Labor Market Adjustments to Globalization:

Unemployment versus Relative Wages[‡]

by

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Abstract

The aim of this paper is twofold: First, we analyze the role of wage rigidities in labor market adjustments to international trade and biased technological progress in a small open economy. We introduce efficiency wages into a neoclassical trade model and show that changes in relative wages are independent of wage rigidities. Secondly, we examine the impact of capital market integration on relative wages and unemployment and find that wage inequality will rise (fall) and unemployment will fall (rise) when capital is being imported (exported).

Keywords: International Trade, Capital Movements, Biased Technological Progress, Efficiency Wages

JEL: F11, F21, J31

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1. Introduction

A large body of literature, known as the *Globalization and Wage Inequality* literature, tries to untangle the influence of growing world trade and technological progress on the labor markets of industrialized countries.[1] Along the lines of the Stolper-Samuelson theorem, it is argued that an increase in commodity trade with unskilled-labor-abundant, low-wage countries leads to an increase in the wage rate of skilled workers and depresses the wage rate of unskilled workers. On the other hand, labor market theorists point to the invasion of computers into our lives and workplaces and argue that they have increased the productivity of mainly skilled workers and white collar employees, thereby reducing relative demand for unskilled workers. A lively empirical debate revolves around the question of whether the observed increase in the skill premium in the United States and in the United Kingdom should be attributed mainly to the increase in international trade with low-wage countries or whether biased technological change was to be blamed for the relative decline of unskilled wages in these countries.[2]

However, the U.S. and UK experiences of a rapidly rising skill premium have been relatively unique among industrialized countries (Krugman, 1995; OECD ,1996, p. 61f.; Fortin and Lemieux, 1997; Dewatripont, Sapir and Sekkat, 1999). This is striking because trade and technology are worldwide shocks, or at least shocks that most industrialized countries are exposed to. If they are responsible for an increase in the skill premium in some industrialized countries, why did the skill premium in other industrialized countries not increase or even decline?

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1 For a good overview see Freeman (1995), Richardson (1995), and Wood (1995) in a special feature of the Journal of Economic Perspectives on the *Globalization and Wage Inequality* debate. See also Bhagwati and Dehejia (1994) and Deardorff and Hakura (1994).

2 A special issue of the Journal of International Economics features the debate on the "factor content" approach. See Deardorff (2000), Krugman (2000), Leamer (2000), and Panagariya (2000) for an overview over the various arguments.

Some authors point to labor market institutions as a possible explanation (Freeman, 1995; Fortin and Lemieux, 1997; Siebert, 1997). They argue that when relative demand for unskilled labor falls, either prices (i.e., wages) or quantities (i.e., employment) have to adjust. Therefore, if wages of unskilled workers are rigid due to labor market institutions, then a fall in demand for unskilled labor does not necessarily lead to a higher skill premium but to an increase in unemployment of unskilled workers.

Krugman (1995) and Davis (1998) study the presence of minimum wage constraints in an international trade framework. Although they illustrate that international trade could have been responsible for the increase in unemployment in Europe, their framework does not address the issue of divergence in wage patterns across countries. The present paper tries to contribute in two ways. First, we provide an alternative approach to wage rigidities based on efficiency wage considerations. This approach has several advantages which are laid out in detail in the next section. In contrast to previous studies we find that the Stolper-Samuelson pressure remains on relative wages in spite of wage rigidities. Second, we extend the analysis to include not only biased technological change, but also capital movements. Even though real capital mobility is one of the key characteristics of globalization, its impact on relative wages and unemployment has not yet been fully explored. We will discuss the reasons for explicitly including capital and capital mobility in section 3. The analysis of international capital market integration reveals that capital movements have an impact on both relative wages and unemployment, too.

The remainder of the paper is organized as follows. Section 4 sets up the model. The equilibrium is illustrated in section 5. In sections 6-8, we conduct a comparative-static analysis to derive the impact of international trade, biased technological progress, and capital market integration on the skill premium and the unemployment rate. Section 9 summarizes these results and concludes the paper.

2. Labor Market Adjustments: Unemployment versus Relative Wages

In a general equilibrium free trade environment, wage rigidities raise an important question: If wage rates do not fall when demand for labor declines, how can import competing industries remain competitive? Without wage rigidities, imports lower demand for domestic labor, which leads to a fall in wages and allows domestic producers to lower their prices. But if wage rates are rigid due to labor market institutions, domestic producers will not be able to compete with imports, and the industry will eventually disappear (Brecher, 1974).

Krugman (1995) points to a possible adjustment of a country's terms of trade if the economy is large enough to affect world market prices (large country case). If domestic demand for imports is large so that wages in the rest of the world rise, foreign producers have to raise their prices and domestic producers become relatively more competitive. He illustrates that a binding minimum wage constraint in a large country can re-direct the Stolper-Samuelson pressure on wages towards employment. However, Davis (1998) points out that this result only holds in a two country framework. In a free trade world with more than two countries, producers in all economies face the same commodity prices. If they have access to identical technologies, too, the factor price equalization theorem continues to hold. In this case, there can be only one diversified country with a binding minimum wage constraint in the entire trading world so that the mechanism described by Krugman only works in a single country. All other countries will either be completely specialized (in which case there is no import competing industry and the Stolper-Samuelson relationship between relative commodity prices and relative factor demand ceases to exists) or enjoy full employment at the constrained economy's wage rate. Furthermore, as world commodity prices are determined by the one binding minimum wage constraint, all other countries, independent of their size, face conditions as if they were a small country. Nothing outside the constrained economy has an influence on world market commodity prices, so that all other countries within the free trade community are insulated from the rest of the world. All shocks are absorbed by the constrained economy only, via changes in unemployment.

The present paper focuses on a different kind of wage rigidity. We show that when firms pay efficiency wages,[3] a diversified trading equilibrium is feasible where all countries experience at least some unemployment. A country's rate of unemployment depends on its degree of wage rigidity which we measure explicitly by the elasticity of the wage curve. We are thus able to show how countries with different degrees of wage rigidity adjust to international shocks. In order to contrast the mechanisms described here to those described by Krugman and Davis we conduct the analysis within a small country framework.

3. Globalization and the Role of Capital Market Integration

In much of the debate on *Globalization and Wage Inequality*, physical capital (also referred to as capital goods or equipment) is excluded from the analysis. This seems awkward at first since real capital mobility is often referred to as one of the key characteristics of globalization. However, if capital goods are tradable, it seems fair to assume that their prices will converge. Thus, so the argument goes, if capital goods are freely tradable, they cannot constitute a comparative advantage and can, therefore, be omitted (Wood, 1994).

However, Eaton and Kortum (2001) showed that international equipment prices are not equalized. These deviations from the law of one price indicate that barriers to trade in capital equipment are important. Besides, the fact that a country's endowment with capital goods is irrelevant for the determination of its comparative advantages does not mean that trade in capital goods has no influence at all. If, for example, equipment is imported, a country's

[3] Earlier contributions to the theory of international trade with efficiency wages include Agell and Lundborg (1995), Brecher (1992), Copeland (1989), Hoon (1991), and Matusz (1994 and 1996).

supply with capital goods rises and subsequent changes in output can also affect factor rewards.[4]

We assume that advances in technology have reduced the barriers to capital trade by reducing trading costs associated with transporting capital goods to foreign locations, adapting equipment to foreign conditions and standards, or providing parts, maintenance, and customer service from abroad. As a result to this integration of capital markets, international trade in capital goods has increased. We are interested in the impact of such a rise in capital goods trade on the labor markets of the trading economies. We show that the impact of capital market integration on the skill premium and on the rate of unemployment depends on whether capital is being exported or whether it is being imported. This result offers a demand-driven explanation as opposed to a wage rigidity explanation for the diverging labor market experiences of some industrialized countries.

4. The Model

We assume a traditional 3×2 model of international trade. Three factors of production, physical capital (K), skilled labor (H), and unskilled labor (L), are used to produce two homogeneous goods (X and Y) using a constant-returns-to-scale technology. Both goods are traded and the respective commodity prices are given by the world markets (small country case). All factors of production are perfectly mobile between sectors. In addition, capital goods can be traded between countries, but a country's endowments with both types of labor are exogenously given.

4 The question of whether changes in factor supply affect factor rewards raises an issue of dimensionality. In a traditional 2×2 framework, an increase in an economy's endowment with capital has no influence on relative factor rewards as long as relative sectoral total factor productivity and relative commodity prices remain constant. However, the Stolper-Samuelson theorem requires a diversified equilibrium which is only feasible if the number of non-tradable factors of production is at least two. Thus, we adopt a framework with three factors (two non-tradables and one tradable) and two commodities.

In order to explain wage rigidities we introduce efficiency wages into the model. The efficiency wage theory postulates a positive relationship between wages paid and the rate of unemployment, on the one hand, and workers' effort, on the other.[5] We assume that this relationship between wages, unemployment, and productivity is not independent of a worker's education and reputation. A skilled worker's lifetime earnings do not depend on his education only, but also on his reputation (Holmström, 1999). A skilled worker seeking career advancement will increase effort even in the absence of greater compensation if that enhances reputation (Shapiro and Stiglitz, 1984). Moreover, as Akerlof and Yellen (1986) note, high-skill workers may have different utility functions than low-skill workers. Where education and motivation are positively correlated, highly educated workers will get less utility from shirking than low-skill workers.

These considerations suggest that the need to pay efficiency wages in order to boost workers' productivity is stronger for unskilled workers than for skilled workers. It seems to be in line with empirical evidence on unemployment rates, too: unemployment rates of skilled workers are significantly lower than those of unskilled workers in almost all industrialized countries across both sexes and all ages (OECD, 1994). This indicates that skilled workers receive wages closer to market clearing levels than unskilled workers. To simplify the analysis, we assume in our model that skilled workers receive market-clearing wages.

Thus, dual cost functions x and y per unit of output for the two sectors (X and Y) are given by

$$x(r, \omega, w) = \pi, \tag{1}$$

$$y(r, \omega, w) = 1. \tag{2}$$

[5] For a survey, see Akerlof and Yellen (1986).

In equilibrium, costs per unit of output equal product prices. Here, commodity Y is taken as the numeraire, so that π is the relative price of X. Let r denote the relative price of capital goods (in terms of good Y), let ω denote the real wage rate of skilled workers, and let w be the real effective wage rate of unskilled workers. The latter is defined as

$$w = \frac{\ell}{e}, \tag{3}$$

where ℓ is the real wage paid and e is workers' effort. According to the efficiency-wage theory, workers' effort is a positive function of both wages paid and the rate of unemployment. Furthermore, an interior solution requires that the effort function is concave. Thus,

$$e = \alpha \ln \ell + \beta \ln u, \tag{4}$$

where α and β denote the weight of the two influences on workers' effort ($\alpha,\beta>0$).

In this setting, companies raise wages above market-clearing levels until the additional effort triggered by the wage increase equals the increase in production cost. Thus, an equilibrium is reached when the Solow (1979) condition is satisfied, i.e., when the elasticity of effort with respect to the wage rate $(\varepsilon_{e,\ell})$ is one:

$$\varepsilon_{e,\ell} = \frac{\alpha}{e} = 1. \tag{5}$$

Furthermore, we suppose that capital is not freely tradable between countries. If capital was freely tradable, equipment prices would be equalized across countries, so that $r = r^*$ (r^* denotes the world market price for capital goods). Here, we assume that there are barriers to trade in capital equipment and that costs associated with these barriers are proportional in the volume of trade. Equilibrium in the international market for capital goods requires that the world market price of capital goods in a capital-exporting country equals the price of capital goods in a capital-importing country minus trading costs τ. Equipment is traded if trading costs are smaller than autarky price differences.

In the small-country case, where the world market equipment price is exogenously given, the domestic price is determined by the world market price and the trading costs. If the small country is a capital-exporting country, r is given by

$$r = r^{*} - \tau . \tag{6a}$$

If, on the other hand, the small country is a capital-importing country, we get

$$r = r^{*} + \tau . \tag{6b}$$

If trading costs fall, international price differentials decline. When τ approaches zero, international equipment prices equalize.

Taking differentials, (1)-(6) can be expressed in rates of change:

$$a^{Kx}\hat{r} + a^{Hx}\hat{\omega} + a^{Lx}\hat{w} = \hat{\pi} , \tag{7}$$

$$a^{Ky}\hat{r} + a^{Hy}\hat{\omega} + a^{Ly}\hat{w} = 0 , \tag{8}$$

$$\hat{w} = \hat{\ell} - \hat{e} , \tag{9}$$

$$\hat{e} = \frac{\alpha}{e}\hat{\ell} + \frac{\beta}{e}\hat{u}\,, \tag{10}$$

$$\hat{e} = 0\,, \tag{11}$$

$$\hat{r} = \hat{\phi}\,, \tag{12}$$

where $\hat{\phi} = \begin{cases} \frac{r^*}{r}\hat{r}^* - \frac{\tau}{r}\hat{\tau} & \text{(capital export case)} \\ \frac{r^*}{r}\hat{r}^* + \frac{\tau}{r}\hat{\tau} & \text{(capital import case)} \end{cases}$.

A circumflex denotes relative changes. Cost shares of factor i in the production of commodity j are represented by a^{ij}, e.g., $a^{Kx} = \frac{rK^X}{\pi X}$. With constant returns to scale, the adding up theorem holds, so that $\sum_i a^{ij} = 1$.

Substituting (5) and (11) into (10) yields

$$\hat{\ell} = -\frac{\beta}{\alpha}\hat{u}\,. \tag{13}$$

(13) indicates a negative relationship between the rate of unemployment and the wage rate. This relationship is known as the *wage curve*. Blanchflower and Oswald (1994, 1995) provide empirical evidence for the existence of the wage curve from a number of countries. As the elasticity of the wage curve $\varepsilon_{\ell,u} = -\beta/\alpha$ measures the responsiveness of the wage rate to the amount of excess supply in the labor market, it can be viewed as an index of wage rigidity. The lower the elasticity of the wage rate with respect to the rate of unemployment, the "stickier" the wage rate.

The skill premium is defined as the wage rate of skilled workers over the wage rate of unskilled workers, i.e. $\theta = \omega/\ell$. Therefore, $\hat{\theta} = \hat{\omega} - \hat{\ell}$. Now, after rearranging, (7) and (8) yield

$$a^{Hx}\hat{\theta} - \frac{\beta}{\alpha}\left(a^{Hx} + a^{Lx}\right)\hat{u} = \hat{\pi} - a^{Kx}\hat{\phi}, \tag{14}$$

$$a^{Hy}\hat{\theta} - \frac{\beta}{\alpha}\left(a^{Hy} + a^{Ly}\right)\hat{u} = -a^{Ky}\hat{\phi}. \tag{15}$$

5. Equilibrium

Equations (14) and (15) provide the elasticities of the two sectors' isocost curves in a θ - u space. Ceteris paribus, these elasticities are given by (i=x,y)

$$\frac{\hat{\theta}}{\hat{u}} = \frac{\beta}{\alpha}\left(1 + \frac{a^{Li}}{a^{Hi}}\right) > 0, \tag{16}$$

Equation (16) shows that these isocost curves are upward sloping. In the area to the left of or above these curves, production costs exceed the product price, whereas in the area to the right of or underneath these curves, companies are making profits. To illustrate the influence of the unemployment rate on production costs, assume that the unemployment rate falls. As workers associate a lower rate of unemployment with a lower disutility from being fired, their effort decreases and effective production costs rise. In this case, companies have two ways to lower production costs: they can lower wages of the skilled, or increase wages of the unskilled in order to boost productivity and reduce effective production costs. In either case, the skill premium decreases.

Equation (16) also shows that as long as α and β are identical across sectors, the slopes of the two isocost curves differ only with respect to the skill intensities of the two sectors $\left(a^{Li}/a^{Hi}\right)$: The higher the skill intensity, the flatter the slope of the respective isocost curve. For analytical purposes, we assume that X is the skill-intensive good and that Y uses unskilled workers intensively in its production. Then, capital is the "middle factor", such that factor intensities yield the following inequality:

$$\frac{a^{Hx}}{a^{Hy}} > \frac{a^{Kx}}{a^{Ky}} > \frac{a^{Lx}}{a^{Ly}}. \tag{17}$$

Additionally, let the high-skill sector also have a higher capital intensity (in the sense that total labor costs constitute a lower proportion of the value of its output) than the low-skill sector:

$$a^{Kx} > a^{Ky}. \tag{18}$$

Wood (1994) provides evidence for a positive correlation between a sector's skill intensity and its capital intensity. His results are supported by an earlier study by Forstner and Ballance (1990). According to Wood, a possible explanation for this collinearity could be the empirically observed complementarity between capital and skill in manufacturing (capital-skill complementarity hypothesis, Griliches, 1969). If relative demand for skilled labor rises as the capital intensity of a sector increases, capital-intensive industries have higher skill-intensities.

[INSERT figure 1 here]

The equilibrium is illustrated in figure 1 (assuming linearity for simplification). The intersection of the two isocost curves yields the equilibrium values for the relative wage of skilled workers (θ) and for the rate of unemployment of unskilled workers (u). The real wage ℓ of unskilled workers and their effective wages w are then given by $\ell = E \times \exp\left(1 - \frac{\beta}{\alpha} \ln u\right)$ and $w = \alpha^{-1} E \times \exp\left(1 - \frac{\beta}{\alpha} \ln u\right)$, respectively (E is the base of the natural logarithm). The real wage rate of skilled workers is $\omega = \theta E \times \exp\left(1 - \frac{\beta}{\alpha} \ln u\right)$. Finally, the world market equipment price (r^*) and capital market trading costs (τ) determine the domestic price for capital goods.

6. International Trade

If our country is relatively skill-abundant compared to the rest of the world, it will export the skill-intensive good X and import good Y (Heckscher-Ohlin theorem)[6]. As a result of international trade, its terms of trade, given by the relative product price π, will rise.

Proposition 1: *An increase in the terms of trade leads to an increase in the skill premium and drives up unemployment of unskilled workers.*

Proof: An increase in π leads to an upward shift of the X sector's isocost curve. The new intersection of the two curves yields a higher skill premium and a higher rate of unemployment. The new equilibrium is illustrated in figure 2.

[INSERT figure 2 here]

Mathematically, solving (14) and (15) for $\hat{\theta}/\hat{\pi}$ and $\hat{u}/\hat{\pi}$ yield the following results (the signs are derived using (17)):

$$\frac{\hat{\theta}}{\hat{\pi}} = -\frac{\left(a^{Hy} + a^{Ly}\right)}{\left(a^{Hy} a^{Lx} - a^{Hx} a^{Ly}\right)} > 0, \tag{19}$$

[6] See Hoon (1991) for the validity of the Heckscher-Ohlin theorem with efficiency wages.

$$\frac{\hat{u}}{\hat{\pi}} = -\frac{a^{Hy}}{\frac{\beta}{\alpha}\left(a^{Hy}a^{Lx} - a^{Hx}a^{Ly}\right)} > 0\,. \tag{20}$$

The reason for the rise in the skill premium is very much what the Stolper-Samuelson theorem predicts and what the *Globalization and Wage Inequality* literature emphasizes: Because of a rise in the relative price of the skill-intensive commodity X, this industry expands and relative demand for skilled labor increases. Consequently, the skill premium rises. What is new in this model is that the unemployment rate also adjusts to changes in the terms of trade. As companies pay wages above the market clearing level for unskilled labor (and thus create unemployment), changes in the demand for low-skill workers lead to both changes in the wage rate and changes in employment [see (13)]. In the case of an increase in the relative price of the skill-intensive good X, relative demand for unskilled labor falls and unemployment rises.

Note that expression (19) is independent of α and β. Thus, the elasticity of the wage curve has no effect on the impact of product price shocks on relative wages. In fact, (19) is identical to the result obtained with no labor market rigidities (see appendix). This leads to proposition 2:

Proposition 2: *The extent of labor market rigidities has no impact on the rate of change of relative wages.*

Let us first clarify what proposition 2 does *not* say: Proposition 2 does not say that wage rigidities have no impact at all on relative wages. Labor market rigidities do have an influence on the *scale* of wage dispersion. The larger these rigidities in the market for unskilled workers, the lower the skill premium. However, proposition 2 does have something to say about the *change* in relative wages: According to proposition 2, relative changes in the skill premium are independent of the degree of inflexibility of the labor market. This result sharply contradicts the popular view that different developments of the skill premium in various industrialized countries can be explained by different labor market institutions. No matter how rigid wages are (as long as they are not fixed), a change in relative product prices leads to the same increase in the skill premium.

The reason for this result is tied to the logic of competitive pricing. To illustrate the underlying mechanism suppose that the commodity price in the import competing industry falls. If wage rates were fixed, firms in this sector could no longer compete with foreign competitors. The respective industry would disappear and classical (Ricardian) specialization would follow. However, with efficiency wages, the rise in unemployment relaxes the rigidity constraint and allows firms to lower wages. The industry continues to contract as long as production costs exceed world market commodity prices. But as the industry contracts, unemployment rises and firms are able to lower their wages. Consequently, this process eventually comes to an end and a diversified equilibrium is feasible. The extent to which firms have to adjust wages in order to stay competitive is the same as in the case where wages are market-clearing: it depends on the commodity price constraint and on technology, i.e., factor intensities.

It should also be pointed out that proposition 2 applies only to the impact on relative wages. The change in the rate of unemployment is not independent of the degree of wage stickiness. As (20) shows, $\partial(\hat{u}/\hat{\pi})/\partial\varepsilon_{\ell,u} < 0$, so that the larger wage rigidities are (the lower the elasticity of the wage curve), the greater is the impact on the rate of unemployment.

7. Biased Technological Progress

Proposition 2 holds for biased technological progress, too. In general, we have to distinguish between factor bias and sector bias in technological progress. The applicability of proposition 2 for sector-biased technological progress is straightforward, because the mechanism that leads to changes in factor prices is the same. Jones (2000) has shown that the mathematical solutions for the impact on relative factor rewards are even identical between a one percent increase in the relative product price of X (international trade) and a one percent increase in relative productivity of X (sector-biased technological progress). Therefore, our irrelevance theorem can be transferred one-to-one to the case of sector-biased technological progress.

But what about factor-biased technological progress? Xu (2001) has shown that the factor bias of technological progress is irrelevant in a small, open economy when the technological progress is confined to one sector (local technical progress). In this case, it is only the sector bias that matters: If technological progress occurs in the skill intensive sector, it will lead to an increase of the skill premium, independent of whether it is skill-biased or unskilled-biased.

But if the technological progress is economy-wide and occurs in both sectors, factor bias matters again (Jones, 2000). In how far does economy-wide, skill-augmenting technological progress affect relative wages and unemployment in a small open economy, and what role do wage rigidities play in this? To answer this question we introduce a new technological parameter t which captures exogenous changes in the efficiency of skilled workers. Consequently, tH measures the effective supply of skilled workers in efficiency units and ω/t denotes the effective wage rate of skilled workers. Similar to the definition of the effective wage rate of unskilled workers ($w = \ell/e$), ω/t is the wage paid per efficiency unit of skilled labor. Contrary to effort e, however, t is not determined endogenously. Instead, it is intended to capture exogenous changes in economy-wide, skill-augmenting technological progress. The impact of such technological progress on the skill premium and on the rate of unemployment can then be analyzed explicitly by an increase in t.

Equations (1) and (2) convert to

$$x\left(r, \frac{\omega}{t}, w\right) = \pi, \tag{1'}$$

$$y\left(r, \frac{\omega}{t}, w\right) = 1. \tag{2'}$$

Proposition 3: *(i) Skill-augmenting technological progress leads to an increase in the skill premium. The rate of unemployment of unskilled workers is unaffected. (ii) This result is independent of wage rigidities.*

Proof: The introduction of t changes equations (14) and (15) so that

$$a^{Hx}\hat{\theta} - \frac{\beta}{\alpha}\left(a^{Hx} + a^{Lx}\right)\hat{u} = \hat{\pi} - a^{Kx}\hat{\phi} + a^{Hx}\hat{t}, \tag{14'}$$

$$a^{Hy}\hat{\theta} - \frac{\beta}{\alpha}\left(a^{Hy} + a^{Ly}\right)\hat{u} = -a^{Ky}\hat{\phi} + a^{Hy}\hat{t}. \tag{15'}$$

As a result of an exogenous increase in the productivity of skilled workers, the two isocost curves are shifted upwards. Equations (14') and (15') reveal that the extent of the upward shift is identical for both curves $\left(\hat{\theta}/\hat{t}\Big|_{\hat{u}=0}^{X/Y} = 1\right)$. Therefore, the new equilibrium is characterized by a higher skill premium, whereas the rate of unemployment of unskilled workers has remained constant. Figure 3 illustrates the adjustment to skill-augmenting technological progress.

[INSERT figure 3 here]

The mathematical solution proves proposition 3(ii). The results are independent of the wage curve:

$$\frac{\hat{\theta}}{\hat{t}} = 1, \tag{21}$$

$$\frac{\hat{u}}{\hat{t}} = 0. \tag{22}$$

The mechanism at work here is very similar to the well-known Rybczynski theorem. An increase in t increases the effective supply of skilled labor tH. The rise in productivity of skilled workers initially lowers relative production costs in the skill intensive industry X. With commodity prices remaining constant, relative demand for X increases. Therefore, resources are shifted away from the production of Y towards the production of X. The output expansion of X and the output contraction of Y induced by these structural adjustments lead to an increase in the relative demand for skilled labor, thus pushing up the skill premium [see equation (21)].

On the other hand, the result in equation (22) might come as a surprise. One could expect that - similar to the impact of international trade - a decline in relative demand for unskilled workers also leads to an increase in the rate of unemployment. However, the rate of unemployment is not determined by relative demand, but by absolute demand for unskilled labor. And absolute demand for unskilled labor is unaffected by changes in t ($\hat{\ell}/\hat{t} = 0$). Instead, the entire increase in relative demand for skilled labor is driven by an increase in absolute demand for skilled labor ($\hat{\theta}/\hat{t} = \hat{\omega}/\hat{t} = 1$). To see this rewrite (1') and (2') in rates of change and set $\hat{r} = \hat{\pi} = 0$. Then we obtain $\left(\hat{\omega} - \hat{t}\right) = -\frac{a^{Lx}}{a^{Hx}}\left(\hat{\ell} - \hat{e}\right)$ and $\left(\hat{\omega} - \hat{t}\right) = -\frac{a^{Ly}}{a^{Hy}}\left(\hat{\ell} - \hat{e}\right)$. Since $\frac{a^{Lx}}{a^{Hx}} \neq \frac{a^{Ly}}{a^{Hy}}$, both equations can only hold if $\left(\hat{\omega} - \hat{t}\right) = \left(\hat{\ell} - \hat{e}\right) = 0$. Divide by $\hat{t}$ and set $\hat{e} = 0$ [see (11)] to obtain $\left(\frac{\hat{\omega}}{\hat{t}} - 1\right) = \frac{\hat{\ell}}{\hat{t}} = 0$. It is obvious that wage rigidities play absolutely no role in this result. Since absolute demand for unskilled workers does not change, neither the wage of unskilled workers nor the unemployment rate is affected.

The equation $(\hat{\omega}-\hat{t})=(\hat{\ell}-\hat{e})=0$ also shows that effective wage rates do not change. This indicates that demand per efficiency unit of both types of labor also remains unaffected. This result can be interpreted as a modified version of the Rybczynski theorem. As long as relative commodity prices remain constant, changes in the effective supply of labor affect outputs, but they do not affect effective wage rates.

8. Capital Market Integration

When barriers to trading capital goods fall, additional trade in capital goods reduces international equipment price differentials. In the small country case, this leads to a move of the domestic price for capital goods towards the world market price. As the world market price is exogenously given $(\hat{r}^* = 0)$, the sign of the rate of change of the domestic equipment price depends on whether the small country is a capital exporting country or whether it is a capital importing country. According to (12), if $\hat{r}^* = 0$ and $\hat{\tau} < 0$, the sign of $\hat{r}$ depends on whether $\hat{\phi} < 0$ (capital importing case) or whether $\hat{\phi} > 0$ (capital exporting case). The impact of the adjustment processes on the labor market is summarized in proposition 4:

Proposition 4: *(i) Capital market integration leads to an increase in the skill premium and a fall in the rate of unemployment of unskilled workers in a small capital importing country. This result is reversed if the country is a capital exporting country. (ii) The irrelevance of wage rigidities for the determination of changes in relative wages holds.*

Proof: Mathematically, we obtain

$$\frac{\hat{\theta}}{\hat{\phi}} = \frac{\left(a^{Kx} - a^{Ky}\right)}{\left(a^{Hy}a^{Lx} - a^{Hx}a^{Ly}\right)} < 0\,, \tag{23}$$

$$\frac{\hat{u}}{\hat{\phi}} = \frac{\left(a^{Kx}a^{Hy} - a^{Ky}a^{Hx}\right)}{\frac{\beta}{\alpha}\left(a^{Hy}a^{Lx} - a^{Hx}a^{Ly}\right)} > 0\,. \tag{24}$$

The signs are determined using equations (17) and (18). Thus, changes in the skill premium and the unemployment rate triggered by an increase in capital goods trade depend on whether ϕ rises or falls as a consequence of the declining trading costs. As $\hat{\phi} = -\frac{\tau}{r}\hat{\tau} > 0$ when the home country is a capital-exporting country, this country is faced with a declining skill premium and a rising rate of unemployment. On the other hand, in a capital-importing country, $\hat{\phi} = \frac{\tau}{r}\hat{\tau} < 0$, so that the skill premium rises while the unemployment rate falls.

In our graphical analysis an increase in capital goods trade leads to a shift of both sectoral isocost curves. If $r < r^*$, so that the home country is a capital-exporting country, a fall in trading costs will be followed by an increase in export demand for domestic capital goods. Consequently, r rises. Thus, production costs increase in both sectors and the sectoral isocost curves are shifted downwards (to the right). A closer look at the extent of the two shifts reveals that the downward shift of the Y sector's isocost curve exceeds the downward shift of the X sector's isocost curve, whereas X's isocost curve is shifted more to the right than Y's isocost curve (i=x,y):

$$\left.\frac{\hat{\theta}}{\hat{\phi}}\right|_{\hat{u}=0} = -\frac{a^{Ki}}{a^{Hi}}\,, \tag{25}$$

$$\left.\frac{\hat{u}}{\hat{\phi}}\right|_{\hat{\theta}=0} = \frac{a^{Ki}}{\frac{\beta}{\alpha}\left(a^{Hi} + a^{Li}\right)}, \tag{26}$$

If conditions (17) and (18) hold, $\left(\hat{\theta}/\hat{\phi}\right)^{X}_{\hat{u}=0} < \left(\hat{\theta}/\hat{\phi}\right)^{Y}_{\hat{u}=0}$ and $\left(\hat{u}/\hat{\phi}\right)^{X}_{\hat{\theta}=0} > \left(\hat{u}/\hat{\phi}\right)^{Y}_{\hat{\theta}=0}$. The shifts of the two curves and the new equilibrium are illustrated in figure 4. Suppose that the initial equilibrium was at point A. The new equilibrium is then given by point B. From A to B, the skill premium has fallen and the rate of unemployment of unskilled workers has risen.

[INSERT figure 4 here]

Capital exports reduce the supply of capital goods. Consequently, r rises and production costs increase so that firms have to downscale their activities in order to prevent losses. Because of $a^{Kx} > a^{Ky}$ (18), firms in the X industry are hit harder by the increase in r and since they also use skilled labor more intensively than firms in the Y industry, relative demand for skilled labor falls. As low-skill wages are somewhat rigid, part of the adjustment pressure has to be carried by employment. The result is a higher rate of unemployment and a lower skill premium.

The opposite case, where the home country is a capital importing country, can be described as a movement from B to A. In this case, a reduction in barriers to capital goods trade reduces the equipment prices, so that production costs in both sectors fall. As a result, the two isocost curves shift upward (to the left). The skill premium increases and the rate of unemployment falls.

Concerning proposition 4(ii), expression (23) shows that the impact of capital goods trade on relative wages is again independent of the elasticity of the wage curve (see appendix). Therefore, relative changes in the skill premium triggered by capital goods trade do not depend on the degree of wage stickiness. This finding underlines the generality of the irrelevance of efficiency-wage based rigidities for relative factor rewards in general equilibrium.

9. Summary and Conclusion

In the previous sections we have made extensive use of the *ceteris paribus* clause. The impact of international trade, technological progress, and capital market integration were all analyzed as if they were the only change brought about by globalization. In reality, however, all three changes coincide. So if we are to say something about the impact of globalization as a whole, we have to look at all three changes simultaneously. In this case we have to differentiate between the effects in a capital-exporting country and in a capital-importing country. Table 1 summarizes our results.

[INSERT table 1 here]

Table 1 shows that capital importing countries can expect to see their skill premium rise, whereas the impact on the rate of unemployment is somewhat ambiguous in these countries. Capital-exporting countries, on the other hand, should experience a sharp rise of unemployment, while the impact on relative wages is not as clearly determined.

Most interestingly, the total impact of globalization is either largely skill-premium-increasing or largely unemployment-increasing. However, it is not wage rigidities that decide whether relative wages or unemployment rates adjust. We showed that wage rigidities are rather irrelevant in that respect. It is the directions of capital flows that make the difference.

Appendix

Proof of Proposition 2 and 4(ii):

Without efficiency wages, equations (14) and (15) are rewritten as

$$a^{Hx}\hat{\theta} + \left(a^{Hx} + a^{Lx}\right)\hat{\ell} = \hat{\pi} - a^{Kx}\hat{\phi},$$

$$a^{Hy}\hat{\theta} + \left(a^{Hy} + a^{Ly}\right)\hat{\ell} = -a^{Ky}\hat{\phi}\,.$$

Concerning changes in relative wages $\left(\hat{\theta}\right)$, these two equations yield the following solutions:

$$\frac{\hat{\theta}}{\hat{\pi}} = -\frac{\left(a^{Hy} + a^{Ly}\right)}{\left(a^{Hy}a^{Lx} - a^{Hx}a^{Ly}\right)}$$

$$\frac{\hat{\theta}}{\hat{\phi}} = \frac{\left(a^{Kx} - a^{Ky}\right)}{\left(a^{Hy}a^{Lx} - a^{Hx}a^{Ly}\right)}$$

For the derivation of the latter result, recall that $\sum_i a^{ij} = 1$.

Comparing these solutions with the solutions in expressions (19) and (23) proves the irrelevance of wage rigidities.

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Figures and Tables

Figure 1:
Equilibrium

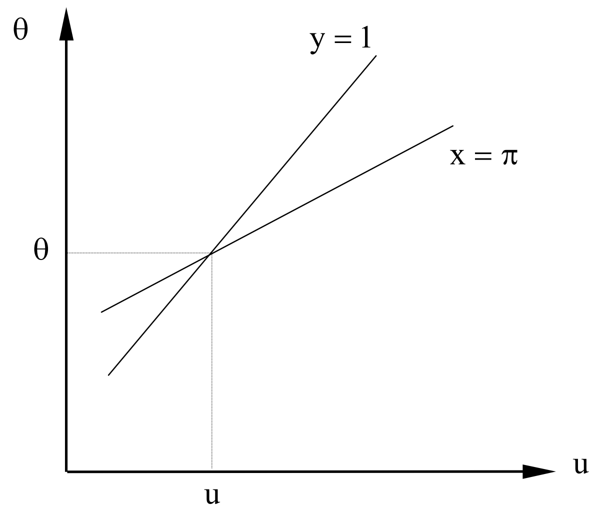

Figure 2:
International Trade

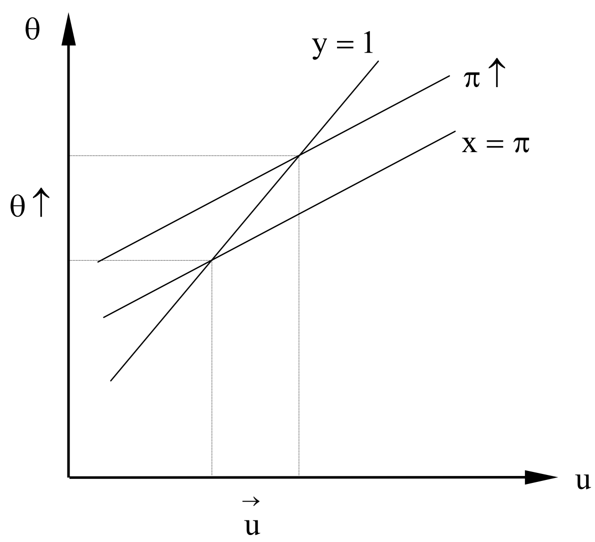

Figure 3:
Skill-Augmenting Technological Progress

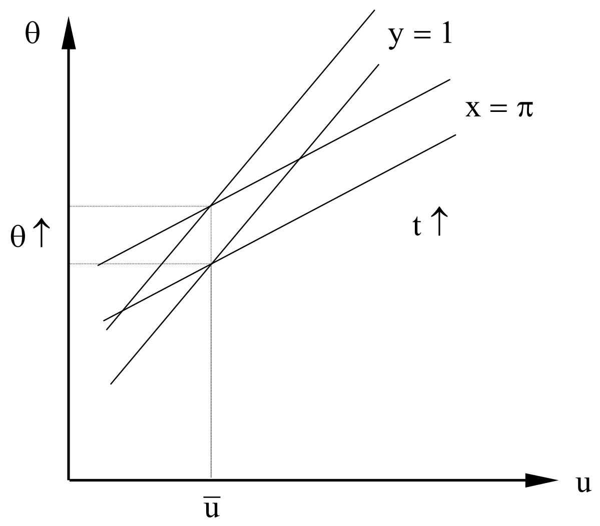

Figure 4:
Capital Movements

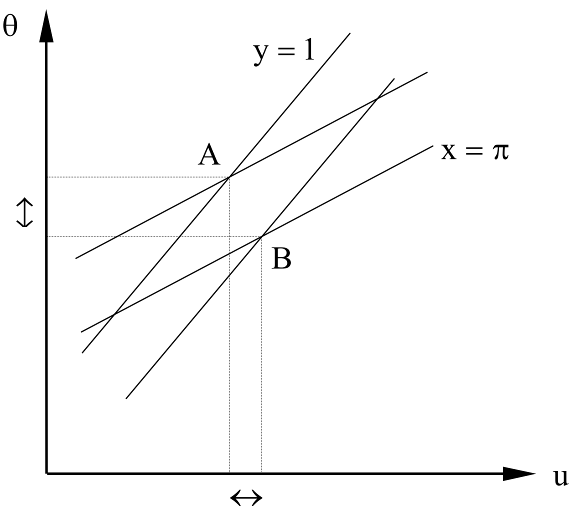

Table 1:

	Capital Movements	Biased Technological Progress	International Trade	Total Impact
Capital Importing Country	θ↑ u↓	θ↑ $\bar{u}$	θ↑ u↑	θ↑↑ u↑↓
Capital Exporting Country	θ↓ u↑	θ↑ $\bar{u}$	θ↑ u↑	θ↑↓ u↑↑