Globalization, Wage Volatility and the Welfare of Workers

Daniel A. Traca\textsuperscript{1}
INSEAD
traca@econ.insead.fr

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\textsuperscript{1}INSEAD, Bd de Constance, 77300 Fontainebleau, France. Fax: 33 1 60746171. I wish to thank the comments of Olivier Cadot, Antonio Fatas. Errors and omissions are my own.
Abstract

This paper analyzes the effects of globalization (i.e. trade liberalization) on the level and volatility of factor returns, in the presence of a non-tradable sector and uncertainty. The results show an increase in the return to capital and, under certain conditions, a decline in the real wages and welfare of workers, along with an expansion of wage dispersion and volatility. Remarkably, these results do not depend on the relative capital intensity of imports and exports. The model assumes that uncertainty arises from industry-specific shocks to productivity and to world prices.

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

JEL Classification: F16, D33
1 Introduction

The last two decades have been a distressful period for workers in industrialized countries, namely in the United States. On one hand, wage growth has declined dramatically (Katz and Murphy, 1992; Bosworth and Perry, 1994; Mishel and Bernstein, 1994). On the other, there has been an increase in the short-term volatility of wages (Gottschalk and Mox, 1994). In addition to technological factors that have slowed the growth of productivity, forces like de-regulation, de-unionization, and globalization have also been suggested to have played a role in the wage slowdown.

Recently, the role of globalization has been downplayed by studies showing that the degree of openness to developing countries and the labor content of imports are too small to produce the extent of wage variation in the data. (For a survey, see Cline, 1997, ch. 2). Yet, few studies have considered the labor market implications of trade among industrialized countries, - two thirds of the total (Rodrik, 1998).

This paper shows that globalization, i.e. the expansion of the tradable sector that follows trade liberalization, reduces industry wages, increases the return to capital and expands volatility. Shedding new light on the evidence usually presented to dismiss the role of globalization (above), these effects are stronger when the degree of openness is not too high and, more importantly, they arise not only from trade with lower-wage countries, but from all types of foreign trade, regardless of its factor content (e.g. trade among industrialized nations).

We look at a small open economy where factor returns are stochastic due to domestic and external risk, arising from industry-specific shocks to productivity and to world prices, respectively. Like in Matusz (1985) and Fernandez (1992), capital is perfectly divisible and a capitalist’s endowment can be spread across different goods, while workers must allocate their labor entirely to the same good. Assuming that insurance markets break down, diversification enables capitalists to hedge risk, given that shocks are idiosyncratic, whereas the income of workers is uncertain.

This paper argues that an industry’s exposure to international competition expands the uncertainty of factor returns. In a non-tradable good, where a supply shock affects the price of the good negatively, the price and the marginal product are negatively correlated, and the volatility of returns is less than that of the productivity shock. In contrast, in a tradable good, where stochastic world prices determine domestic prices, factor returns are

1Rodrik (1997) argues that, by increasing the elasticity of the labor demand schedule, international competition brings down wages and expands wage volatility and employment movements resulting from labor supply shocks.
more volatile than the productivity shock, since prices are random and uncorrelated with the marginal product. Thus returns to capital and labor in the non-tradable sector are less volatile than in tradables.\(^2\)

Since workers cannot hedge risk, the volatility of the tradable sector has two implications: first, expected wages are higher in that sector, to compensate for uncertainty; second, tradables are more capital intensive than non-tradables, even if technologies are identical (Gourinchas, 1998; Bernard and Jensen, 1995). Consequently, in what we address as the volatility effect, an expansion of the tradable sector brings down the capital intensity of all industries, in order to preserve full-employment. The volatility effect affects factor returns by reducing the marginal product of labor, and expanding that of capital.

The main implications of trade liberalization, i.e. globalization, are as follows. First, it expands the (more volatile) tradable sector, leading to an increase in (cross-sectional) wage dispersion and (time series) wage volatility.\(^3\) Second, it improves the return to capital, due to the gains from trade. Third, when the economy is not very open and the tariff not too high, it brings down real wages across industries and the welfare of workers, since the volatility effect dominates the gains from trade. Finally, fourth, trade liberalization always enhances aggregate welfare, as the gains from trade make the case for free-trade.

The next section introduces the model and describes the features of the equilibrium. Section three analyzes the implications of trade liberalization. Section four addresses the optimal tariff. Section five concludes.

2 The model

Consider a small open economy composed of three sectors: the non-tradable \((n)\), the importable \((i)\) and the exportable \((x)\). Imports are subject to a uniform tariff, whose revenues accrue to the trade authority and are distributed

\(^2\)The NBER database (Feenstra, 1996, 1997; Bartelsman and Gray, 1996) provides evidence of higher wage volatility in tradables. Let \(V\text{WAG}_i\) and \(V\text{TFP}_i\) be the volatility of Wages and TFP, respectively, and \(OPEN_i\), the Degree of Openness, for each 4-digit SIC industry \(i\). OLS estimates of \(\hat{\gamma}_0\) and \(\hat{\gamma}_2\) in \(V\text{WAG}_i = \hat{\gamma}_0 + \hat{\gamma}_1 OPEN_i + \hat{\gamma}_2 V\text{TFP}_i\) were positive and highly significant (both P-values lower than 0.1%). Variables: \(V\text{WAG}\): Standard deviation of de-trended CPI-delated average compensation, divided by its average. \(V\text{TFP}\): Standard deviation of de-trended TFP divided by its average. \(OPEN\): (Exports + Imports)/Domestic Shipments; average for the period. Yearly data: 1958-94.

\(^3\)For the United States, changes in the sectoral distribution of labor explain 12% of the increase in earnings volatility, which, in turn, accounts for 1/3 - 1/2 of the widening of the wage distribution from the 1970’s to the 1980’s (Gottschalk and Moe, 1994).
lump-sum. Later, a liberalization of this tariff will capture the impact of globalization.

Each sector contains a continuum of measure one of goods (or industries). Only non-tradables and exportables are produced domestically, and only non-tradables and importables are consumed domestically. To set notation, the subscript $n_j$ ($j \leq n$) denotes industry (good) $j$ in the non-tradable sector, the subscript $i_j$ ($j \leq i$) denotes good $j$ in the importable sector, and the subscript $x_j$ ($j \leq x$) denotes industry $j$ in the exportable sector.

Technologies are identical for all goods, whether in the exportable or non-tradable sector. Letting $k_j$ and $l_j$ denote, respectively, the capital and labor employed in industry $j$, the output of good $j$ ($z_j$) is given by:

$$z_j = A_j l_j^{\beta_j} k_j^{\alpha_j} j \leq n \quad (1)$$

The productivity in each industry is stochastic. $A_j$ is a log-normally distributed random variable, independent across goods, with the mean of log $A_j$ equal to $\mu$ and the variance of log $A_j$ given by $\sigma^2$, with $\sigma > 0$. Hence we obtain that $E(A_j) = 1$ and that the coefficient of variation of $A_j$ is given by $\frac{\sqrt{h}}{E(A_j^{1/2})} = \varepsilon$, yielding that $\sigma$ captures the exogenous uncertainty arising from domestic shocks. More generally, the $h^{th}$ moment of the distribution of $A_j$ is given by:

$$E(A_j^h) = \exp(h \sigma^2) \quad (2)$$

The economy is composed of workers and capitalists. Preferences are identical for workers and capitalists, given by the CRRA utility function,

$$\mu Z \quad \left( \frac{1}{z_{n_j}} \right)^{\gamma_{n_j}} + \left( \frac{1}{z_{i_j}} \right)^{\gamma_{i_j}} \quad (3)$$

where $\gamma$ is the coefficient of relative risk aversion, and $\gamma$ is the elasticity-of-substitution.

Taking aggregate nominal expenditure as the numeraire, let $p_{n_j}$ denote the price of non-tradable good $j$, $p_{i_j}$ the price of importable $j$ and $p_{x_j}$ the price of exportable $j$, and define the consumer price index, CPI ($\ell$), as:

$$\ell = \mu Z \quad \left( \frac{1}{p_{n_j}} \right)^{\gamma_{n_j}} + \left( \frac{1}{p_{i_j}} \right)^{\gamma_{i_j}} \quad (4)$$

Footnotes:

4. For the properties of the log-normal distribution, see Newberry and Stiglitz (1981).
5. We use the coefficient of variation as a measure of dispersion (volatility, uncertainty), because it is invariant to a multiplicative transformation of the random variable. For example, given (1), the volatility of output, measured by the coefficient of variation, is independent of the amount of labor employed.
Assuming that a consumer’s expenditure is her income, the welfare of a consumer with income $I$ is given by

$$V_I = (I + 1)^{\frac{1}{2}}$$

(5)

while her demand for a non-tradable and an importable good are given, respectively, by $z_{nj}^d = p_{nj}^{1 + \xi} I^{1 + \eta}$ and $z_{ij}^d = p_{ij}^{1 + \xi} I^{1 + \eta}$. Moreover, since preferences are homothetic and aggregate expenditure is the numeraire, the aggregate demand for a non-tradable ($z_{nj}^d$) and an importable ($z_{ij}^d$) can be written

$$z_{nj}^d = \frac{p_{nj}^{1 + \xi}}{I^{1 + \eta}}, \quad z_{ij}^d = \frac{p_{ij}^{1 + \xi}}{I^{1 + \eta}}$$

(6)

2.1 Product markets

We start by looking at the equilibrium prices in product markets, contingent on the output in the different industries. Assuming a small open economy, the relative prices among tradable goods (importables and exportables) are given from abroad. We assume that these are random. Hence we define the prices of tradable goods as follows:

$$p_{ij} = p_x S_{ij}; \quad p_{xj} = p_x S_{xj}$$

(7)

where $p_x$ is the price-index for tradable goods and $\zeta$ is one plus the ad-valorem tariff rate. $S_{ij}$ and $S_{xj}$ are independent, log-normally distributed random variables, with the mean of log $S_j$ equal to $\mu_j$ and the variance of log $S_j$ given by $\sigma_j^2$ with $\sigma_j > 0$. Hence we have that $E(S_j) = 1$, while the coefficient of variation of $S_j$ is given by $\frac{\sigma_j}{S_j} = e^\sigma_j$, yielding that $\sigma_j$ captures the external risk arising from the volatility of the terms of trade. More generally, the $h^{th}$ moment of the distribution of $S_j$ is given by:

$$E(S_j^h) = \exp(h \mu_j + 1)$$

(8)

Since consumption equals income, the current account is balanced, yielding: $p_{xj} z_{xj} = \zeta^{1 + \eta} p_{ij} z_{ij}$, which from (6) implies:

$$Z p_x S_{xj} z_{xj} = \zeta^{1 + \eta} p_{xj}^{1 + \xi} I^{1 + \eta} S_{ij}^{1 + \eta},$$

$$p_x = \zeta^{1 + \eta} \frac{1}{I^{1 + \eta}} p_{xj}^{1 + \xi} S_{xj} z_{xj}$$

(9)

For simplicity, we ignore the role of precautionary savings as a risk hedging device, as well as other issues of capital accumulation.
Meanwhile, the demand for each non-tradable good has to be satisfied by domestic production, which from (6) yields

\[ p_{nj} = z_{nj} \] 

(10)

The impact of a productivity shock on the price of the good, due to changes in the quantity supplied, can be obtained from equations (7)-(9) and (10). The actual effect depends on the sector, due to the role played by international competition. Equation (10) shows that for a non-tradable good, a supply shock affects the price of the good negatively. In contrast, equation (9) shows that the price of a tradable good \((p_{xj} = p_x S_{xj})\) is only influenced to the extent that the supply shock affects export revenues. But, since each exportable industry is part of a continuum of tradable industries, a supply shock has only a negligible effect on \(p_{xj}\). A crucial assumption here is that the economy is small enough that domestic shocks have a negligible effect in world supply, and hence on world relative prices. In sum, for a small open economy, the price of the a non-tradable good reacts negatively to a supply shock in the industry, while in a tradable sector, foreign competition breaks the link between the quantity supplied domestically and the price, which is given from world markets.

2.2 Factor Markets

There is 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. Labor and capital are allocated to each good before the realization of uncertainty (in the terms of trade and productivity), and cannot be reallocated ex-post. A crucial assumption in this paper is the absence of an insurance market for income risk.

To set notation, \(r_j\) 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. Ex-post, good specific capital and labor markets are perfectly competitive, with factor returns given by the value of the marginal

\footnote{If exportable and foreign goods are differentiated, supply shocks have an impact on the world price of the good. However, the elasticity of the price to the productivity shock is higher in non-tradables, as long as each good (exportable or non-tradable) has a closer (albeit imperfect) substitute abroad than domestically (e.g. domestic and foreign cars, domestic and foreign haircuts). In that case, the presence of trade costs undermines the potential for substitution in non-tradables, leading to a higher price effect. In the model, we have taken the extreme assumption that each domestic industry has a perfect substitute abroad.}
product. Hence, from (1), they are given by

\[ w_j = \frac{P_j Z_j}{l_j} ; \quad r_j = \left( 1 - \frac{P_j Z_j}{k_j} \right)^{\frac{1}{2}}, \quad j \in [2, n] \tag{11} \]

Given the presence of shocks to productivity and to the terms of trade, the returns to capital and labor are stochastic. Since, due to the absence of insurance markets, the income of capitalists and workers consists of the return to their endowment, the ability to hedge risk arises as a crucial determinant of their welfare.

The crucial difference between capitalists and workers in this paper is in their ability to hedge risk by diversifying the allocation of their endowments across different goods. On one hand, each worker must allocate his unit of labor 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.

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 (5), is given by:

\[ E(V_r) \overset{\text{max}}{=} \frac{\mu Z}{\sum_j t_j r_j^{\frac{1}{2}}}, \quad \text{st} \quad t_j = 1, \quad j \in [2, n] \tag{12} \]

where \( t_j \) is the share of capital to allocate to each good, while \( r_j \) denotes ex-post income. The capitalist takes as given the rate of return for any given asset \((r_j)\) in (11) and the price level \((\frac{1}{Z})\) in (4) 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 \( \frac{1}{Z} \), 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:

\[ E(r_j) = E(r_{j0}), \quad 8j; j \in [2, n] \tag{13} \]

Moreover, full diversification implies that each capitalist will span her assets across all goods, exportable or non-tradable, yielding that \( t_j > 0; 8j; j \in [2, n] \). Since all capitalists choose the same (optimal) risk-free portfolio, the expected utility of a representative capitalist, ignoring the distribution of the tariff revenue, is given by

\[ E(V_r) = (E(r_j) = E(\frac{1}{Z}))_{\frac{1}{2}}, \quad \text{for any} \ j \in [2, n] \tag{13} \]
Workers, who cannot diversify, have different wages, depending on the productivity shock in the good they choose to work on, thus bearing risky returns. Since workers are identical ex-ante, in equilibrium they must be indifferent between committing into the production of any good. Hence, since the income of a worker who chose sector \( j \) is given by \( w_j \), the labor market equilibrium condition is:

\[
E \left( (w_j)^{1/2} \right) = E \left( (w_0)^{1/2} \right) \quad 8j; j^0 \in \mathbb{N} \]

Since shocks are idiosyncratic, \( \epsilon \) is uncorrelated with the wage in each sector, which implies that the equilibrium condition can be simplified into

\[
E \left( (w_j) \right)^{1/2} = E \left( (w_0) \right)^{1/2} \quad 8j; j^0 \in \mathbb{N} \]

Meanwhile the expected utility of the representative worker in equilibrium, ignoring the distribution of the tariff revenue, denoted by \( E(V_w) \), is given by

\[
E(V_w) = E \left( (w_j) \right)^{1/2} \quad 8j; j^0 \in \mathbb{N} \]

From (11) we have that if two goods \( j \) and \( j^0 \) in the same sector (e.g. non-tradables, exportables) employ the same amount of capital and labor, then conditions (12) and (14) 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, we take \( l_x \) and \( k_x \) to denote the amount of labor and capital, respectively, employed in each and every exportable good (\( l_{xj} = l_x; k_{xj} = k_x \)). Since each sector contains a continuum of measure one of goods, \( l_x \) and \( k_x \) capture also the total amount of labor and capital, respectively, in the exportable sector. Moreover, since the endowments of capital and labor are normalized to one, \( (1 - l_x) \) and \( (1 - k_x) \) capture the amount of labor and capital, respectively, employed in each and every non-tradable good (\( l_{nj} = 1 - l_x; k_{nj} = 1 - k_x \)), as well as the total amount of labor and capital in the non-tradable sector. Thus, \( l_x \) and \( k_x \) fully characterize the allocation, with the output in an exportable and a non-tradable good given, respectively, by:

\[
z_{xj} = A_j l_x^{[1]} k_x^{[1]} \quad \text{and} \quad z_{nj} = A_j (1 - l_x)^{[1]} (1 - k_x)^{[1]} \]

Now we obtain the expression for factor returns in each sector from (11). Substituting (9) and (16) in (11), and using the law of large numbers (Judd, 1985), the wage and rate-of-return in an exportable good, denoted respectively by \( w_{xj} \) and \( r_{xj} \), are given by:

\[
\]
\[ w_{xj} = \beta_{xj}^{1/3} \sum_{i=1}^{3} S_{ij}^{1/3} \left( \frac{S_{xj} A_{xj}}{E(S_{xj})^2 E(A_{xj})^{1/2}} \right) \left( \frac{1}{k_x^{1/2}} \right) \] 

\[ r_{xj} = (1_i \otimes \xi^{1/2}) \sum_{i=1}^{3} S_{ij}^{1/2} \left( \frac{S_{xj} A_{xj}}{E(S_{xj})^2 E(A_{xj})^{1/2}} \right) \left( \frac{1}{k_x^{1/2}} \right) \] 

where it should be noted that \( E(S_{xj}) = 1 \) and \( E(A_{xj}) = 1 \).

On the other hand, from (10) we have \( p_{nj} z_{nj} = z_{nj}^{1/2} \), which given (16) implies that the wage and rate-of-return for a non-tradable good, respectively \( w_{nj} \) and \( r_{nj} \), are given by

\[ w_{nj} = \beta_{nj}^{1/2} (1_i \otimes l_x)^{1/2} \left( \sum_{i=1}^{3} S_{ij}^{1/2} \right) \left( \frac{1}{k_x^{1/2}} \right) \] 

\[ r_{nj} = (1_i \otimes A_{nj}^{1/2}) (1_i \otimes l_x)^{1/2} \left( \sum_{i=1}^{3} S_{ij}^{1/2} \right) \left( \frac{1}{k_x^{1/2}} \right) \] 

Finally, using (16) in (7)-(9) and (10), and substituting in (4), after taking the properties of the lognormal distribution in (2) and (8), we can rewrite it as:

\[ \mu_x = (1_i \otimes k_x^{1/2}) (1_i \otimes l_x)^{1/2} \sum_{i=1}^{3} S_{ij}^{1/2} \left( \sum_{i=1}^{3} S_{xj}^{1/2} \right) \] 

\[ w/ x_n \] 

\[ \mu_x = \exp \left( \frac{1}{n^2} \right) \] 

and,

\[ \mu_x = \exp \left( \frac{1}{n^2} \right) \prod_{i=1}^{n} \mu_i \] 

where \( x_n \) and \( x_x \) capture the productivity in non-tradable and exportable industries, respectively, adjusted for the impact on the price of the goods.

Now, we can address the volatility of factor returns in the two sectors, and the extent of consumption risk in the economy. Using the coefficient of variation to measure volatility, we obtain:

**Proposition 1** The coefficient of variation of factor returns in non-tradable goods is given by \( \gamma_A = \exp(\frac{1}{2} \gamma_x) \), while in tradable goods, it is given by \( \gamma_A = \exp(\gamma_x + \delta) \). Hence the coefficient of variation of factor returns is higher in the tradable sector. Moreover, there is no aggregate consumption risk in the economy; i.e. the CPI \( (\cdot) \) is non-stochastic.

**Proof.** For the coefficient of variation of wages and the rate-of-return, we obtain that in the non-tradable sector: \( \gamma_A = E(A_{nj}^{1/2})^{1/2} \), while in the tradable sector: \( \gamma_A = E(S_{xj}^{1/2})^{1/2} \). Given (2) and
we obtain the expressions above. That \( \frac{1}{1+\xi} \) is non-stochastic is immediate from (19).

The volatility of factor returns is higher in the tradable sector for two reasons. First, the higher elasticity of the price to supply shocks reduces the volatility of factor returns, in non-tradables: while in a tradable good, the volatility of the marginal product fully passes through to factor returns, given the independence between the price and the marginal product; in a non-tradable good, the negative correlation of the impact of the productivity shock on the price and on the marginal product reduces the volatility of the value of marginal product.

Second, the presence of external risk implies that, in addition to being independent of the productivity shock, the price of the tradable good is random, further increasing the volatility of factor returns in tradable industries. Note that each source of uncertainty (terms of trade, productivity) contributes independently to increase the volatility in tradables relative to non-tradables - on its own, either is sufficient to produce a higher wage volatility in tradables.

### 2.3 Equilibrium and Factor Returns

Now we look at the equilibrium allocation and factor returns, contingent on the tariff. To ensure that \( l_x \) and \( k_x \) describe an equilibrium, we must verify that (12) and (14) are satisfied for two goods 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, - \( E(w_{nx}^{1/\gamma}) = E(w_{nx}^{1/\gamma}) \) - and that goods in the non-tradable and the exportable sectors have the same expected rate-of-return, - \( E(r_{nx}) = E(r_{nx}) \).

Given (17) and (18), we can use the properties of the lognormal distribution in (2) and (8), to obtain

\[
\begin{align*}
k_x &= h \left( 1 + \xi \right)^{\alpha} (\alpha_{nx})^{\gamma} \frac{1}{\alpha_{nx}} \frac{1}{\alpha_{nx}} \\
l_x &= h \left( 1 + \xi \right)^{\alpha} (\alpha_{nx})^{\gamma} \frac{1}{\alpha_{nx}} \frac{1}{\alpha_{nx}}
\end{align*}
\]

where

\[
\alpha_{nx} = \exp \left( \frac{1}{\gamma} \frac{1}{\gamma} + \frac{2}{\gamma} \right) - \left( 2^{\alpha_{nx}} \right) \left( \frac{1}{\gamma} \right) \left( \frac{1}{\gamma} \right)
\]

To understand \( \alpha \), which will reappear frequently, look at (17) and (18) and assume that both sectors are employing the same amounts of labor and capital.
Then, \( c \) compares the welfare of workers and capitalists in non-tradables, taking into account the ability to hedge risk through diversification. Meanwhile, \( d \) does the same for the tradable sector. Hence \( e \) shows the benefit of the non-tradable sector (compared to the tradable sector) for workers relative to capitalists. Now, since capitalists can hedge against risk, they care less than workers about the volatility of the returns in tradable goods, yielding that the non-tradable sector is relatively more attractive to workers than to capitalists.\(^8\) Hence we obtain:

**Lemma 2** \( e \) is strictly greater than one, does not depend on \( \zeta \), and increases with \( \sigma \) and \( \pm \).

**Proof.** see (21).

An immediate consequence is that the equilibrium allocation implies that the capital intensity of production in the tradable sector is higher than in the non-tradable sector, although technologically the sectors are identical.\(^9\)

**Proposition 3** Let \( n \cdot \frac{x_{l+1} + n_{l+1}}{x_{l+1} + n_{l+1}} \). Then the capital intensity in the exportable sector, \( k_x = l_x \), is given by \( f \), while in the non-tradable sector, we obtain: \( (1 + k_x) = (1 + l_x) = f \). Hence the non-tradable sector uses more labor intensive techniques than the tradable sector.

**Proof.** Use (20) and \( f > 1 \)(see lemma 2).

Finally, we address the returns to capital and labor in equilibrium. Substituting (20) for \( k_x \) and \( l_x \) in (19), we obtain that \( f \) is given by

\[
\hat{z} = a \frac{\pi_x^i \pi_x^j + \pi_n^i \pi_n^j}{\pi_x^i \pi_x^j + \pi_n^i \pi_n^j} \tag{22}
\]

Now, to compensate workers in tradable goods for the higher volatility in income, the mean wage in tradables is higher than in non-tradables. Hence, substituting (20) in (17) and (18), we obtain

\[
E(w_{xj}) = f E(w_{nj}) \tag{23}
\]

\(^8\) 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.

\(^9\) Gourrinchas (1998) shows that the tradable sector is, on average, more capital intensive, and has higher employment volatility. Bernard and Jensen (1995) argue that within a given sector, firms that export are more capital intensive and pay a higher wage.
which, since $\beta > 1$, reflects the wage premium paid to workers in the exportable sector.

Letting $T_{\ell}$ denote the tariff revenue, which implies that $\ell T_{\ell}$ captures national income, i.e. the total gross return to the factors in the economy, we can substitute (20) in (18) to obtain that the expected real wage in the non-tradable sector is given by

$$E(w_{nj}) = (1 - \beta)(1 - T_{\ell})$$

(24)

while the expected real rate-of-return, which is identical across both sectors, is given by

$$E(r_j) = (1 - \beta)(1 - T_{\ell})$$

(25)

where, after some algebraic manipulation, we obtain:

$$1 - T_{\ell} = \frac{3}{4} x_i^1 \delta_{1i}^i + \frac{3}{4} \delta_{1i}^i \beta(1 - 1 - 1)$$

(26)

where $\delta$ is given in (22).

To conclude, we can compute the welfare of the representative capitalist and of the representative worker. Ignoring the distribution of tariff revenue, we can use (24) and (25) in (13) and (15) to obtain that the expected utility of capitalists and workers are given, respectively, by:

$$E(V_r) = E(r_j)$$

(27)

$$E(V_w) = E(w_{nj})$$

where $\delta$ is given in (21).

3 Globalization

Now, we address the consequences of trade liberalization, thus capturing the phenomenon of globalization. The decline in the tariff increases the consumption of importables, causing an imbalance in the current account. Hence, in order to increase exports and to re-establish the external balance, the employment of capital and labor in the tradable sector increases, at the expense of the non-tradable sector (see 20). Consequently, in what we address as the volatility effect, the fall in the tariff causes a decline in the capital intensity in each and every good (independently of the sector it is in), due to the need to combine full-employment with the expansion of the tradable sector, which is more capital intensive.\(^{10}\)

\(^{10}\)Since the capital intensity of the economy's endowment is unitary, we have: $l_x(k_x = l_x) + (1 - l_x)[(1 - l_x) = (1 - l_x)] = 1$, which given that proposition 3 establishes $k_x = l_x = \ell(1 - k_x = (1 - l_x))$, yields that $k_x = l_x$ and $(1 - k_x) = (1 - l_x)$ have to fall as $l_x$ increases.
Proposition 4 A decline in \( \zeta \) (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. (a) obvious from (20), since \( \gamma > 1 \) and does not depend on \( \zeta \). (b) in proposition 3 is a decreasing function of \( \zeta \). •

Now we turn to the implications for wages and welfare. To start, since the coefficient of variation of the wage distribution is higher in the tradable sector, as shown in proposition 1, trade liberalization leads to an increase in (cross-sectional) wage dispersion and (time series) wage volatility of the representative worker.

In terms of the level of real factor returns and welfare, trade liberalization has two effects. First, there are the gains from trade, as the decline in the tariff increases national income by cutting down on deadweight losses and reducing the transfers to the government through tariff revenue.\(^{11}\) Second, by affecting the marginal product, the volatility effect works to expand the rate-of-return and to reduce the wage in each sector. Hence, while for capitalists, both the gains from trade and the volatility effect imply an increase in the real return to capital, for workers, the two effects work is opposite directions: the gains from trade increase the real wage, while the volatility effect reduces it. And since, as can be seen from (27), the decline in the expected wage is a sufficient condition to bring down the welfare of workers, trade liberalization hurts workers when the volatility effect dominates.

To see the conflicting forces of the volatility effect and the gains from trade on the wage, we can use (22) and (26) in (24) to obtain the elasticity of the real wage to the tariff

\[
\frac{\ln E(w_{ij})}{\ln \zeta} = \left( \gamma' \zeta + 1 \right) \left( k'x + 1 \right) + \frac{1}{\zeta'} \left[ 1 + \left( k'x + 1 \right) \zeta' \right] \frac{1}{\zeta'}
\]

(28)

where \( \gamma' = 1 \) and \( \zeta' = \zeta - 1 \). The first term is positive and captures the volatility effect while the second term is negative and depicts the gains from trade effect. Note that the magnitude of the volatility effect increases with \( \gamma' \), and is zero when \( \gamma' = 1 \), i.e. when volatility or risk-aversion are not present.

Equation (28) shows that the strength of the gains from trade and the volatility effect depends on the degree of openness in the economy, measured by the share of capital in the tradable sector (\( k_x \)), and on the initial size of the

\(^{11}\)Since we ignore the redistribution of tariff revenue, its decline (from trade liberalization) constitutes a gain from trade, as agents are left with a higher share of domestic income.
tarif \((\zeta)\).\(^{12}\) The volatility effect is maximized at an intermediate degree of openness, since in both extremes \((k_x = 1\) and \(k_x = 0\)) the capital/labor ratio remains unchanged with a small change in the tarif. On the other hand, the gains from trade are stronger for more open economies \((k_x\) large), since the scope of the tarif is higher. They are also stronger when the initial tarif is high, since the marginal loss of a tarif increases with the size of the tarif. Hence, the volatility effect is more likely to dominate at intermediate-to-lower degrees of openness, and if the initial tarif is not too high.

Proposition 5 summarizes our findings.

Proposition 5 (a) A decline in \(\zeta\) increases the mean coe cient of variation of wages. (b) It expands the expected rate-of-return on capital and the economy-wide mean wage. (c) A decline in \(\zeta\) reduces the expected wage in each sector if and only if: \(k_x < k_{x*} < \hat{k}_x\), with

\[
\begin{align*}
&k_x \cdot 1 \cdot \frac{[(\gamma j \cdot j) \cdot 4 \cdot (\gamma j \cdot j) \cdot i \cdot j \cdot 1]}{2 \cdot (\gamma j \cdot j) \cdot i \cdot j} + (\gamma j \cdot j) \cdot 1), \\
&\hat{k}_x \cdot 1 + \frac{[(\gamma j \cdot j) \cdot 4 \cdot (\gamma j \cdot j) \cdot i \cdot j \cdot 1]}{2 \cdot (\gamma j \cdot j) \cdot i \cdot j} < 1
\end{align*}
\]

where \(k_x\) and \(\hat{k}_x > 0\) exist only if \(i \cdot j \cdot 1 > 1\cdot i \cdot j(\gamma j \cdot j)^2 = 4\), i.e. the tarif is not too high, and \(\gamma > \gamma \Rightarrow \gamma \cdot i \cdot j = 1\), i.e. the elasticity of substitution 

\(^{12}\text{Remarkably, the proposition has established that not only in economies with a high degree of openness does globalization (i.e. trade liberalization) induce a decline in wages and on the welfare of workers. In fact, the volatility}\)
The effect is likely to dominate in economies that are relatively closed and have low tariff barriers, such as the United States. This result sheds new light on the ubiquitous argument that, from an industrialized country perspective, the extent of trade with developing countries is too small to exert pressure on wages, through the Stolper-Samuelson theorem (see Cline 1997): first, a country does not have to be very open for the volatility effect to dominate; second, trade with all countries, including those with similar wage levels, can bring down wages.

4 Optimal Tariff

In this section, we look at the aggregate effect of globalization; addressing the question of the optimal tariff. To represent aggregate welfare, we keep the welfare of capitalists at the free-trade level, and transfer to workers, through a proportional wage subsidy, the net gains in the real income of capitalists and the tariff revenue.\(^\text{13}\) Thus, letting \(\hat{\alpha}\) denote the subsidy rate, the welfare of the representative worker after the subsidy, which captures our measure of social welfare, i.e. the objective function of the planner, is given by \(E(V_w) = E((\hat{\alpha}w_j t) + \hat{\alpha}w_j t - \hat{\alpha}w_j t)\), which yields:

Lemma 6 The aggregate welfare function can be written as:

\[
E(V_w) = \hat{\alpha}^{-1} \left( \left( 1 - \hat{\alpha} \right) \left( 1 - \hat{\alpha} \right) \right)^{1/2}.
\]

Proof. Letting \(E(r_j)\) denote the income of a capitalist under free-trade, her net income gains are given by \(E(r_j) - E(r_j)\). Since the economy’s total wage bill is given by \(\hat{\alpha}(1 - T^\prime)\), budgetary balance yields: \(\hat{\alpha}(1 - T^\prime)(\hat{\alpha} - 1) = T^\prime + \left[ E(r_j); \left( 1 - \hat{\alpha} \right) \right] E(r_j)\). Since, from (25), we have \(E(r_j) = (1 - \hat{\alpha})\), (1 - \(\hat{\alpha}\) \(\hat{\alpha}\)) and, consequently, \(E(r_j) = (1 - \hat{\alpha})\), we obtain \(\hat{\alpha} = \left( 1 - \hat{\alpha} \right)^{-1}\). Therefore, given (24), \(E(V_w) = E((\hat{\alpha}w_j t) + \hat{\alpha}w_j t - \hat{\alpha}w_j t)\) and, consequently, \(E(V_w) = E((\hat{\alpha}w_j + \hat{\alpha}w_j - \hat{\alpha}w_j)\). Thus, solving for the optimal tariff, we obtain:

Proposition 7 The optimal policy, given this redistribution mechanism, entails free-trade.

\(^{13}\) An important feature of this redistribution scheme is that it leaves unaltered the coefficient of distribution of the wage distribution. Other transfer schemes, that make non-proportional payments, would reduce the volatility of a worker’s income, thus providing insurance and increasing welfare. We assume that the market failure that caused the break down of insurance markets would hinder the possibility of such type of transfers.
Proof. From (22) we obtain $@ = @_{l=1} = 0$. Use $\cdot = \cdot_{l}$ (see 22) in (29) and take $@\mathbb{E}(V_{w}) = @_{l=1} = 1$. Hence, the usual deadweight losses of tariffs constitute first order effects, and protectionism reduces aggregate welfare, implying that free-trade is optimal and trade liberalization increases social welfare. 

5 Conclusion

This paper has shown that factor returns are more volatile in tradable goods, due to the presence of external risk from the volatility of world prices, and because, under foreign competition, the price is independent of domestic productivity shocks.

Assuming that workers are less able to diversify away idiosyncratic risk than capitalists, we have shown that the higher volatility of factor returns in tradables implies that the latter are more capital intensive. Hence, we have identified the volatility effect, capturing the decline in capital intensity across sectors, in the wake of an expansion of the tradable sector. This effect contributes to the demise of workers, by reducing wages and expanding the rates-of-return, through its effect on the marginal product.

Building of these findings, we have shown that, in the absence of insurance markets, trade liberalization (globalization) increases the volatility of earnings and the return to capital, but brings down wages and the welfare of workers, when the economy is not very open and the initial tariff is not very large. The finding that an economy does not need to be very open, for trade liberalization to have a negative impact on wages and welfare, sheds new light on the empirical argument that industrialized countries are too closed for trade to have an important influence on wages.

Our findings have established also that not only trade with countries with different factor endowments has distributive implications. If trade does

\footnote{Nevertheless, the government may improve upon the competitive equilibrium through state-dependent policies (e.g. ex-post redistribution from high-wage to low-wage workers; state-contingent and good-specific, production, sales or trade, subsidies or taxes (Eaton and Grossman, 1985)). But, as Dixit (1987, 1989a and 1989b) argues, the market failures that bring down insurance markets can undermine the case for these policies, and an appropriate analysis should model explicitly the break down of insurance markets.}
occur due to differences in factor endowments, the volatility and the Stolper-Samuelson effects contribute together for the impact of trade liberalization on factor returns and, more importantly, on welfare. In capital abundant countries, they go in the same direction, but in labor abundant countries, they have conflicting implications. The volatility effect is likely to take a prominent role when factor endowments are less important (e.g., North-Atlantic trade, regional integration), while the Stolper-Samuelson becomes more important for countries that trade based on their factor abundance.

From an empirical and policy perspective, the wage stagnation of the last two decades arises from the combination of these forces, along with the primal influence of slowdown in productivity growth. If the empirical challenge is to assess the contribution of each of them, the policy challenge is to address each with the appropriate policy framework. In this context, we have shown that claims for protection are misplaced, since the optimal policy is still free-trade and trade liberalization increases aggregate welfare, despite the failure of insurance markets.

References


