity.

In contrast, in a non-tradable good, the productivity shock inversely affects the price of the good; for example, a negative shock to productivity increases the price because the quantity supplied domestically falls and demand must be entirely satisfied by local producers. The conflicting impact of the productivity shock on the price and the marginal product reduces the volatility of the value of the marginal product, i.e. of factor returns, in non-tradable goods. Hence, using the coefficient of variation to measure the volatility of returns, we obtain:

Lemma 2 The coefficient of variation of factor returns is lower in non-tradable goods than in tradable goods.

Proof. Let $C(X) \equiv VarX/(EX)^2$ denote the coefficient of variation of a random variable X. Given (16) and (17), we have: $C(w_{j\in x}) = C(r_{j\in x}) = C(A_j) = \sigma^2$ and $C(w_{j\in n}) = C(r_{j\in n}) = C\left(A_j^{\frac{\varepsilon-1}{\varepsilon}}\right)$. Taking a first-order approximation of $A_j^{\frac{\varepsilon-1}{\varepsilon}}$ around $E(A_j) = 1$, we obtain: $C\left(A_j^{\frac{\varepsilon-1}{\varepsilon}}\right) \simeq \left(\frac{\varepsilon-1}{\varepsilon}\right)^2 \sigma^2 < C(A_j)$ ■

3 A Benchmark: Complete Markets

Under complete markets, perfect competition between insurers hedges the volatility of a worker's income. Since there are an infinite number of workers with identical, independent wage distributions, in both the exportable and non-tradable sector, an insurance company can pool the workers in each sector and promise to pay the expected wage with certainty. Hence, using the superscript "^" to denote the variables under complete markets, and since ¦ is non-stochastic, a worker's income and expected utility are given, respectively, by

$$
\begin{aligned}
\hat{I}_{w\, j\in n\cup x} &= E(\hat{w}_{j\in n\cup x}) \qquad (18)\\
E(\hat{V}_w) &= \frac{\left[E(\hat{w}_{j\in n\cup x})\right]^{1-\rho}}{\hat{P}}
\end{aligned}
$$

Capitalists do not need insurance, since they are able to hedge the volatility of the returns in the different goods through a diversified portfolio. Thus, under complete markets, (13) becomes:

$$
\begin{aligned}
E(\hat{w}_{j\in n}) &= E(\hat{w}_{j\in x}) \qquad (19)\\
E(\hat{r}_{j\in n}) &= E(\hat{r}_{j\in x})
\end{aligned}
$$

From (16) and (17), we obtain that the equilibrium conditions above yield

$$\hat{k}_x = \hat{l}_x = (1+\mu^{\varepsilon})^{-1} \quad \text{with } \mu \equiv (\alpha/\gamma)^{\frac{\varepsilon-1}{\varepsilon}} \qquad (20)$$

where $\hat{l}_x$ and $\hat{k}_x$ denote the tradable sector's share of labor and capital, respectively, under complete markets. The term μ compares the expected profitability in the non-tradable sector relative to the tradable sector.

An increase in the terms-of-trade expands the share of capital and labor in the tradable sector,- see (20),- thus increasing the economy's degree of openness. Hence we use it to capture the consequences of globalization. The improvement in the terms-of-trade has an income effect, which constitutes a standard result in models of international trade[10]. Therefore we obtain:

Proposition 3 *An increase in the terms-of-trade τ increases the expected real wage and rate-of-return in all goods. Hence, it expands the real income and welfare of workers and capitalists.*

Proof. Taking as a reference a good in the non-tradable sector (see equation 19), substituting (20) in (14) and (17), the expected real wage and the expected real rate-of-return are given, respectively, by $E\left(\hat{w}_{j\in n\cup x}\right)/\hat{\Pi} = \alpha/\hat{\Pi}$ and $E(\hat{r}_{j\in n\cup x})/\hat{\Pi} = (1-\alpha)/\hat{\Pi}$, with $\hat{\Pi} = \left(a^{\varepsilon-1} + \tau^{\varepsilon-1}\right)^{\frac{1}{1-\varepsilon}}$. On the other hand, since all workers and capitalists get a non-random real income equal to the expected wage and the expected rate-of-return, respectively, the impact on income and welfare is straightforward (see equations 10 and 18). ■

4 No insurance markets

Due to the presence of moral hazard, adverse selection or other informational anomalies, insurance markets are usually unable to provide for the risk-sharing arrangements of the previous section[11]. So, now we look at the case where factor market outcomes determine the income of workers, which is thus volatile. Hence, since Π is non-stochastic, the income of and expected utility of a worker are given, respectively, by

$$\begin{aligned} I_{wj\in n\cup x} &= w_{j\in n\cup x} \\ E(V_w) &= \frac{E\left[w^{1-\rho}_{j\in n\cup x}\right]}{\Pi^{1-\rho}} \end{aligned} \tag{21}$$

[10] In the Heckscher-Ohlin model, the benefits of an expansion in the terms-of-trade are distributed unevenly, with the returns to the factor used intensively in imports declining. Here, this redistributive channel (the Stolper-Samuelson theorem) is inoperative, because tradable and non-tradable goods alike have the same factor intensity

[11] Insurance to workers could also be offered by a manager paying a fixed real wage, which would shift risk to capitalists as residual claimants (implicit contracts). However, without external enforcement, a worker has the ex-post incentive to move to another firm producing the same good and get a higher wage, in the case of a good productivity shock.

while the equilibrium conditions in (13) become:

$$\begin{aligned} E\left[w_{j\in n}^{1-\rho}\right] &= E\left[w_{j\in x}^{1-\rho}\right] \\ E\left(r_{j\in n}\right) &= E\left(r_{j\in x}\right) \end{aligned} \tag{22}$$

With the break down of insurance markets, the volatility of wages extends to the income of workers. Hence, for the same expected wage, workers have an incentive to move to the non-tradable sector, given the lower wage volatility in that sector. The re-allocation of workers has an impact on the marginal product of capital, building an incentive for a similar re-allocation of capital to the non-tradable sector. As a result, the absence of insurance markets reduces the degree of openness of the economy, as measured by the share of capital and labor allocated to the tradable sector.

Moreover, the inexistence of insurance markets not only reduces the share of factors employed in the tradable sector, but affects also the relative distribution of capital and workers. Since capitalists can hedge against risk, they care less than workers about the volatility of the returns in tradable goods. Hence, the non-tradable sector is relatively more attractive to workers than to capitalists, yielding that the capital intensity of production in the tradable sector is higher than in the non-tradable sector, although technologically the sectors are identical.

Substituting (16) and (17) in (22) we obtain

$$k_x = \left[1+\theta^{\epsilon}\lambda^{\alpha(\epsilon-1)}\right]^{-1} \quad ; \quad l_x = \left[1+\theta^{\epsilon}\lambda^{1+\alpha(\epsilon-1)}\right]^{-1} \tag{23}$$

$$\lambda \equiv \frac{\left\{E\left(A_j^{\frac{\epsilon-1}{\epsilon}(1-\rho)}\right)/\tau^{\frac{\epsilon-1}{\epsilon}(1-\rho)}E\left[A_j^{1-\rho}\right]\right\}^{\frac{1}{1-\rho}}}{E\left(A_j^{\frac{\epsilon-1}{\epsilon}}\right)/\tau^{\frac{\epsilon-1}{\epsilon}}E\left(A_j\right)}$$

where θ is given in (20).

To understand λ, which will reappear frequently, look at (16) and (17) and assume that both sectors are employing the same amounts of labor and capital. Then, the numerator of λ compares the welfare of workers in non-tradables to those in tradables. It takes into account volatility and expected wage rates. The denominator does the same for risk-hedging capitalists. Hence the ratio λ shows the attractiveness of the non-tradable sector (as opposed to the tradable sector) for workers compared to capitalists, and we obtain:

Lemma 4 λ is strictly greater than one, does not depend on τ, and increases with σ^2.

Proof. Using a second-order Taylor approximation, we obtain: $E(X^{1-\rho}) \simeq E(X)^{1-\rho}[1-\rho(1-\rho)C(X)]$, where $C(X)$ is the coefficient of variation, which from lemma 2, yields

$$\lambda \simeq \left(\frac{1-(1-\rho)\rho\left(\frac{\varepsilon-1}{\varepsilon}\right)^2\sigma^2}{1-(1-\rho)\rho\sigma^2} \right)^{\frac{1}{1-\rho}} > 1$$

■

Hence, in the absence of a market for income risk, the equilibrium allocation implies:

Proposition 5 (a) The share of factors allocated to tradables is lower than under complete markets; (b) The non-tradable sector uses more labor intensive techniques than the tradable sector, despite the similar technologies.

Proof. Obvious from comparing (20) and (23), and using $\lambda > 1$. ■

Now, substituting (23) for k_x and l_x in (14), we obtain that Π is given by

$$\Pi = [1+(\lambda-1)l_x]^{-\alpha}\left[a^{\varepsilon-1}+\tau^{\varepsilon-1}\lambda^{\alpha(1-\varepsilon)}\right]^{\frac{1}{1-\varepsilon}} \tag{24}$$

with l_x given in (23).

Looking at the equilibrium wages and rate-of return, we have that, since the volatility of income of workers is higher in the tradable sector, the mean wage in tradables is higher than in non-tradables, to compensate workers in tradable goods for the higher volatility. Substituting (23) in (16) and (17), we obtain

$$E(w_{j\in x}) = \lambda E(w_{j\in n}) \tag{25}$$

which, since $\lambda > 1$, reflects the wage premium paid to workers in the exportable sector.[12] Meanwhile, substituting (23) in (17), the expected real

[12] Since in equilibrium the wage equals the value of marginal product (see equations 16 and 17), equation (25) implies that the expected value of marginal product in a tradable good exceeds that in a non-tradable good. Thus, moving the marginal worker from a non-tradable to a tradable good would result in an increase in (expected) aggregate income. That is, from the point of view of income maximization, the degree of openness is sub-optimal.

wage in the non-tradable sector is given by

$$\frac{E(w_{j\in n})}{\Pi} = \alpha(1+(\lambda-1)l_x)^{-1}\Pi^{-1} \tag{26}$$

where l_x is given in (23), and the expected real rate-of-return, which is identical across both sectors (see 13), is given by

$$\frac{E(r_{j\in n\cup x})}{\Pi} = (1-\alpha)\Pi^{-1} \tag{27}$$

where Π is given in (24).

As to welfare, the expected utility of a representative capitalist (see 10) and of a representative worker (see 21) are given, respectively, by:

$$\begin{aligned} E(V_r) &= [(1-\alpha)\Pi^{-1}]^{1-\rho} \\ E(V_w) &= \left[\alpha\frac{(1+(\lambda-1)l_x)^{-1}}{\Pi}\Psi_w\right]^{1-\rho} \quad \text{with } \Psi_w \equiv \frac{\left(E\left(A_j^{(1-\rho)\frac{\varepsilon-1}{\varepsilon}}\right)\right)^{\frac{1}{1-\rho}}}{E\left(A_j^{\frac{\varepsilon-1}{\varepsilon}}\right)} < 1 \end{aligned} \tag{28}$$

Now, we address the consequences of globalization. Like in the case of complete markets, an increase in the terms-of-trade expands the profitability of goods in the exportable sector, thus causing the displacement of factors into the this sector. Hence we capture the impact of globalization through an improvement in the terms-of-trade, which increases the degree of openness. The expansion of the tradable sector implies an increase in the volatility of wages, since, as shown in lemma (2), the coefficient of variation of wages is higher in the tradable sector.

A new and important effect is the decline in the capital intensity in each and every good (independently of the sector it is in), which we address as the volatility effect. To understand it, let $\mu_x \equiv k_x/l_x$ denote the capital intensity in the exportable sector and $\mu_n \equiv (1-k_x)/(1-l_x)$ the capital intensity in the non-tradable sector. Now, since the capital intensity of the economy's endowment is unitary, we have: $l_x\mu_x + (1-l_x)\mu_n = 1$. Hence, given that the capital intensity is higher in tradables ($\mu_x > \mu_n$; see proposition 5), the increase in l_x from globalization implies that both μ_x and μ_n fall, to preserve full-employment. Hence:

Proposition 6 *An increase in the terms-of-trade τ (a) increases the share of workers and capital in the tradable sector, and (b) reduces the capital intensity in each good in both sectors.*

Proof. Obvious from (23), since $\lambda > 1$ and does not depend on τ, while θ is a decreasing function of τ. ■

Turning to real factor returns and welfare, in the absence of insurance markets, the effect of an improvement in the terms-of-trade is uneven for workers and capitalists. The impact of the terms of trade on factor returns can be decomposed in two effects. First, there is the income effect, whereby the increased profitability in the tradable sector attracts workers and capitalists alike, thus driving up the real wage and the real rate-of-return. This was the only effect present in the case of complete markets (proposition 3). Second, there is the volatility effect, whereby the higher volatility in tradables makes them more capital intensive (proposition 5), which implies that the increase in the terms-of-trade brings down the capital intensity in each and every good (proposition 6). By affecting the marginal product, the volatility effect works to expand the rate-of-return and reduce the wage in each sector. Hence, while for capitalists, both the income and volatility effects imply an increase in the real return to capital, for workers, the two effects work is opposite directions: the income effect increases the real wage, while the volatility effect reduces it. And since the volatility of the wage distribution remains unchanged in each sector, the impact of globalization on the expected real wage determines also the consequences for the welfare of workers. Proposition 7 establishes the conditions under which the volatility effect dominates the income effect, and, therefore, the expansion in the terms-of-trade reduces the expected real wage and the welfare of workers.

Proposition 7 (a) An increase in the terms of trade τ expands the expected rate-of-return on capital, and the welfare of capitalists. (b) If (29) holds, an increase in τ reduces the expected wage in each sector and the welfare of workers. Nevertheless, it increases the economy-wide mean wage.

$$\tau < [(\lambda - 1)(\varepsilon - 1)(1 - \alpha) - \lambda]^{\frac{1}{\varepsilon - 1}} \lambda^{\alpha} a \tag{29}$$

Proof. (a) Since $\lambda > 1$, (24) yields that Π is a decreasing function of τ, which, from (27), implies that the rate of return and the expected utility increase with τ.(b) Using (23) to substitute for l_x in (24), (26) and (28), we obtain:

$$E(w|_{2n}) = \Pi = \alpha \left(a^{\varepsilon - 1} + \tau^{\varepsilon - 1} \lambda^{\alpha(1-\varepsilon) - 1} \right)^{1-\alpha} \left(a^{\varepsilon - 1} + \tau^{\varepsilon - 1} \lambda^{\alpha(1-\varepsilon)} \right)^{\frac{1}{\varepsilon - 1} - (1-\alpha)}$$

and $E(V_w)$ = $(ª_w E(w_{j2n})=¦)^{1 ¡ ½}$, respectively. Hence, when (29) holds, the expected real wage and the welfare of workers are a decreasing function of ¿. Finally, letting $\bar{E}(w_j)$ ´ $(1 ¡ l_x)E(w_{j2n}) + l_x E(w_{j2x})$ denote the economy-wide average wage, we have, from (25) and (26), $\bar{E}(w_j) = ¦ = ®¦^{¡1}$, which, from (24), increases with ¿. ■

The condition in (29) establishes an upper bound in the terms-of-trade, so that the volatility e¤ect dominates, and an increase in the terms of trade brings down the expected wage and the welfare of workers[13]. Since economies with lower terms-of-trade are, ceteris-paribus, less open, i.e. have a smaller share of capital and labor allocated to tradables, the expression in (29) suggests that globalization, brought about by an improvement in the terms of trade, is more likely to reduce wages and the welfare of workers when the economy is relatively less open to start with. Hence, the ubiquitous argument (see Cline 1997) that the industrialized economies are too closed for Stolper-Samuelson e¤ects to have a wide impact, suggests here that they may be closed enough for the volatility e¤ect to dominate. On the other hand, relatively more open economies are less likely to see a negative wage e¤ect arising from the volatility e¤ect of globalization.

To conclude, in this section we have shown that in the absence of insurance markets an increase in the terms-of-trade can bring down the wage and the welfare of workers, due to the volatility e¤ect. This e¤ect arises because workers are less able diversify away domestic idiosyncratic risk than capitalists. Since tradable goods yield more volatile factor returns, they are more capital intensive. Hence, their expansion (in the wake of an increase in the terms-of-trade) brings down the capital intensity across sectors in the economy, reducing the expected wage and expanding the expected rate-of-return.

5 Trade policy

In this section, we analyze the role of government policy in the economy. There are various ways in which government intervention may improve upon the competitive equilibrium. First, the government can make up for the lack of insurance markets, through an ex-post redistributive policy that transfers from workers with high wages to those with low wages. This policy would

[13] Note that, unless " is small, the expression increases with ¸. Hence, from lemma 4, the likelihood that the volatility e¤ect dominates increases with the exogenous volatility in the economy.

achieve the same result as in section 3, when insurance markets were assumed to exist. Second, if a redistribution of the income of workers were not possible, the government could still attenuate the volatility of income through a system of state-contingent and good-specific, production, sales or trade, subsidies or taxes. This would reduce the volatility of factor returns, including wages, and thus the volatility of workers' income. However, as Dixit (1987, 1989a and 1989b) argues, the same market failures that bring down insurance markets, can undermine the case for these policies, and an appropriate analysis should model explicitly the reason for the break down of insurance markets.

With this caveat in mind, we analyze the impact of an across the board import tariff, - the effects of which are equivalent to a tax on exports. We address these policies as protectionism, because they lead to an expansion of the non-tradable sector. Letting $\phi \gtreqless 0$ denote one plus the ad-valorem tariff on imports (if $\phi < 1$, it is an import subsidy), henceforth, we use the subscript ϕ to denote the equilibrium value for the variables under the tariff. Therefore, if we let $p_{\phi x}/\tau$ denote the border price of imports, consumers now pay: $p_{\phi x}\phi/\tau$ per unit, and the trade balance equation in (5) now becomes: $p_{\phi x} = \phi^{-1}\tau^{\frac{\varepsilon-1}{\varepsilon}}\left(\int z_{\phi j\in x}\right)^{-1/\varepsilon}\Pi_\phi^{\frac{\varepsilon-1}{\varepsilon}}$, yielding that the wage and rate of return in the different sectors can be written

$$
\begin{aligned}
w_{\phi j\in x} &= \phi^{-1}\alpha\tau^{\frac{\varepsilon-1}{\varepsilon}}A_j l_{\phi x}^{\alpha\frac{\varepsilon-1}{\varepsilon}-1}k_{\phi x}^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}}\Pi_\phi^{\frac{\varepsilon-1}{\varepsilon}} \\
r_{\phi j\in x} &= \phi^{-1}(1-\alpha)\tau^{\frac{\varepsilon-1}{\varepsilon}}A_j\, l_{\phi x}^{\alpha\frac{\varepsilon-1}{\varepsilon}}k_{\phi x}^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}-1}\Pi_\phi^{\frac{\varepsilon-1}{\varepsilon}} \\
w_{\phi j\in n} &= \alpha A_j^{\frac{\varepsilon-1}{\varepsilon}}(1-l_{\phi x})^{\alpha\frac{\varepsilon-1}{\varepsilon}-1}(1-k_{\phi x})^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}}\Pi_\phi^{\frac{\varepsilon-1}{\varepsilon}} \\
r_{\phi j\in n} &= (1-\alpha)A_j^{\frac{\varepsilon-1}{\varepsilon}}(1-l_{\phi x})^{\alpha\frac{\varepsilon-1}{\varepsilon}}(1-k_{\phi x})^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}-1}\Pi_\phi^{\frac{\varepsilon-1}{\varepsilon}} \\
\Pi_\phi &= \left[a^{\frac{\varepsilon-1}{\varepsilon}}(1-k_{\phi x})^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}}(1-l_{\phi x})^{\alpha\frac{\varepsilon-1}{\varepsilon}}+\tau^{\frac{\varepsilon-1}{\varepsilon}}k_{\phi x}^{(1-\alpha)\frac{\varepsilon-1}{\varepsilon}}l_{\phi x}^{\alpha\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{1-\varepsilon}}
\end{aligned}
\tag{30}
$$

where Π_ϕ denotes the CPI under the tariff.

From (13), the equilibrium now implies: $E\left(w_{\phi j\in n}^{1-\rho}\right) = E\left(w_{\phi j\in x}^{1-\rho}\right)$ and $E(r_{\phi j\in n}) = E(r_{\phi j\in x})$. Given (30), we obtain

$$
\begin{aligned}
l_{\phi x} &= \left(1+\phi^{\varepsilon}\theta^{\varepsilon}\lambda^{1+\alpha(\varepsilon-1)}\right)^{-1} \\
k_{\phi x} &= \left(1+\phi^{\varepsilon}\theta^{\varepsilon}\lambda^{\alpha(\varepsilon-1)}\right)^{-1}
\end{aligned}
\tag{31}
$$

which, substituted in the expression for Π_ϕ in (30), yields:

$$\Pi_\phi = [1 + (\lambda - 1)l_{\phi x}]^{-\alpha} \left(\frac{a^{\varepsilon-1} + \phi^{-\varepsilon} \lambda^{\alpha(1-\varepsilon)} \tau^{\varepsilon-1}}{a^{\varepsilon-1} + \phi^{1-\varepsilon} \lambda^{\alpha(1-\varepsilon)} \tau^{\varepsilon-1}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{32}$$

Looking at the expected wages and rate-of-return, we obtain that, as before, the exportable sector pays a risk-premium to its workers, to compensate for volatility - hence substituting (31) in (30) yields: $E(w_{\phi j \in x}) = \lambda E(w_{\phi j \in n})$. Meanwhile, letting the tariff revenue be denoted by: $T_\phi \equiv (\phi - 1)p_{x\phi} z_{-\phi}/\tau$ (with $z_{-\phi}$ denoting imports under the tariff), such that $1 - T_\phi$ captures national income, the expected wage in non-tradables and the expected rate-of-return across sectors are given, respectively, by:

$$\begin{aligned}
\frac{E(w_{\phi j \in n})}{\Pi_\phi} &= \alpha [1 + (\lambda - 1)l_{\phi x}]^{-1} \frac{1 - T_\phi}{\Pi_\phi} \\
\frac{E(r_{\phi j \in n \cup x})}{\Pi_\phi} &= (1 - \alpha)\frac{1 - T_\phi}{\Pi_\phi} \\
T_\phi &= \frac{1 - \phi^{-1}}{1 + \phi^{\varepsilon-1} \theta^{\varepsilon} \lambda^{\alpha(\varepsilon-1)}}
\end{aligned} \tag{33}$$

The distributional impact of protectionism to the tradable sector constitutes a new example of the volatility effect. By expanding the non-tradable sector, where capital intensity is lower, the tariff increases the capital intensity across sectors, which works to increase the expected real wage in each sector relative to the expected rate-of-return. Hence, as can be seen from (33), the ratio of the expected rate-of-return to the expected wage in each sector declines with the tariff.

Finally, we turn to the pareto optimality of the policy. To ensure pareto optimality, we maintain the welfare of capitalists constant, at the free-trade level, by distributing to workers, in a lump-sum fashion, the net gains in the real income of capitalists: $I_{r\phi} - \Pi_\phi I_r/\Pi$, where $I_{r\phi} = E(r_{\phi j})$, for any $j \in n \cup x$. In addition, we transfer also to workers, in a lump-sum fashion, the tariff revenues T_ϕ.

One non-distortionary way to distribute to workers the tariff revenues and the net gains of capitalists, is through a proportional subsidy on income, where, letting γ denote the subsidy rate, the expected welfare of a worker with wage $w_{\phi j}$ is given by:

$$E(V_{\phi w}) = E\left[\left(\frac{(1+\gamma)w_{\phi j\in N\cup X}}{\Pi_\phi}\right)^{1-\rho}\right] \tag{34}$$

This re-distribution system has two important features. First, it ensures that the equilibrium conditions in the labor market (in 31) remain unchanged, and do not depend on γ. Second, it preserves the ratio, in terms of welfare and expected wages, between workers in different sectors, and, therefore, does not affect income distribution among workers. Now, from (33), the economy's total wage bill, is given by $\bar{E}(w_{\phi j}) = \alpha(1-T_\phi)$, implying that the balance of the planner's budget constraint yields: $\alpha(1-T_\phi)\gamma = T_\phi + I_{r\phi} - \Pi_\phi I_r/\Pi$. Hence, from (10), (27) and (33), the subsidy rate that distributes the tariff revenues and the net gains of capitalists yields:

$$1+\gamma = \frac{1-(1-\alpha)\Pi_\phi/\Pi}{\alpha(1-T_\phi)}$$

Substituting in (34) yields

$$E(V_{w\phi}) = \frac{E\left[w_{\phi j\in N\cup X}^{1-\rho}\right]}{(\alpha(1-T_\phi))^{1-\rho}}\left[\Pi_\phi^{-1} - \Pi^{-1}(1-\alpha)\right]^{1-\rho} \tag{35}$$

which constitutes the objective function of the planner. To the extent that it does not affect the volatility of a worker's income, protectionism is ineffective in addressing the market failure caused by the break down of insurance markets. Hence, the usual deadweight losses of tariffs constitute first order effects, and protectionism reduces aggregate welfare, implying that the solution to the planner's problem yields free-trade.

Proposition 8 *The optimal policy, given this redistribution mechanism, entails free-trade.*

Proof. Substituting from (33) in (35), we obtain:

$$E(V_{w\phi}) = \bar{a}_w^{1-\rho}\left[[1+(\lambda-1)I_{\phi x}]^{\alpha-1}\Omega_\phi - (1-\alpha)[1+(\lambda-1)I_{\phi x}]^{-1}\Pi^{-1}\right]^{1-\rho}$$

where $\Omega_\phi \equiv \dfrac{\left(a^{\varepsilon-1} + \phi^{1-\varepsilon}\tau^{\varepsilon-1}\lambda^{\alpha(1-\varepsilon)}\right)^{\frac{\varepsilon}{\varepsilon-1}}}{a^{\varepsilon-1} + \phi^{-\varepsilon}\tau^{\varepsilon-1}\lambda^{\alpha(1-\varepsilon)}}$

with $l_{\phi x}$ given in (31). Straightforward algebra yields: $\partial \Pi_{\phi} / \partial \phi_{(\phi=1)} = 0$, which implies that the derivative with respect to ϕ, computed at $\phi = 1$ can be written:

$$\left.\frac{\partial E(V_{w\phi})}{\partial \phi}\right|_{(\phi=1)} = C \left(\Pi^{-1} - [1 + (\lambda - 1) l_x]^{\alpha} \left[a^{\varepsilon - 1} + \tau^{\varepsilon - 1} \lambda^{\alpha(1-\varepsilon)} \right]^{\frac{1}{\varepsilon - 1}} \right) \left.\frac{\partial l_{\phi x}}{\partial \phi}\right|_{(\phi=1)}$$

where $C > 0$ and l_x is given in (23). From (24), we have that the term in brackets is zero. Consequently, we obtain that $\phi = 1$, i.e. free-trade, yields: $\partial E(V_{w\phi}) / \partial \phi_{(\phi=1)} = 0$, thus solving the first-order condition to the planner's problem. ■

6 Conclusion

This paper has analyzed the role of globalization in expanding earnings volatility, when the latter arises from domestic, good specific productivity shocks. We have shown that factor returns are more volatile in tradable goods, given the higher elasticity of demand arising from foreign competition. We view globalization as an expansion of the tradable sector, brought about by an increase in the terms-of-trade. Looking at its consequences, our results show: first, that an expansion in the volatility of earnings arises, as the tradable sector expands, and second, that this may cause a decline in wages and in the welfare of workers, while expanding the returns to capital, due to the volatility effect. This effect arises because workers are less able to diversify away domestic idiosyncratic risk than capitalists. Since tradable goods yield more volatile factor returns (i.e. risk), they are more capital intensive. Hence, the expansion in tradables (in the wake of an increase in the terms-of-trade) brings down the capital intensity across sectors in the economy, reducing the expected wage and expanding the expected rate-of-return. There is also a positive income effect, from the increase in the purchasing power of exports, benefiting workers and capitalists, which is of second order, unless the economy is very open. Nevertheless, despite the negative effects of globalization on wages and the welfare of workers, the optimal policy, from a utilitarian standpoint is still free-trade, even if protectionism helps to reduce the gap between workers and capitalists.

Eventual Stolper-Samuelson (SS) effects that reduce the mean wage of unskilled workers, would act independently and in addition to the volatility effect stressed here. Moreover, unlike SS effects, our results do not apply only to the case of trade arising from di¤erences in factor abundance, but to all forms of international trade and competition.

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