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in a Global Economy*

by

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Abstract

In this paper we analyze the effects of global and national technological change on employment levels and relative wages in an integrated two-country world (“Europe” and “America”), where both countries are characterized by equilibrium unemployment due to fair wage constraints. The asymmetry between the two countries arises from country-specific preferences towards wage inequality, with Europe's preferences being more egalitarian. Furthermore, we look at trade integration between this two-country world and a third country (“low wage south”). We derive an analytical tool, the *Virtual Integrated Equilibrium*, that allows us to adapt Dixit and Norman's well known Integrated Equilibrium approach to a situation where both trading countries have endogenous unemployment levels.

JEL classification: F11, F16

Keywords: Fair Wages, Unemployment, Virtual Integrated Equilibrium, Factor Price Equalization

Outline

1. *Introduction*
2. *The Model*
3. *Comparative Statics*
4. *Conclusion*

Non-Technical Summary

In this paper we analyze the effects of global and national technological change on employment levels and relative wages in an integrated, asymmetric two-country world ("Europe" and "America"). Both countries are characterized by equilibrium unemployment due to country-specific fair wage constraints. We also look at trade integration between this two-country world and a third country ("low wage south").

Beginning with now classic papers by Solow (1979), Akerlof (1982), and Akerlof and Yellen (1988, 1990) a sizable literature has developed deriving efficiency wages from a fairness constraint. The basic idea is that worker effort is a function of the perceived fairness of the wage relative to some standard of reference. From both a theoretical and empirical point of view, the difficult thing is identifying a plausible and observable basis for the evaluation by workers of the fairness of a wage offer. In this paper we will follow Akerlof and Yellen (1990) in supposing that there are two types of labor (skilled and unskilled) and that the fair wage has two determinants: the market wage of the other group and their own expected wage if they become separated from the firm (taking into account the possibility that they might be unemployed). In equilibrium, this setup leads to full employment for skilled workers, while some of the unskilled workers are unemployed in equilibrium. The asymmetry between Europe and America in the present paper is modelled as arising from country-specific weights being given to the wage of the respective other group in determining the fair wage. European unskilled workers attach a higher weight to the wage paid to their skilled colleagues, which *ceteris paribus* results in a higher rate of unemployment.

Our analysis complements earlier work by Xu (2001), who looks systematically at the effects of global and country specific technological change on relative factor prices in a Heckscher-Ohlin framework with full employment, and by Davis (1998a,b) who looks at trade integration with the low-wage south and at technological change in an asymmetric two-country model where involuntary unemployment exists only in Europe and is due to a binding minimum wage. In our model, trade integration with the low-wage south increases unemployment proportionally in Europe and America. Relative unemployment rates between the two countries remain unchanged with global technological progress as well, the relative wage effects having the same sign as in the full employment model of Xu (2001). This is different from the minimum wage model of Davis (1998b), where the relative wage effect is not related to the determinants relevant in the full employment model, but depends solely on the choice of the numeraire good. Finally, country specific technological change leads to divergent unemployment paths between the two countries, whereby both the sector and the factor bias of the technology shock are relevant. Again, the relative wage effects are related to those of Xu (2001), but it is shown that in contrast to the case of global technology shocks the sign of the change in the relative wage in our model may differ from those analyzed in Xu's paper. This is due to an effect specific to our setup, namely the employment effect in the country that does *not* experience the technology shock.

1 Introduction

As with many issues, there would appear to be a sizable gap between the way economists view the effects of real globalization (i.e. trade, direct investment, immigration) and the way citizens in general view these phenomena. At least as revealed by current research, economists seem to believe that globalization is no big deal, at least as far as labor market effects are concerned, while citizens appear to be quite concerned about the effects of globalization. Among the many possible reasons for this gap is that economists and citizens are looking at different things. Specifically, we economists have invested most of our effort in analyzing the effect of trade (and other forms of globalization) on wages. Public opinion data suggest that most citizens are far more concerned with levels of employment, and unemployment, than wages.¹ One specific claim that has received some attention is that the differing labor market institutions in the US and Europe have resulted in systematically different outcomes as a result of globalization (Davis, 1998a; Krugman, 1995). In this paper, we extend a simple, but plausible, model of equilibrium unemployment to a model of trade between large economies. Ours is not the first paper to examine this question so, prior to presenting our analytical framework and results, we begin by briefly situating our work relative to the related research.

Broadly speaking, we need a framework with: equilibrium economy-wide unemployment; sufficient sectoral structure to permit international trade; and, because we are

¹Slaughter (2000) provides an overview of research on the link between changes in commodity prices and changes in the skill premium. Chapter 2 of Scheve and Slaughter (2001) does a nice job of reviewing the results of current poll data on questions related to globalization. We are not arguing that research of the sort reviewed in Slaughter (2000) is misguided. What provoked this research was the striking rise in the skill premium in the 1980s, a period characterized by an increase in the supply of skill. What the research reviewed in Slaughter shows is that, at least in the context of the competitive general equilibrium model, changes in the relative prices of traded goods cannot account for more than a small share of the change in the skill premium. The analysis in this paper is provoked by an interest in the link between globalization and unemployment, a link that obviously cannot be understood in a model which posits full employment as an equilibrium condition. It should be noted, however, that if unemployment is generated by downward inflexibility of wages, which varies across types of labor and industries, inference based on mandated wage regressions may be problematic.

interested in the effect of international asymmetries in labor market institutions on the effects of globalization, we will need to introduce these asymmetries. Much of the literature on unemployment works with a one-sector model. As a result, any institutional structure that supports wages above the market-clearing level will produce equilibrium unemployment. Among the variety of models producing equilibrium unemployment are: minimum wages; insider-outsider/union models; implicit contracts; search; and efficiency wages.² As Solow (1980) points out, all of these might play a role in any given firm or sector and contribute to the existence of equilibrium unemployment at the macroeconomic level. In this paper we choose to focus on a source of unemployment for which there is considerable microeconomic evidence across virtually all sectors as well as experimental evidence: the fair wage model.³

Beginning with now classic papers by Solow (1979), Akerlof (1982), and Akerlof and Yellen (1988, 1990) a sizable literature has developed deriving efficiency wages from a fairness constraint. The basic idea is that worker effort is a function of the perceived fairness of the wage: $e_k = f(w_k/w_k^*)$, where e_k is effort and w_k is the wage of worker type k and the star denotes the wage perceived as fair by workers of type k . Like all efficiency wage models, firms are induced to pay wages above the market clearing wage, resulting in equilibrium unemployment. From both a theoretical and empirical point of view, the difficult thing is identifying a plausible and observable basis for the evaluation by workers of the fairness of a wage offer. In this paper we will follow Akerlof and Yellen (1990) in supposing that there are two types of labor (skilled and unskilled) and that the fair wage has two determinants: the market wage of the other group, and their own expected wage if they become separated from the firm (taking into account the possibility that they might be unemployed).

Where most theoretical work on unemployment proceeds under the assumption of

²Davidson (1990) and Layard, Nickell and Jackman (1991) provide clear discussions of these alternatives.

³Recent reviews of the evidence can be found in Howitt (2002) and Bewley (2002). Both stress the wide extent and strength of evidence supporting the fair wage model from a range of sources including: surveys of managers and workers; firm-level studies of pay and termination patterns; experiments; and common sense/personnel management textbooks.

a single productive sector, our interest in international trade requires that we develop a model with at least two sectors. Furthermore, since we are interested in equilibrium unemployment, we will need the fairness constraint to be binding in both sectors. In previous work, Agell and Lundborg (1995) have provided a two-sector general equilibrium model of a trading fair wage economy that is loosely related to the Akerlof/Yellen model.⁴ In contrast, the framework we use is a direct extension of the Akerlof/Yellen model to a two sectors. The closer resemblance to the Akerlof/Yellen setup makes our paper different from Agell and Lundborg (1995) in two important ways: First, the fair wage mechanism in the present paper operates for both types of workers, and the outcome with full employment of skilled workers and unemployment for unskilled workers arises endogenously. In contrast, Agell and Lundborg *assume* that the fair wage mechanism operates only for one of the factors. While this may be appropriate in their setup with the two factors labor and capital, it would be hard to justify in a model with two types of labor. Second, in our model, as in Akerlof and Yellen (1990), both types of workers provide a well-defined level of full effort in equilibrium. Due to a different specification of the effort function, there is no full effort in Agell and Lundborg (1995), and equilibrium effort is variable. It is the simplification of a constant equilibrium effort which will allow us to represent our model in a simple graphical framework.⁵

Finally, in contrast to Agell and Lundborg who analyze a small open economy, we are interested in the interaction between two large economies and the impact of asymmetries between labor market institutions in the two economies. In this, our analysis is motivated by the important work of Krugman (1995), Davis (1998a, b), and Xu (2001). In his analysis of the effect on OECD countries of manufactured exports from low-wage developing countries, Krugman develops two models of the OECD – a flexible wage "American" model and a "European" model with fixed wages in which adjustment occurs on the em-

⁴Agell and Lundborg (1992) examine the introduction of a fair wage constraint in a Harberger model. Rapanos (1996) extends Agell and Lundborg's (1995) model to an examination of technical change.

⁵The Akerlof/Yellen specification of the effort function with a well-defined level of full effort is further-compatible with the empirical observation that workers' effort falls when they are underpaid but does not increase when they are overpaid.

ployment margin. Davis (1998a) extends Krugman's analysis by considering the impact of economic linkage between the American and European economies on their respective adjustments to the opening of trade with a low-wage South. In that paper, the American economy is a standard Heckscher-Ohlin economy with flexible wages in both sectors, while the European economy is characterized by an economy-wide minimum wage of the sort analyzed by Brecher (1974). Davis shows that the asymmetry between economies produces spillovers in the form of higher unemployment in Europe and higher wages in the US as a result of liberalized trade with developing country exporters of manufactures. In the words of Davis' title, European unemployment props up American wages. Davis gets very strong results from a model of very stark differences between the European and American economies. This was useful in a first presentation of results of this sort, but it is important to audit results of this sort by considering less stark assumptions.⁶

In this paper both the American and European economies are characterized by fair wage constraints. The asymmetry between the two countries remains, however, because the European fair wage constraint is, in a sense specified below, tighter than that in the American economy. As a result, while both countries will have equilibrium unemployment, the levels of unemployment will differ between the two in empirically plausible ways.⁷ Not only does this framework have analytical advantages relative to the framework in Davis (related to dependence of results on which good is taken as the numeraire), but it also produces results that differ in interesting ways without losing the fundamental linkage between economies emphasized by Davis.

One of the premier issues in evaluating empirical results on the relationship between international trade and the skill premium is the relationship between various forms of

⁶Another example of such auditing is Oslington (2002), which retains Davis' labor market assumptions but looks at the case where Europe becomes completely specialized in production of the skill intensive good, and hence factor prices are not equalized. Under this assumption, Oslington shows that some of Davis' results do not hold.

⁷See Nickell (1997) for an argument, and supporting data, to the effect that US and European labor markets are not nearly as distinctive as common beliefs suggest. In particular, unemployment rates between the US and Continental European countries are not dramatically different.

technical change, trade, and wages.⁸ Leamer (1998) and Krugman (2000) engage with one another on the issue of the relative importance of the factor-bias versus sector-bias of technological change for the skill premium in the context of a small-open economy. Xu (2001) presents a sophisticated and comprehensive analysis of this question in the context of a two-country world in which both countries are large and characterized by perfect competition in factor and commodity markets. Davis (1998b) addresses the effects of technical change in his model of a flexible wage America and a Europe with a binding minimum wage. In this paper, we extend the analyses of Xu and Davis by considering the effect of technical change in our two-country world with fair wages and equilibrium unemployment. As with the case of falling prices for the unskilled good, we derive distinctive results for this case as well.

Our analysis proceeds by developing our notation in the standard competitive 2-good \times 2-factor case (section 2.1), introducing the fair-wage constraint (section 2.2), and then developing the 2-country world economy (section 2.3). In this last section we introduce the virtual integrated equilibrium (VIE), a key concept for the rest of our analysis. In section 3 we develop our main results on reactions to trade shocks (section 3.1) and technology shocks (section 3.2). Section 4 concludes.

2 The Model

The model is set up in three steps. First, the well known two-sector full employment model of a closed economy is introduced. This mainly serves to introduce the notation. Second, we introduce the fair wage mechanism and show that it generates involuntary unemployment in equilibrium. Third, we show how the equilibrium in the closed fair wage economy can be related to the equilibrium in an asymmetric two-country trading world consisting of America and Europe. The asymmetry is generated by the assumption that workers' attitudes towards wage inequality are different across countries. This third step

⁸The classic treatments of these relationships for the two-sector competitive model are Findlay and Grubert (1959) and Jones (1965). More recent work in the small economy context includes: Jones (1997, 2000); Leamer (1998); Krugman (2000); and Neary (2002).

builds on Dixit and Norman's (1980) well-known integrated equilibrium (IE) approach.

2.1 The Closed Economy with Full Employment

The closed flexible-wage economy is assumed to produce the two goods X and Y using the factors unskilled labor L and skilled labor H . Good Y serves as the numeraire and is assumed to be labor intensive relative to X at all common factor price ratios. Product markets are perfectly competitive, and production functions in both sectors exhibit constant returns to scale. Both factors of production are supplied inelastically in the quantities L^W and H^W , respectively. Finally, preferences are assumed to be homothetic with both goods being essential in consumption. With w_L as the return to labor, w_H as the return to skill, and P as the relative price of X , the zero profit conditions for the two sectors are given by the equality of goods prices to unit costs, i.e.

$$c_X(w_L, w_H) = P \qquad c_Y(w_L, w_H) = 1. \qquad (1)$$

It is assumed at this stage that flexible factor prices clear the markets for both skill and labor. Hence, the employment ratio of skill relative to labor, denoted by h , equals their endowment ratio $h^W \equiv H^W/L^W$. Furthermore, ω is defined as the ratio of w_L and w_H . Equilibrium in the closed economy is then given by the following two relations:

$$P = \lambda(h) \qquad \text{with} \qquad \lambda'(h) < 0 \qquad (2)$$

$$\omega \equiv \frac{w_L}{w_H} = \psi(P) \qquad \text{with} \qquad \psi'(P) < 0 \qquad (3)$$

For a given $h = h^W$, (2) gives the equilibrium relative goods price and (3) gives the equilibrium relative factor price. The sign of λ' follows from the assumptions of good X being skill intensive and consumers having homothetic preferences. Under these assumptions, the Heckscher-Ohlin theorem ensures that the higher the skill-to-labor endowment of a country, the lower is its autarky price of the skill intensive good. The sign of ψ' is implied by the factor intensity assumption alone. Under this assumption, it follows from the Stolper-Samuelson theorem that an increase in the price of X decreases the relative price of unskilled labor.

2.2 Fair Wages in the Closed Economy

In the next step, the fair wage mechanism is introduced into the closed economy. Involuntary unemployment is generated by a variant of the Akerlof and Yellen (1990) model. The adaptations made serve the sole purpose of making their one-sector model work in a two-sector general equilibrium framework. The two factors L and H are supplied inelastically, and both types of workers are able to choose their effort at work. In doing so, workers take into account the effort norm ε^n , and they maximize their utility by providing effort ε equal to ε^n . This is formalized by defining the utility function for a worker of group k as

$$\nu = v(X, Y) + \Delta\varepsilon_k \quad (4)$$

where $\Delta\varepsilon_k \equiv -|\varepsilon_k - \varepsilon_k^n|$ is the degree of norm violation, and $v(\cdot)$ is assumed to be homothetic. Workers' effort norms are determined by

$$e_k^n = \min\left(\frac{w_k}{w_k^*}, 1\right) \quad k = L, H \quad (5)$$

where w_k^* denotes the fair wage for workers of group k . From (4), utility maximizing workers of group k will always choose $\varepsilon_k = \varepsilon_k^n$. Hence it follows from (5) that workers provide the normal level of effort, which is normalized to one, if they are paid at least their fair wage.

Firms are wage setters but they are assumed to treat the fair wage, which is determined in general equilibrium, parametrically. Under this assumption, profit maximization can be thought of as a two-stage process, just as in the standard efficiency wage model of Solow (1979). In step one, firms set the wage rate for each type of labor k to minimize the wage paid for an efficiency unit, which is w_k/ε_k . In step two, they hire workers up to the point where the value marginal product of labor is equal to the wage set in step one. It can be seen from (5) together with $\varepsilon_k = \varepsilon_k^n$ that the wage rate for an efficiency unit of labor (skilled or unskilled) stays constant (at w_H^* and w_L^* , respectively) if a firm pays a wage below the fair wage. We can therefore safely assume, following Akerlof and Yellen (1990), that firms choose to pay wages at least as high as the fair wage for the respective factor.

For each of the two groups, the fair wage has two determinants: first the market wage of the respective other group, and second the remuneration they could expect outside their

own firm, taking into account that they might be unemployed with a probability that is equal to the factor-specific rate of unemployment.⁹ Hence, we have

$$w_L^* = \theta w_H + (1 - \theta)(1 - U_L)w_L \quad (6)$$

$$w_H^* = \theta w_L + (1 - \theta)(1 - U_H)w_H \quad (7)$$

where U_L and U_H are the factor-specific rates of unemployment, and θ is the weight attached to the respective other factors remuneration in one factor's determination of its fair wage.

We assume that in a perfectly competitive labor market the wage for skilled workers would be higher than the wage for unskilled workers. Under this condition it is straightforward to see that the following must be true in equilibrium:

$$U_L > U_H = 0 \quad (8)$$

$$w_H > w_H^* > w_L = w_L^* \quad (9)$$

$$\varepsilon_L = \varepsilon_H = 1 \quad (10)$$

i.e., there is a strictly positive rate of unemployment $U = U_L$ for unskilled workers but full employment for skilled workers, the fair wage is binding only for unskilled workers, and both types of workers provide the normal effort.¹⁰

Using (8) to (10), one can derive an equilibrium relationship between the wage differential and the rate of unemployment. Using $\omega \equiv w_L/w_H$, we get

$$\omega = \alpha(U, \theta) = \frac{\theta}{\theta + (1 - \theta)U}. \quad (11)$$

Following Akerlof and Yellen (1990), (11) is called the *fair wage constraint*. For a given value of θ , the fair wage constraint describes equilibrium combinations between the rate

⁹Instead of the expected wage rate, Akerlof and Yellen (1990) use the (hypothetical) market clearing wage rate of the respective group as the second determinant of the fair wage. The two approaches yield similar results as in the presence of involuntary unemployment for the respective factor both its expected wage and its market clearing wage lie below the actual wage. The approach used here is more straightforward to apply in a multi-sector model.

¹⁰These results are the same as in the model of Akerlof and Yellen (1990).

of unemployment of unskilled workers and the relative gross wages of skilled and unskilled workers.¹¹ Partial differentiation gives

$$\frac{\partial \alpha}{\partial U} = \frac{-\theta(1-\theta)}{(\theta + (1-\theta)U)^2} < 0 \quad \text{and} \quad \frac{\partial^2 \alpha}{\partial U^2} = \frac{2\theta(1-\theta)^2}{(\theta + (1-\theta)U)^3} > 0,$$

and hence the fair wage constraint is negatively sloped and convex in $\omega - U$ -space, i.e. higher rates of unemployment (for unskilled workers) lead firms to paying them relatively lower wages. This is because with higher rates of unemployment, the fair wage needed to elicit normal effort from unskilled workers is lower. Considering the extreme cases $U = 0$ and $U = 1$, we have $\alpha(0, \theta) = 1$ and $\alpha(1, \theta) = \theta$. Hence, wages can vary over the range $[\theta, 1]$, and the model gives us an intermediate case between full wage flexibility and a fixed wage differential.¹²

Furthermore, given that skill is fully employed, there is by definition a relationship between the rate of unemployment U , the endowment ratio h^W and the employment ratio h :

$$U = 1 - \frac{h^W}{h} \equiv \beta(h, h^w) \quad \text{with} \quad \frac{\partial \beta}{\partial h} > 0. \quad (12)$$

This relation is identical to the “Brecher relation” stated in Davis (1998a) but for the fact that we have divided both sides by L^W .¹³ Taken together, equations (2), (3), (11) and (12) determine the endogenous variables P , ω , U and h in the closed fair wage economy. Note that contrary to the full employment model, the goods market equilibrium condition (2) now describes possible combinations between two endogenous variables.

It is convenient to illustrate the determination of equilibrium using a figure similar to figure 1 of Davis (1998a). This is done in figure 1. The graphical representations of

¹¹In deriving (11) unemployment benefits have been set to zero. If we were to assume instead that unskilled workers are entitled to unemployment benefits of γw_L , $\gamma < 1$, the fair wage constraint becomes $\omega = \alpha(U, \theta, \gamma) = \theta/[\theta + (1-\theta)(1-\gamma)U]$, and an increase in γ pivots the fair wage constraint outwards, ie for a given level of unemployment the fair wage increases.

¹²With perfectly competitive markets for both types of labor, ω can vary between 0 and 1, assuming – as we did – that under perfect competition skilled workers are paid the higher wage.

¹³Note that the form of (12) does not depend on the particular mechanism generating unemployment. Observing this, we will not use the term “Brecher relation” in the following because it appears to suggest a connection to the minimum wage model originally due to Brecher (1974).

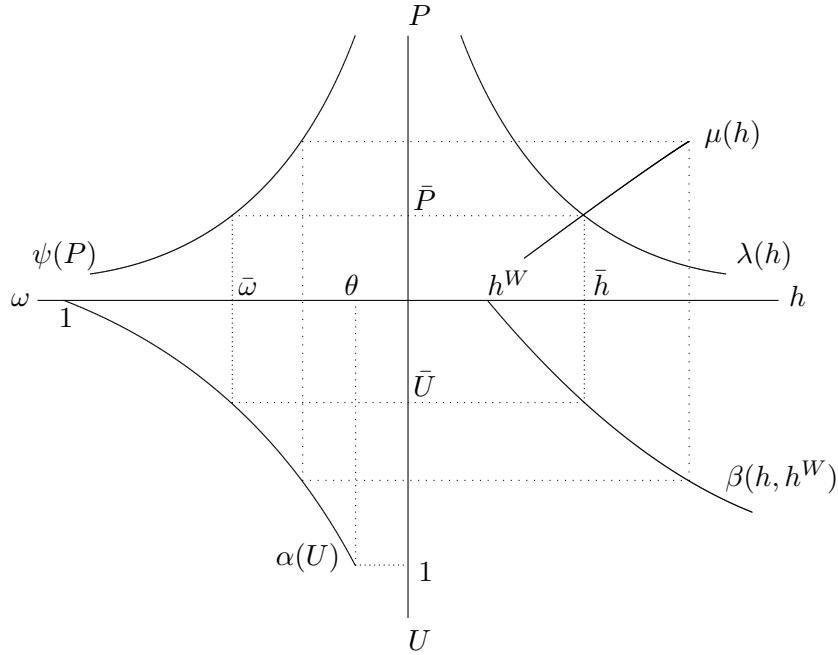


Figure 1: The Closed Economy Equilibrium

equations (2), (3) and (12) in quadrants I, II and IV are straightforward and do not need further elaboration. The fair wage constraint, equation (11) is depicted in quadrant III. The upward sloping curve in quadrant I, labelled $\mu(h)$, is implied by (3), (11) and (12): For a given zero-profit relation (3), it gives combinations of h and P which are compatible with workers supplying the profit maximizing level of effort along the fair wage constraint. It can be easily verified that there is a unique equilibrium for the closed economy, with the equilibrium values of the respective variables being denoted by a “-”.

2.3 Conditions for Factor Price Equalization

In this section, the equilibrium for the closed fair wage economy just derived is re-interpreted as describing the situation of a world economy in which both goods and factors are freely mobile. Then Samuelson’s angel (Samuelson, 1949), descends from the theorist’s heaven and allocates the factors among two countries (Europe and the US). Following Dixit and Norman (1980), we then examine the conditions under which free trade in goods, but

not in factors, can replicate the integrated equilibrium.¹⁴

It is shown in the following that a modified IE approach can be used to derive conditions for factor price equalization in an asymmetric trading world consisting of Europe and America. We assume that the two countries differ in their attitudes towards wage inequality, with European workers disliking high skill premiums to a larger extent. Formally, this is captured here by the assumption $0 < \theta^A < \theta^E < 1$, where A and E are country superscripts applying to America and Europe, respectively. From (11) we have that $\partial\alpha/\partial\theta > 0$ for $U > 0$, and hence the European fair wage constraint lies above the American fair wage constraint for all strictly positive values of U . Linking the two-country case to the integrated equilibrium, we assume that Europe inherits all properties – and in particular the value for θ – of the closed economy in the previous section. It is clear from (1) that in the absence of technological differences and with diversified production in both countries as well as free goods trade, factor prices will be equalized internationally. This implies, as can be seen in figure 2 for the equilibrium relative wage $\bar{\omega}$, that the rate of unemployment is higher in Europe than in America in any diversified equilibrium with free trade and equal technologies.

As a preliminary step, we show that the standard version of the IE approach cannot be applied to our case of differing values for θ , i.e. different attitudes towards wage inequality, between countries. Let $H^W = H^A + H^E$ and $L^W = L^A + L^E$ describe the distribution of endowments across countries, with W being the superscript for the integrated world. We then have the following result.

Lemma 1. *It is impossible to find a division of labor between the two countries that leads to both countries having the same factor prices as the integrated world.*

The proof is by contradiction. Assume that the endowment split leaves world factor prices unaltered. An unaltered wage rate elicits the profit maximizing effort from the European

¹⁴This integrated equilibrium approach by Dixit and Norman has its roots in early work by Travis (1964) and Samuelson (1949), and has been extended in a number of directions – e.g. Helpman and Krugman (1985) make it the fundamental tool of their work on the positive economics of trade under various market structures, while Deardorff (1994) considers the extension to many countries.

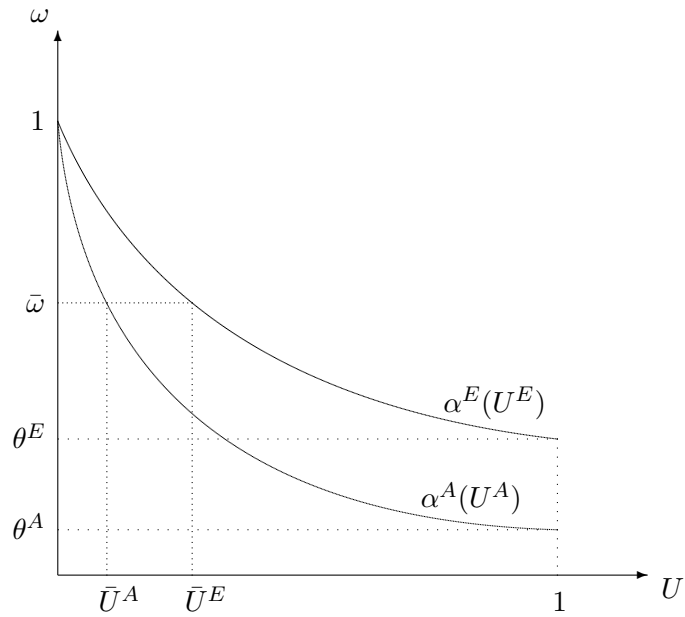


Figure 2: European and American Fair Wage Constraints

workers – and hence is chosen by European firms – if and only if after the endowment split Europe has the same rate of unemployment as the integrated world had before. But a constant rate of unemployment in Europe implies a decreasing *average* rate of unemployment in the world compared to the integrated equilibrium. This means a lower average skill intensity of production and hence a higher relative price of the skill intensive good. Any change in relative goods prices however is incompatible with both countries having the same factor prices as in the integrated equilibrium.

It is now checked whether there are allocations of factors to the two countries that lead to free trade equilibria in which the factor prices, although different from the integrated equilibrium, are the same in both countries. To this end, we construct a *hypothetical* one-country world with fair wages which has

- (i) the same skill endowment as the two-country world,
- (ii) the same average skill intensity of production as the two-country world, and

(iii) the same rate of unemployment as Europe.

In analogy to the Dixit-Norman terminology, this hypothetical one-country world is called the *virtual integrated equilibrium* (VIE). Let s^L be the European share of the unskilled labor force. With different rates of unemployment across countries, the average unemployment rate in the world is $U^E s^L + U^A(1 - s^L)$. Let $a \equiv U^A/U^E$ denote the ratio between the American and European unemployment rate and $d \equiv \omega^E/\omega^A$ the ratio between European and American relative wages. From (11), it follows that

$$a = \frac{d - \omega^E}{1 - \omega^E} \frac{\theta^A(1 - \theta^E)}{\theta^E(1 - \theta^A)}. \quad (13)$$

With equal technologies between countries and diversified production it follows that $d = 1$ and $a < 1$.¹⁵ Furthermore, one can see from (13) that under FPE a is constant as it only depends on the preference parameters θ^E and θ^A . Using this, as well as the condition $U = U^E$, the average rate of unemployment for the two-country world becomes $U(s^L + (1 - s^L)a)$. Hence, the equivalent to (12) in the asymmetric two-country world becomes

$$U = \frac{1}{s^L + (1 - s^L)a} \left(1 - \frac{h^W}{h}\right) \equiv \beta(h, h^W, s^L), \quad (14)$$

where

$$h \equiv \frac{H^W}{L^W[1 - U(s^L + (1 - s^L)a)]}$$

in this new context is reinterpreted as the the average skill intensity of world production. Denote the variables pertaining to this VIE by a “ \sim ”. In order to satisfy conditions (i) to (iii), the virtual endowment ratio $\tilde{h}^W \equiv H^W/\tilde{L}^W$ has to solve the equation $\beta(h, \tilde{h}^W) = \beta(h, h^W, s^L)$, holding h constant at the level of the two-country world. Substituting from (12) and (14) yields

$$\tilde{h}^W = h + \frac{h^W - h}{s^L + (1 - s^L)a}, \quad (15)$$

¹⁵In Kreickemeier (2004), it is shown for the special case of two countries with identical endowments, that in the presence of endogenous skill accumulation $a < 1$ still holds, but $d = 1$ does not.

Changing the allocation of unskilled labor between countries leads to a different VIE.

More generally, it follows from (16) that there is a unique and finite $\tilde{L} > L$ for every admissible combination of L^W , s^L , U , and a . And one can easily verify by inspecting figure 3 that for *every* value of s^L point B lies strictly to the right of point A (as the European unemployment rate is strictly smaller than one). Finally, given the assumption that X production is more skill intensive than Y production at all common factor price ratios, point E lies strictly above point D. This proves that there is a non-degenerate FPE set in the following sense:

Proposition 1. *Let s^L and s^H be the fractions of the world labor and skill endowments, respectively, which are allocated to Europe. Then, for every s^L with $0 < s^L < 1$ there exists a range of skill allocations $[s_1^H, s_2^H]$ with $0 < s_1^H < s_2^H < 1$ which leads to factor price equalization.*

Now, the FPE set can be described formally in a manner very similar to the standard model. Let goods be indexed by i , countries by j . Then, the divisions of world factor endowments that replicate the VIE can be described as

$$FPE = \left\{ \begin{array}{l} [(H^A, L^A), (H^E, L^E)] \exists \lambda_{ij} \geq 0 \\ \\ \text{such that } \sum_j \lambda_{ij} = 1 \\ \\ (H^A, L^A) = \sum_i \lambda_{iA} (\tilde{H}(i), \tilde{L}(i)) + (0, L^A \cdot aU) \\ \\ (H^E, L^E) = \sum_i \lambda_{iE} (\tilde{H}(i), \tilde{L}(i)) + (0, L^E \cdot U) \\ \\ i = X, Y \quad j = A, E \end{array} \right\} \quad (17)$$

Here, $\tilde{H}(i)$ and $\tilde{L}(i)$ denote the amounts of skill and labor, respectively, employed in sector i in the VIE with factor endowments (H^W, \tilde{L}^W) , where \tilde{L}^W is given by (16). These conditions state that in order to replicate the VIE it must be possible for the two-country world to use the skill intensities of the VIE and thereby achieve full employment for skilled

FPE region from s_1^L to s_2^L rotates $\beta(\cdot)$ outwards. If FPE holds throughout, changes in equilibrium values of the variables of interest are indicated by arrows. Hence, decreasing the relative size of the European labor force leads to a lower skill intensity of production, a higher relative price of the skill intensive good, a lower relative (and absolute) wage of unskilled workers and to a higher rate of unemployment.¹⁷

It is now straightforward to see that, as in Davis (1998a), there is a sense in which labor market characteristics in one country spill over into labor market outcomes in the other. To this end, assume the counterfactual situation where America has the same preferences towards wage equality as Europe. The two countries are then indistinguishable, and hence this case is equivalent to $s^L = 1$. From the above, this would imply an increase in the relative wage of unskilled workers and a decrease in European unemployment. Hence European unskilled workers are negatively affected by the less egalitarian preferences of their American colleagues. It is straightforward to see that the reverse is true as well: American unskilled workers are positively affected in terms of relative wages and employment levels by the more egalitarian preferences of their European colleagues.

3 Comparative Statics

We now conduct two comparative static exercises which appear to have particular interest from a policy point of view. First, we look at the entry of newly industrializing countries into the trading world. Second, we look at global and national technical progress. For both cases, the minimum wage model used by Davis (1998a,b) generates strong results. Part of the aim of this section is to examine the extent to which the special nature of the labor market distortion assumed by Davis is responsible for these results. An obvious second benchmark case would be given by the full employment model. However, we will consider instead the more general benchmark of a constant rate of unemployment which is not necessarily zero. With respect to the comparative static effects, it is immaterial whether

¹⁷In figure 4, \tilde{h}^W for each of the two equilibria can be found by drawing a β -curve with $s^L = 1$ through the respective equilibrium point (\bar{U}, \bar{h}) . The resulting (endogenous) intersection points with the h -axis give the values for \tilde{h}^W . One can easily verify that decreasing s^L leads to a decrease in \tilde{h}^W .

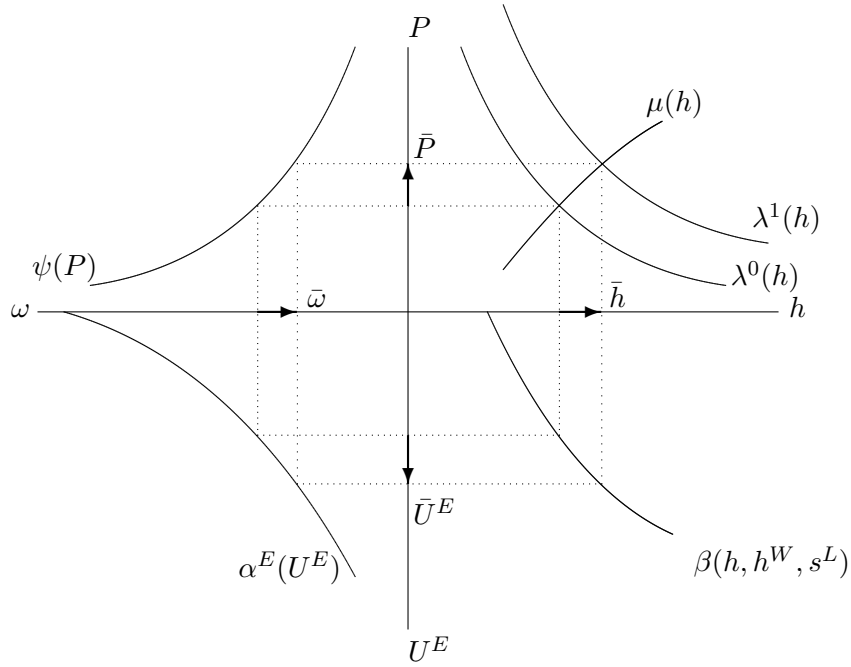


Figure 5: The entry of NICs into world trade

the rate of unemployment is constant at some positive level or zero. And using a positive rate of unemployment as a starting point allows us to sensibly compare comparative static effects of our model, which is characterized by unemployment in the initial equilibrium, to this benchmark.

3.1 Entry of NICs into world trade

Consider the entry of newly industrializing countries (NICs) into the trading world, i.e. the virtual integrated equilibrium comprising America and Europe. It is assumed that at the relative world market price of the VIE, the NICs as a group are net exporters of the labor intensive good.¹⁸ Again, the comparative static effects can be shown by a variant

¹⁸This assumption is quite general in the sense that restrictions for the trade between NICs and the VIE countries are not ruled out. Similarly, technology differences between both groups of countries are allowed for. Clearly, if trade was restricted or technologies between the two groups of countries were different, factor prices between NICs and the VIE countries would not be equalized.

of the familiar four-quadrant diagram, assuming that factor price equalization between America and Europe continues to hold.

In figure 5, the entry of NICs into world trade shifts the goods-market-equilibrium relation outwards, i.e. from position λ^0 to position λ^1 . The vertical distance between the two curves measures the amount by which this change would make P , the relative world market price of the skill intensive good, go up for a given average skill intensity of production in the VIE countries. This would be the price change occurring in a model with a constant rate of unemployment. The horizontal distance between the two curves measures the amount by which the average skill intensity of production in the VIE countries would have to increase in order to accommodate the entry of the NICs into world trade at constant relative goods prices. This is the case described by Davis (1998a). The equilibrium changes in P , ω , U^E and h are indicated in figure 5 by arrows.¹⁹ The β -function does not move because from (13) the ratio of unemployment rates between the two countries is constant as long as factor prices are equalized between them. Hence, we have

Proposition 2. *The entry of NICs into the world trading system decreases relative wages of the unskilled in Europe and America, and it proportionally increases the unemployment rates in both countries.*

Workers in both countries who remain employed experience a loss in real wages through a standard Stolper-Samuelson effect induced by the decrease in the relative price of the labor intensive good. In addition, some of them become unemployed, and hence their wage income falls to zero. The results of the present model are in marked contrast to the minimum wage model where American workers are not affected at all by the entry of NICs into world trade. This strong implication of the Davis (1998a) model does no longer hold in a world with endogenously determined prices.

¹⁹It is possible for h and P to rise at the same time because the VIE countries as a group are now exporting the skill intensive product.

3.2 Technological Change

In a recent paper, Xu (2001) derives the effects of technological change on relative factor prices in a full employment model. His analysis of different cases is exhaustive in considering different elasticities of substitution in demand as well as different types of technological progress (TP). Davis (1998b) looks at the effects of TP in the asymmetric two-country world where “Europe” has a binding minimum wage that is fixed in terms of the numéraire good, and “America” has fully flexible wages.

It turns out to be useful to split the overall effect of technological change on relative wages into four partial effects. The *impact effect* describes the effect of TP on the factor price differential at constant relative goods prices. Now, holding employment levels constant, a goods price change is needed to bring about goods market equilibrium. The resulting change in relative wages is labelled *relative price effect*. These two effects are identical to the full employment model analyzed by Xu (2001). In addition, and specific to the fair wage model, there are a *home employment effect* and a *foreign employment effect* induced by the change in relative prices. For future reference, the home employment effect is assumed to occur in the country that experiences TP, while the foreign employment effect is the effect that occurs in the country that does not experience TP.

In order to facilitate the comparison between our result and the full employment model, we introduce the following terminology.

Definition 1. *The case where the relative price effect of TP is sufficiently large to reverse the impact effect of TP on the factor price differential is called the “inelastic case”. If the relative price effect is sufficiently small to preserve the sign of the impact effect, we call this the “elastic case”. The case where the relative price effect exactly offsets the impact effect is labelled “borderline case”.*

This terminology is meaningful insofar as *ceteris paribus* an increase in the elasticity of substitution in demand decreases the relative price effect. As shown in Xu (2001), the distinction made in this definition corresponds to the elasticity of substitution in demand being smaller than, larger than and equal to one, respectively, for the case of global

technological change that is Hicks-neutral. With non-neutral technological change, the borderline case occurs for an elasticity of substitution which is different from one. With skill-using TP in the skill intensive or labor-using TP in the labor intensive sector, η in the borderline case is smaller than one. In the other two cases (skill-using TP in the labor-intensive sector and labor-using TP in the skill-intensive sector) it is larger than one.²⁰ Replacing global technological change by national technological change *ceteris paribus* reduces η in the borderline case. This is because a national technology shock has a smaller effect on global goods supplies than a global shock of the same type, and hence for it to have the same effect on relative goods prices the elasticity of substitution has to be lower.

Table 1: Effect of technical progress on relative wage of unskilled with full employment

Sector bias	Preferences	Integrated World	Home	Foreign
X	$\eta > \eta^*$	–	–	+
	$\eta = \eta^*$	0	0	+
	$\eta < \eta^*$	+	+	+
Y	$\eta > \eta^*$	+	+	–
	$\eta = \eta^*$	0	0	–
	$\eta < \eta^*$	–	–	–

Using this terminology, the results of Xu (2001) can be summarized in table 1. In contrast to his table 2, where the benchmark case is given by the demand-side substitution elasticity η equal to one, here we choose the benchmark η^* , which is the elasticity of substitution compatible with the borderline case defined above. Hence, η^* is endogenous and depends on the type of technological shock. This particular benchmark will prove useful when we compare the results of the full employment and the fair wage model.

²⁰See Xu (2001), table 2.

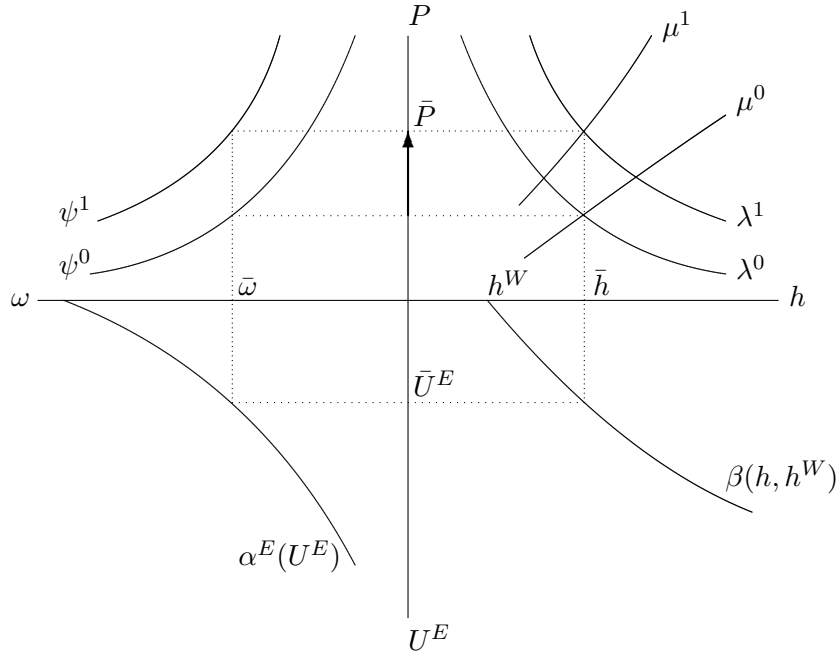


Figure 6: Global technological change

3.2.1 Global Technological Change

Using the above definition, we have the following result.

Proposition 3. *Compared to the full employment model, changes in relative goods and factor prices are qualitatively unchanged in the fair wage model. Relative factor price changes are dampened in all cases, while changes in relative goods prices are augmented in the elastic case, unchanged in the borderline case and dampened in the inelastic case. Unemployment rates for unskilled labor increase if and only if the skill premium increases.*

The result is proved using figure 6. Curves labelled “0” belong to the pre-TP equilibrium, curves labelled “1” to the post-TP equilibrium. For concreteness, in the figure TP is assumed to occur in the labor intensive sector, and the price adjustment is assumed to be such that relative factor prices as well as the skill intensity of production are constant. In other words, figure 6 depicts the borderline case.

The effect of TP in the labor-intensive sector is to shift the zero-profit relation in

quadrant II outwards, from ψ^0 to ψ^1 . Given that both types of labor are paid the value of their marginal product, this move is independent from the labor market characteristics, in particular the shift is identical for the fair wage model and for the standard model with perfectly competitive labor markets. Given the construction of $\mu(h)$ in quadrant I explained above, it is clear that this curve shifts upward by the same amount as the zero profit condition, in the case depicted from μ^0 to μ^1 . For every type of TP in the labor intensive sector, the goods market equilibrium condition in quadrant I is shifted outwards, the extent depending on both the bias of TP and the elasticity of substitution in demand. Again, labor market characteristics play no role here.²¹ Therefore, the effect of TP in an economy with full employment can be derived from figure 6 by holding the skill intensity constant at \bar{h} .²² This is what allows us to relate the results in our model to those derived by Xu (2001), as done in proposition 3 above. In the borderline case depicted, the relative price of the skill intensive good rises to the extent shown by the arrow, and the equilibrium values of ω , U and h remain unchanged.

Given that the shift in μ only depends on the type of TP (but not on demand parameters), post-TP equilibria have to lie on μ^1 . In the elastic case, the goods market equilibrium schedule λ moves to an intermediate position between λ^0 and λ^1 , while in the inelastic case it moves to a position beyond λ^1 . The respective schedules have not been added to the figure in order to avoid clutter. Working through the adjustment process in figure 6 for these cases, the results stated in proposition 3 follow immediately. The effects for relative wages are summarized in column 2 of table 2. While the induced adjustment of relative wages is smaller than under full (or, more generally, constant) employment, the induced adjustment of relative goods prices is augmented if the conditions for the “elastic case” are met. Hence, contrary to what one might expect, it is not true in general that allowing for quantity adjustment in the labor market leads to a decrease in the price effects

²¹Using the terminology introduced above, neither the impact effect nor the relative price effect of TP depend on labor market characteristics.

²²Given that unemployed workers receive no income, the case of a constant but positive unemployment rate is equivalent to the full employment case, provided adequate correction is made for the endowment of unskilled workers.

Table 2: Effect of technical progress on relative wage of unskilled in the fair wage model relative to the full employment case

Preferences	Integrated World	Home	Foreign
$\eta \gg \eta^*$	–	–	+
$\eta > \eta^*$	–	+	–
$\eta = \eta^*$	0	→	–
$\eta < \eta^*$	–	↔	–
$\eta \ll \eta^*$	–	–	–

Note: A + (–) means that the effect of TP on relative wages is larger (smaller) in the fair wage model than in the full employment model. A 0 stands for no change. The ↔ stands for a strong sign reversal of the relative wage effect, and → stands for a change from zero to non-zero.

of technical progress.

3.2.2 National Technological Change

In the case of national – rather than global – technological change, we focus on the case where technologies are identical *ex ante*, and both countries are diversified before and after TP in one of the countries occurs. We then have the following.

Proposition 4. *In the elastic case, the effect of TP on relative wages in one of the two countries is (weakly) augmented in comparison to the full employment model, while it is (weakly) dampened in the other country. In the borderline case, the relative wage effect of TP in the home country is non-zero, the sign being that of the impact effect. In the inelastic case, the sign of TP’s effect on relative wages is reversed relative to the full employment model in the country experiencing the technological change, provided the elasticity of substitution is not too low. In each country, unemployment of unskilled labor increases if and only if the skill premium increases.*

A graphical proof of the proposition is given by means of figure 7. The figure shows the case

where TP occurs in America’s labor intensive sector and $\eta = \eta^*$. Given the complexity of the figure, we describe the adjustment process step by step. \check{P} is the relative price that would be compatible with goods market equilibrium post-TP at a constant average skill intensity of world production. At this price, the American relative wage (and hence the American unemployment rate) is constant, while in Europe the relative wage of the unskilled falls and the unemployment rate increases. Hence European unemployment increases relative to American unemployment and β rotates outwards from $\beta(\cdot, a^0)$ to the position $\check{\beta}$, leading to a shift in μ from μ^0 to $\check{\mu}$. \check{P} is not an equilibrium price because the implied skill intensities compatible with goods market equilibrium and the fair wage constraints, respectively, differ, as shown by the horizontal distance between λ^1 and $\check{\mu}$ at this price. There is downward pressure on P , and the induced changes in ω^A and ω^E lead to further adjustments in a , the relative unemployment rates of the two countries (see (13)), and therefore to a further shift in β and μ to their new equilibrium positions $\beta(\cdot, a^1)$ and μ^1 .²³ The equilibrium changes in ω^A , ω^E , U^E , h , and P are denoted by arrows.

Using the same two-step procedure, comparative static results for the other cases can be derived. They are summarized in columns 3 and 4 of table 2, where “Home” stands for the relative price effect in the country experiencing TP, and “Foreign” for the relative price effect in the other country. One can see that the differences to the full employment case are more significant under national TP than under global TP. The reason is the additional foreign employment effect – i.e. the employment effect in the country that does not experience TP – that is by definition absent in the case of global TP.

3.2.3 Comparison to TP in the minimum wage model

The results derived in the previous section are in marked contrast to Davis (1998b) who analyzes global and local technological change in a minimum wage model where “Europe” has a binding minimum wage for unskilled workers while the unskilled wage in “Amer-

²³From (13) it is not clear whether a increases or decreases in this *second* step of the adjustment process, and therefore whether $\beta(\cdot, a^1)$ lies below $\check{\beta}$ (as drawn) or between $\check{\beta}$ and $\beta(\cdot, a^0)$. The same caveat clearly applies to the relative position of $\check{\mu}$ and μ^1 . The overall effect does not depend on which of the cases applies.

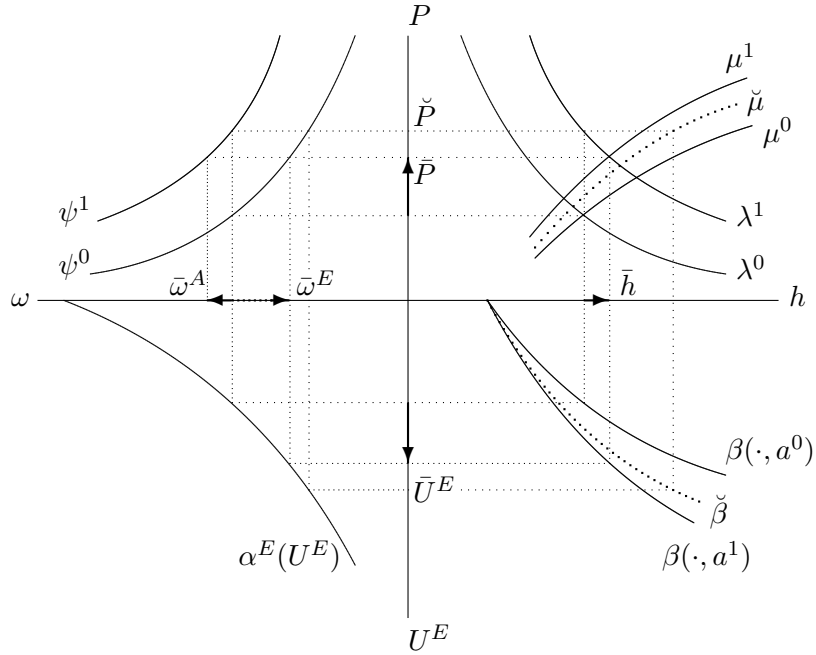


Figure 7: National technological change

ica” is fully flexible. Among the many results in Davis (1998b), one stands out as being fundamentally different from the ones we derived here: Both global or European technological progress in the non-numéraire sector leave relative wages unchanged, while both types of TP lead to an increase in the skill premium when they occur in the numéraire sector. Neither the capital intensity of the sector in which technological change occurs nor the elasticity of substitution in consumption – both of which are crucial in both the full employment analysis in Xu (2001) and in the present paper – play a role for this result. The intuition is straightforward. With TP in the non-numeraire sector the zero profit condition in the numeraire sector is unchanged. Given that w_L is fixed in terms of the numeraire, w_H remains constant as well. The relative goods price adjusts in order to make those factor prices compatible with zero profits in the non-numeraire sector as well. On the other hand, with TP in the numeraire sector there is room for factor price increases at a given goods price. Given that w_L is fixed, w_H increases and hence so does the skill premium.

4 Conclusion

Unemployment is clearly an important part of the policy environment within which trade policy is evaluated. Furthermore, at least since the important work of Davis (1998a) it has been clear that trade between economies with heterogeneous labor markets may produce very different outcomes for the economies. Where Davis made his analysis in the context of very stark institutional assumptions to throw his central point into high relief, we have sought to develop a complementary analysis in terms of a model with a macroeconomically plausible empirical referent (the fair wage model) and a relatively simple form of international heterogeneity (relative strength of preference for fairness).

In this context, we have considered both increased trade with a low-wage south and technological change. While the central point of Davis' analysis (interdependent adjustment to shocks) comes through strongly, some of his results turn out to be specific to his modelling framework. In the fair wage context considered here, neither a global technology shock nor increased trade with the low-wage south – but only technology shocks with a country-specific component – can explain divergent unemployment paths between countries. The relative wage effects are related in a plausible but non-trivial way to those derived by Xu (2001) for the full employment model, making the choice of the numeraire good, that is important in Davis (1998b), irrelevant. Internally to the development of trade theory, we have also seen how the powerful integrated equilibrium approach can be adapted to this class of model.

We have argued that the fair wage model constitutes an empirically plausible and theoretically useful framework for analyzing equilibrium unemployment in trade models. In future work this framework can be extended in a number of directions. A number of standard trade theoretic questions still remain to be studied systematically – e.g. issues of policy competition, dynamics, outsourcing, etc. In addition, as suggested by Solow's remark that the sources of equilibrium unemployment are likely to be many, it also seems useful to consider the interaction of these sources. For example, following recent work in labor economics, the interaction between fair wage constraints and union bargaining seems a particularly fruitful avenue for future research.

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