Unemployment in Models of International Trade

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This version: October 2006

1 Introduction

In recent years, there is a growing interest among trade theorists in the links between international trade and labour market distortions. The contributions to this literature employ microeconomic models of labor market distortions and combine them with a multi-sector model of an open economy. Typically, the labor market models employed in this context are either search theory or efficiency wage models. The chapter by Davidson and Matusz in this volume considers the search theoretic models in quite some detail, which is why the focus of the present paper is on the efficiency wage literature.

Much of the literature has been using a modified Heckscher-Ohlin (HO) framework with two sectors and two factors of production that are inter-sectorally mobile. Most of this chapter will focus on this framework as well. Rather then survey papers in the field in large detail, I suggest a common framework – a "prototype model" – that illustrates the channels through which international trade affects aggregate unemployment (and the labour market more generally) as well as welfare in these Heckscher-Ohlin models that allow for labour market distortions due to efficiency wages.

Compared to the standard HO model with perfectly competitive labour markets, (at least) three additional adjustment margins exist in the efficiency wage models surveyed here. First, the number of employed workers is potentially variable. Second, the effort that

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these workers exert is potentially variable. Third, there can be a wage differential between sectors, making the number of high wage (or low wage) workers potentially variable. If an economy opens up to international trade, there are typically adjustments along all three margins. However none of the models in the literature allows adjustment along all margins – the obvious reason being tractability issues. Rather, the existing models focus on at most two of those margins, which makes them difficult to compare.

The key contribution of this chapter is – hopefully – to increase the transparency by showing that in principle the three potential adjustment margins in the labour market can be consolidated into one. The principal idea is simple, and its essence is already contained in Albert and Meckl (2001). Basically, it consists of measuring units of labour in a way that these units are paid the same wage in all sectors. I suggest calling these "normalised efficiency units" (NEUs) of labour. In this framework, moving a worker from the low wage sector to the high wage sector increases the economy-wide employment of labour in NEUs, ceteris paribus, while the standard way to think about this comparative static exercise would be that it improves the efficiency of the economy for a given level of aggregate employment. Changes in aggregate unemployment and aggregate effort influence the employment of labour in NEUs in the obvious way: higher unemployment reduces it, while higher effort increases it.

The prototype model presented in the main part of the paper abstracts from variable effort and focuses on the remaining two adjustment margins (while making clear how the third could be included). These margins have been highlighted in an early contribution to the literature on efficiency wages in open economies by Matusz (1994). In Matusz' terminology, the change in the rate of unemployment caused by a reallocation of labour between sectors is the *level effect*. In addition, for a given level of employment the reallocation of labour between high wage and low wage sectors has an impact on output via the *composition effect*. The prototype fair wage model presented in this chapter allows a very simple micro-foundation (different from that in Matusz (1994)) for a labour market with involuntary unemployment and intersectoral wage differentials. The framework makes it straightforward to discuss the two effects identified by Matusz (1994). Due to its simplicity

it lends itself to a graphical representation that allows the analysis of a rich set of comparative statics, not all of which can be explored here. This representation is furthermore used to compare the model to two important reference frameworks in the literature, namely the Heckscher-Ohlin model with fully flexible wages and the Heckscher-Ohlin model with a binding minimum wage.

2 Trade and Unemployment in a Heckscher-Ohlin World

2.1 The Minimum Wage Model

The traditional approach to introduce unemployment into a Heckscher-Ohlin trade model is to specify a binding wage floor for one of the factors, which can be fixed in units of either of the goods, or in terms of a price index (Brecher 1974). This basic model is used to introduce the notation and the graphical tools employed throughout the chapter.

Consider a Heckscher-Ohlin economy with the two factors capital K and labour L, receiving returns r and w, respectively, and two sectors, 1 and 2. Good 1 is relatively capital intensive, and there are no factor intensity reversals, i.e. the capital intensity in production of good 1 exceeds the capital intensity in production of good 2 at all common factor prices (formally: $k_1(w,r) > k_2(w,r)$). Good 2 serves as the numeraire, and p denotes the relative price of good 1. Consumers' preferences are homothetic. The return to capital is fully flexible, ensuring that capital is fully employed throughout. The return to labour is fixed in terms of the numeraire above the market clearing level. The determination of equilibrium is illustrated in figure 1. It is taken, with slight modifications, from Davis (1998), and shows in a transparent way the effect of the minimum wage in the HO framework.

The GM locus in quadrant I gives combinations of p and the aggregate capital intensity k (defined as the capital stock K divided by aggregate employment L) that are compatible with goods market equilibrium. The GM locus is downward sloping because a higher aggregate capital intensity increases the relative output of the capital intensive good, and with homothetic preferences a lower relative price is needed to clear the goods market.

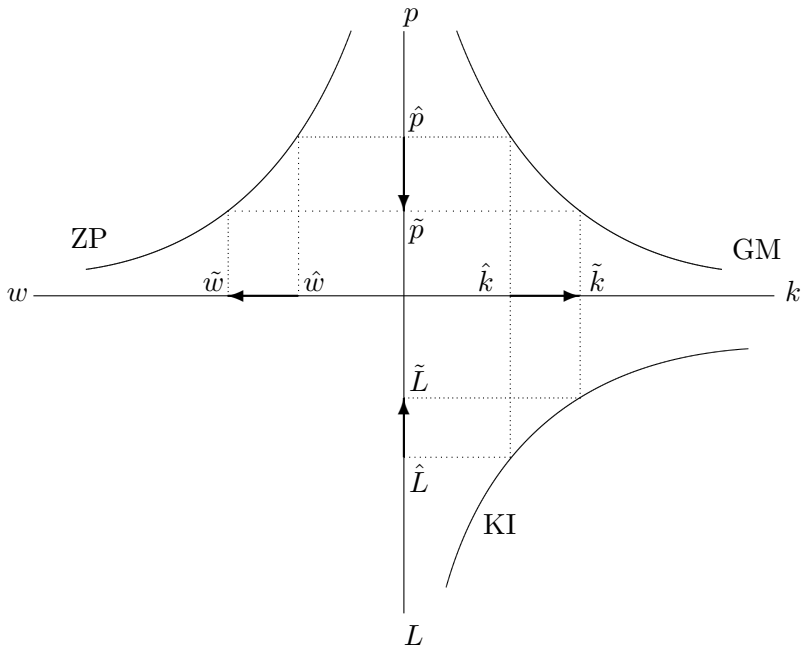

Figure 1: The Equilibrium With and Without Minimum Wages

This is true independent of whether the economy is closed or whether it is a large open economy. The GM locus would be horizontal at the given world market price in the case of a *small* open economy. The ZP locus in quadrant II gives combinations of p and w that are compatible with zero profits under diversified production. The ZP locus is downward sloping due to the Stolper-Samuelson mechanism: A higher price of the capital intensive good leads to a lower return to labour. The KI locus is simply a graphical representation of the definitory relation $k \equiv K/L$ (for a given level of K).

All three loci are identical to what they would be in a standard Heckscher-Ohlin model with flexible factor prices. It is therefore possible to compare equilibria for both cases by using figure 1. In the standard case with fully flexible wages, the determination of equilibrium in figure 1 is counter-clockwise, starting from quadrant IV: The employment of labour $\hat{L}$ is equal to the exogenous endowment $\bar{L}$, which in turn – given the capital stock – determines aggregate capital intensity $\hat{k}$. The implied market clearing goods price is $\hat{p}$, and the resulting wage $\hat{w}$. In the minimum wage case, the determination of equilibrium is

clockwise, starting from quadrant II: The wage is fixed at $\tilde{w} > \hat{w}$, which is compatible with zero profits in both sectors only at a lower relative price of the capital intensive good $\tilde{p}$. Given this price, the goods market clears only if the relative supply of the capital intensive good increases (as consumers want to buy more of it), necessitating a higher aggregate capital intensity $\tilde{k}$. As capital is fully employed throughout, this can only be achieved if aggregate employment falls to $\tilde{L}$. The resulting unemployment rate is $U = (\bar{L} - \tilde{L})/\bar{L}$. The changes in the variables' equilibrium values relative to the flexible wage case are visualised by arrows in figure 1.

There are several noteworthy features of HO-Minimum-Wage framework. First, the minimum wage fixes the relative goods price in the economy, assuming – as in Davis (1998) – that the economy produces both goods.[1] In the case of a large open economy, which is (as shown above) covered by figure 1 as well, the minimum wage therefore determines the relative world market price. Second, the equilibrium determines only the *number* of employed workers, with no particular role attached to the *rate* of employment (or unemployment). To be sure, the rate of unemployment can easily be inferred once the labour endowment of the economy is known. The latter, however, is essentially a non-binding constraint, and varying the labour endowment changes the number of unemployed one-for-one.

There are two ways to look at those features. On the one hand, they make the model readily tractable if the focus of the analysis is either a closed economy or a large open economy where the rest of the world (ROW) has fully flexible labour markets. This has been used to great effect by Davis (1998).[2] On the other hand, they are not fully satisfactory because they result from the arguably arbitrary combination of the minimum wage assumption with the Heckscher-Ohlin production structure.[3] And the fact that

[1] If the economy specialises in the production of one good, the ZP locus as drawn in figure 1 is no longer relevant. Oslington (2002) analyses the case where an open economy that imposes a minimum wage is forced to shut down its labour intensive sector.

[2] See the discussion in section 4 below.

[3] Adding a third factor to the model, for example, would eliminate the first of the two features. See Oslington (2005) for a discussion.

goods prices under diversified production are fully determined by the minimum wage makes the framework unattractive in two important economic environments: (i) the small open economy and (ii) the large open economy where home *and* the rest of the world have minimum wages. In both cases, the world market price is determined in ROW (by ROW supply and demand in case (i), and by the ROW minimum wage in case (ii)). If the relative goods price implied by the domestic minimum wage is different from the ROW price, a trade equilibrium with diversified production in both countries is not feasible.[4] In figure 1, both cases would be represented by a horizontal GM locus in quadrant I (with its position determined solely by the ROW goods price), allowing a straightforward confirmation of the verbal argument made above.

2.2 An Informal Efficiency Wage Model

Combining an efficiency wage model of the labour market with the HO production structure eliminates both features of the minimum wage model mentioned above. While a detailed and more formal exploration is deferred to the next section, the main argument can be made informally with the help of figure 2, a variant of which has been introduced in Kreickemeier and Nelson (2006). The key difference to figure 1 lies in the addition of the upward sloping EW (efficiency wage) curve in quadrant III. Versions of this curve exist in most efficiency wage models.[5] In each case they derive from a setup in which workers can influence the effort that they supply in the workplace, and the better the workers' outside option, the higher is the wage that firms have to pay in order to make workers supply the effort level desired by the firms. *Ceteris paribus*, lower unemployment – and hence, for a given labour endowment, a higher level of employment – improves workers' outside options, and hence firms choose to pay a higher wage. This results in an upward-sloping

[4] There is a noticeable resemblance of the HO minimum wage model with diversified production to the Ricardian model (one fully employed flexprice factor and two sectors, implying a linear transformation curve).

[5] This is true for one-sector efficiency wage models as well as multi-sector efficiency wage models without intersectoral wage differentials. The modifications needed to apply the concept in a model with intersectoral wage differentials are introduced in the next section.

EW curve in wage-employment space, with the labour *endowment* a shift parameter of this curve.

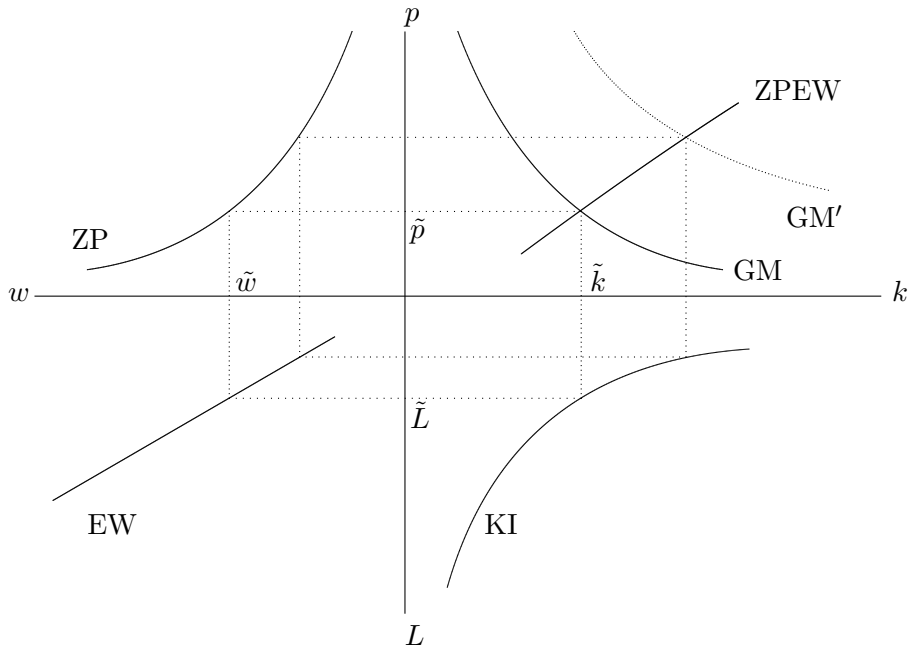

Figure 2: The Equilibrium with Efficiency Wages

The EW curve can now used to derive a second relation between the capital intensity and the relative goods price in quadrant I. The upward sloping ZPEW curve gives combinations of k and p that are compatible with both the zero profit condition (quadrant II) and the efficiency wage curve (quadrant III). The equilibrium relative goods price and equilibrium capital intensity are determined by the intersection between ZPEW and GM (ignore GM$'$ for the moment). Equilibrium values of the model variables are again denoted by a tilde. In contrast to the minimum wage model the wage (and hence the relative goods price) is now endogenous. A change in the labour endowment would shift the EW curve, and hence can be seen to have an effect on equilibrium values of all variables – another important difference to the minimum wage model.

2.3 Comparing Autarky and Trade

Figures 1 and 2 can now be used to show how the transition from autarky to trade affects an economy ("Home") under the different labour market regimes. In all cases, the effect depends on whether the rest of the world is a net supplier of the capital intensive good or of the labour intensive good at the Home autarky goods prices. For concreteness, the latter is assumed, which is compatible with the interpretation that Home is an industrialised country, starting to trade with a less developed rest of the world. In figures 1 and 2, opening up to trade under this assumption shifts the GM locus outwards, leaving all other curves unaffected. In figure 2 the new GM locus is denoted by GM$'$. For simplicity, GM$'$ has been omitted from figure 1.

Both the vertical distance between GM and GM$'$ (measured at $k = \tilde{k}$) and the horizontal distance (measured at $p = \tilde{p}$) have a straightforward economic interpretation. The vertical distance measures the amount by which p, the relative price of the capital intensive good in Home, would have to go up with no change in the aggregate capital intensity, i.e. for a given level of employment. This price change has two effects: it shifts domestic demand towards the labour intensive good and domestic supply towards the capital intensive good, thereby eliminating the excess supply of the labour intensive good. The horizontal distance between the two curves at $\tilde{p}$ measures the amount by which the capital intensity of production in Home would have to increase in order to accommodate trade with the rest of the world at constant relative goods prices. The increase in the aggregate capital intensity (brought about by an increase in aggregate unemployment) is an alternative way of eliminating the excess supply of the labour intensive good because the decrease in aggregate employment has to be accompanied – via the standard Rybczynski effect – by a shrinking of the labour intensive sector and an expansion of the capital intensive sector.

In the minimum wage model, the relative goods price in Home is fixed at $\tilde{p}$, and opening to trade leads to a decrease in employment via the Rybczynski mechanism just described. In the efficiency wage economy, international trade leads to a decrease in both the wage rate and the level of employment, as can be seen in figure 2, where adjustment to the new equilibrium occurs along the ZPEW locus. One can see that *ceteris paribus*

the employment decrease is smaller in the efficiency wage model than in the minimum wage model, where the employment margin bears the full burden of adjustment. On the other hand, the wage decrease in the efficiency wage model is smaller than in an otherwise identical economy with fully flexible wages. This follows from the comparison of the wage decrease resulting for a constant capital intensity with the one resulting for an adjustment of the capital intensity along the ZPEW locus.[6]

The transition from autarky to trade in the case considered constitutes a negative shock to unskilled labour. Depending on the standard of reference there are two possible interpretations for the wage and employment effects of this transition:

(i) For a given level of employment, the negative demand shock to unskilled labour decreases the relative unskilled wage that is compatible with zero profits. Unemployment has to increase in order to make workers accept the lower wage. The relative supply of the unskilled good decreases, and the negative shock is absorbed by a combination of lower wages and higher unemployment.

(ii) For a given relative wage, the negative demand shock increases unemployment, which gives firms the possibility to lower wages for unskilled without jeopardising full effort. They will do so, and the negative demand shock is absorbed by a combination of lower wages and higher unemployment.

Using the framework laid out in this section it is now straightforward to analyse the welfare effects of the transition from autarky to free trade. It is well known and does not need to be discussed here that in the standard trade model there are gains from trade (with constant economy-wide employment ensured by flexible factor prices) that can be decomposed into gains from exchange and gains from specialisation.

In the minimum wage model, if the economy continues to produce both goods and the minimum wage continues to be binding after trade liberalisation, both traditional effects that ensure gains from trade with flexible factor prices are absent because the relative

[6]Krugman (1995) compares the effect of globalisation on a flexible wage country ("America") and a country with a binding minimum wage ("Europe"), using the Heckscher-Ohlin framework presented here.

goods price remains unchanged (Brecher 1974). The welfare effect of the transition from autarky to free trade is therefore driven exclusively by the induced change in economy-wide employment. Hence, in the case considered here where the rest of the world is a net supplier of the labour intensive good, welfare falls along with the level of employment. In the efficiency wage economy, it is clear from the previous analysis that the relative goods price adjusts qualitatively as in the standard model, and hence the traditional effects that increase welfare, ceteris paribus, are effective. The employment effect is added to these standard effects, and hence in case of a decrease in economy-wide employment the welfare effect of globalisation is determined by the relative size of the traditional and labour market effects. Put differently, a *negative* employment effect in the efficiency wage model is a necessary but not sufficient condition for *losses* from trade.[7]

3 A Prototype Heckscher-Ohlin Fair Wage Model

Having shown the basic mechanism of adjustment to globalisation in the Heckscher-Ohlin model under different labour market regimes, I now introduce a properly specified prototype model that allows the simultaneous consideration of unemployment and intersectoral wage differentials.

3.1 The Model: Basics

Consider a Heckscher-Ohlin economy that is identical to the one in the previous section but for the assumption that workers can choose their effort ε at work. I use the idea of Akerlof and Yellen (1990), that workers have an idea of what constitutes a "fair" wage w^*, and that their effort depends on the wage they are paid relative to the fair wage, which forms their standard of reference.[8] Importantly, w^* is determined in general equilibrium and

[7]For a graphical analysis in the context of specific efficiency wage frameworks, see Agell and Lundborg (1995) and Kreickemeier and Nelson (2006).

[8]There is considerable microeconomic evidence across virtually all sectors as well as experimental evidence for the fair wage model. Recent reviews of the evidence can be found in Howitt (2002) and Bewley (2005).

treated parametrically by all firms. In the present two-sector model, the effort supplied by a worker in sector j is assumed to be an increasing function of the wage in this sector, w_j, relative to w^*:

$$\varepsilon_j = f\left(\frac{w_j}{w^*}\right), \tag{1}$$

with $f' > 0$. Following Albert and Meckl (2001), I allow for the productivity of effort to be sector specific. The efficiency e_j of a labour unit employed in sector j is formally given by

$$e_j = g_j\left(\frac{w_j}{w^*}\right) = G_j\left[f\left(\frac{w_j}{w^*}\right)\right] \tag{2}$$

where $g_j' > 0$, $g_j'' < 0$, and $g_j(a) = 0$ for some $a > 0$. As in the standard efficiency wage model by Solow (1979), the firms' hiring decision can be thought of as a two-stage process: In step one, firms in each sector set wages as to minimise the cost of labour in efficiency units, w_j/e_j. In step two they hire workers up to the point where the value marginal product of labour is equal to the wage set in step one.

The properties assumed for the efficiency function g_j ensure that there is a unique minimum for w_j/e_j. This is illustrated in figure 3, taking into account that w^* is treated parametrically by the firms. The cost minimising differential w_j/w^* is denoted by q_j, the associated efficiency by $\bar{e}_j$. Note that an inter-sectoral wage differential can only arise if the efficiency functions are different between sectors. While the efficiency functions fix the (potentially sector specific) q_js and $\bar{e}_j$s, wage rates are determined in general equilibrium because the reference wage w^* is. Whenever wages are sector specific, sector 2 is assumed to be the low wage sector, and without loss of generality we normalise $q_2 = 1$. Hence, the constant wage differential between sectors is $q = q_1 \geq 1$.

3.2 Determining the Fair Wage

While the setup of the model so far is virtually identical to Albert and Meckl (2001), it is useful for the present purpose to use a specification for the fair wage that is different from theirs. In particular, let the reference wage be given by

$$w^* = A\bar{w}^k \tag{3}$$

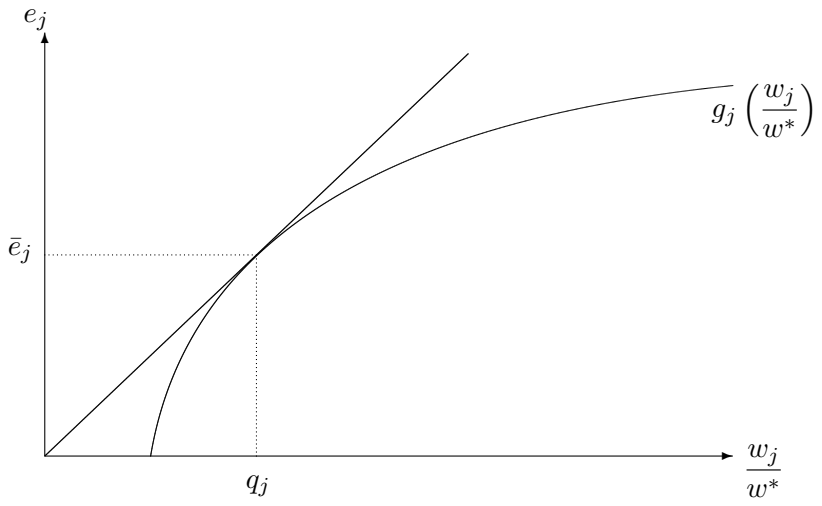

Figure 3: Equilibrium in Sector j

where $A > 0$ and $k < 1$ are two parameters and $\bar{w} = (w_1 L_1 + w_2 L_2)/\bar{L}$ is the average wage for all workers in the economy, including those who are unemployed. Note that $k < 1$ is a key behavioural assumption: It says that the reference wage of workers varies less than proportionally with the average wage in the economy, which can be interpreted as the workers' expected outside option should they be separated from their current job. This assumption should be thought of as a shortcut that in this prototype model captures omitted variables in (3) that vary less than proportionally with $\bar{w}$.[9]

The average wage can obviously be re-written as $\bar{w} = (qw^* L_1 + w^* L_2)/\bar{L} = (w^*/\bar{L})L^e$, where $L^e \equiv qL_1 + L_2$. The new variable L^e is the economy-wide employment of labour, measured in *normalised efficiency units* (NEUs). These are labour units for which the value marginal product is equalised between sectors, and equal to w^*. Measuring labour units in this way simplifies the analysis dramatically, as the two adjustment margins

[9]Most importantly, in the present Heckscher-Ohlin framework, one could think of the return to capital as an omitted variable. Akerlof and Yellen (1990) argue that in determining their reference (fair) wage, workers take into account the wage of other factors of production, with their own wage demands increasing *ceteris paribus* if the remuneration of the other factor increases. In the Heckscher-Ohlin framework w and r move in opposite directions, and the movement of r can therefore be expected to have a dampening effect on w. We will come back to this below.

present in the labour market are collapsed into one, namely the economy-wide employment of NEUs of labour. Using the definition of L^e, eq. (3) can be rewritten as

$$L^e = (w^*)^{\frac{1-k}{k}} C \tag{4}$$

where $C \equiv A^{-1/k}\bar{L}$ is a positive parameter. Under the assumption $k < 1$ made above, $\partial L^e/\partial w^*$ is strictly positive: Whenever the reference wage in the economy increases, so does the economy-wide employment of labour, measured in NEUs. The reason is simple: firms adjust wages by less than would be compatible with constant employment, and hence employment adjusts in the same direction as the sectoral wage rates (w^* and qw^*, respectively).

Albert and Meckl (2001) consider the case $w^* = \bar{w}$, i.e. they set $A = k = 1$ in eq. (3). Consequently, L^e is constant, which models of the case where the level effect and the composition effect on aggregate output identified by Matusz (1994) exactly offset each other.[10] As stressed by Albert and Meckl, their model as a consequence behaves exactly as a flexible wage Heckscher-Ohlin model, with NEUs of labour replacing physical units of labour.

3.3 The Closed Economy Equilibrium

The closed economy equilibrium can now be represented by figure 4, which closely resembles figure 2 above. For concreteness, it is assumed that good 1 (with relative price p) is capital intensive if labour is measured in NEUs: At all common factor prices w^* and r we have $k_1^e > k_2^e$. Under this assumption, the GM locus in quadrant I gives combinations of p and k^e that are compatible with goods market equilibrium. The ZP locus quadrant II gives combinations of p and w^* that are compatible with zero profits under diversified production. Both loci are directly analogous to the respective loci in a standard Heckscher-Ohlin model, where the two factors are capital and NEUs of labour, with the returns r and w^*.

The FW (fair wage) locus in quadrant III is the graphical representation of eq. (4).[11]

[10] Albert and Meckl (2001) use the label "labour absorption" for what I call "normalised efficiency units of labour".

[11] The FW locus is linear, as drawn in figure 4, if $k = .5$.

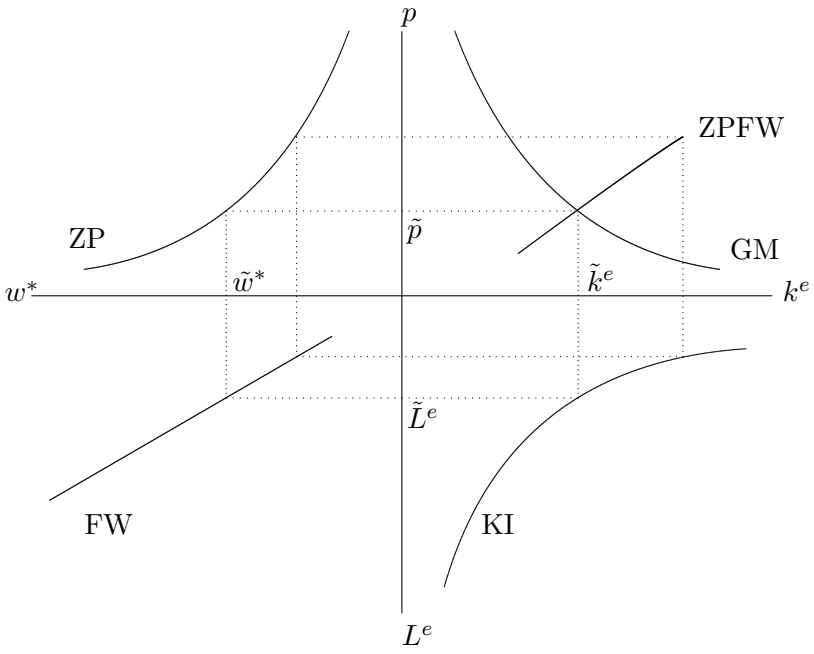

Figure 4: The One-Country Equilibrium

In analogy to section 2, the KI locus in quadrant IV is the graphical representation of the definitory relation $k^e \equiv K/L^e$ between the economy-wide capital intensity, the exogenous capital stock, and the economy-wide employment of labour, measured in NEUs. The ZPFW locus in quadrant I is implied by the ZP, FW and KI loci, and it gives combinations between the relative goods price and the capital intensity that are compatible with both the fair wage constraint and the zero profit condition. There is a unique equilibrium for the closed economy, and the equilibrium values of p, w^*, L^e, and k^e are denoted by a tilde.

3.4 Comparing Autarky and Trade

The effect of a globalisation shock on the closed economy can now be deduced with the help of figure 4. In analogy to section 2 the effect depends on whether at the Home autarky goods prices the rest of the world is a net supplier of the capital intensive good or of the labour intensive good, where the factor intensity this time is measured using NEUs of

labour.[12] For concreteness, and in analogy to the previous discussion, the case where the rest of the world is a net supplier of the labour intensive good is considered. In figure 4 opening up to trade under this assumption shifts the GM locus upwards, leaving all other curves unaffected. Employment of NEUs of labour falls along with the reference wage, and hence the wage in both sectors. The economic intuition for this adjustment is exactly as explained for the efficiency wage model in section 2.3, and there is no need to repeat it here.

3.5 What about the Unemployment Effect?

It has been shown that in a model with involuntary unemployment and an intersectoral wage differential important comparative static properties of the model can be derived by looking at NEUs rather than physical units of labour. The employment (or rather unemployment) of actual workers in many cases is of independent interest, however. From the definition of L^e it is immediate that aggregate employment $L \equiv L_1 + L_2$ can be written as

$$L = L^e - (q-1)L_1. \tag{5}$$

This shows that in principle it is possible for L to decrease (and therefore the unemployment rate U to increase) despite an increase in L^e if the high-wage sector 1 expands. It follows immediately that in the model of Albert and Meckl (2001), where L^e is constant, unemployment increases if and only if globalisation leads to an expansion of the high-wage sector. On the other hand, in a model without an intersectoral wage differential (and therefore $q = 1$) we have $L = L^e$, and the composition effect on aggregate output identified by Matusz (1994) disappears.

[12] In principle, with a wage differential between sectors it is possible for the factor intensity ranking in terms of physical labour units and NEUs of labour to diverge. Specifically, if the capital intensive sector, measured in terms of physical labour, is also the high wage sector, it may be labour intensive in terms of NEUs if the wage differential is sufficiently large. See Jones (1971) for a discussion of this issue in the case of a full employment model with an exogenous intersectoral wage differential. In that framework, Jones distinguishes capital intensity in the physical sense and in the value sense.

3.6 Variants of the Prototype Model

The model of Matusz (1994) gives a microfoundation of the wage differential between sectors that is different from the one in the prototype model presented here. Instead of the fair wage model by Akerlof and Yellen, Matusz uses the Shapiro-Stiglitz (1984) efficiency-wage model in which workers have to be supervised in order to prevent them from shirking. Matusz (1994) assumes the rate at which shirking is detected to be sector specific, and in equilibrium the sector with the higher detection rate can afford to – and does – pay a lower wage because the threat of being fired is more severe for workers, who as a consequence moderate their wage demands. This difference to the prototype model is not important for the results derived, which are driven by the relative size of the level effect and the composition effect on the value of output.[13]

The first application of the fair wage approach in an open economy model is due to Agell and Lundborg (1995). Their approach features two major differences from the prototype model presented here. First, there is no intersectoral wage differential for labour. Second, the effort provided by workers is not constant in equilibrium. The second difference is triggered by the fact that Agell and Lundborg model the unemployment rate U and the relative returns to labour and capital r/w as separate arguments in the effort function.[14] Despite these differences the Agell-Lundborg model could in principle be analysed using figure 4. L^e is now the employment of labour in efficiency units (the need to normalise these efficiency units no longer arises, as there is no wage differential between sectors), and w^* the wage of an efficiency unit of labour. As in the prototype model, there are two sources for the change in L^e: the change in the employment of physical units of labour,

[13] In contrast to the prototype model of section 2, the intersectoral wage differential is not constant in the Matusz model. Eliminating this additional adjustment margin is what allows the simple graphical representation in figure 4.

[14] In the prototype model, the relative wage is omitted as an explicit argument, but taken into account by the assumption that the reference wage adjusts by less than the expected average wage $(1-U)\bar{w}$. Given the efficiency function shown in figure 3, the effort that minimizes w_j/e_j is then constant in each sector. In Agell and Lundborg (1995), the efficiency function of figure 3 is replaced by a three-dimensional effort surface in $w/r - U - e$ space, and the effort no longer needs to be constant.

and the change in the effort the workers supply. This latter *aggregate effort effect* replaces the composition effect that was triggered by the intersectoral wage differential in both the Matusz model and the prototype model.

All models discussed so far assume that the efficiency wage mechanism operates for only one of the factors, while the market for the other factor is perfectly competitive. This is appropriate if the two factors of production are thought of as being labour and capital, and the efficiency wage mechanism works only for labour. The assumption is less easy to justify if one thinks of the two factors as skilled and unskilled labour, respectively. Kreickemeier and Nelson (2006) follow the original modelling of Akerlof and Yellen (1990) in considering the two factors unskilled labour L and skilled labour K, whose returns are denoted with w and r, respectively. The fair wage mechanism operates for both factors symmetrically, and the respective fair wages are given by:

$$w^* = \theta r + (1-\theta)\bar{w} \tag{6}$$

$$r^* = \theta w + (1-\theta)\bar{r} \tag{7}$$

where in analogy to the notation used earlier $\bar{w} = (1-U_L)w$, $\bar{r} = (1-U_K)r$, and U_i is the rate of unemployment for factor i. Hence, for both factors the fair wage is a weighted average of the wage the other factor is paid and the own-factor average wage. In contrast to the prototype model, it is assumed that there is a well-defined level of full effort (normalised to 1) which workers provide if they are paid the fair wage. Reducing the wage below the fair wage results in a proportional reduction of effort, paying more than the fair wage leaves effort constant. The effort function for unskilled labour is depicted in figure 5 and there is an identical function for skilled labour.

With the additional assumptions that firms pay the fair wage if this does not reduce their profit and that in a (hypothetical) full employment equilibrium the wage for skilled workers would exceed the wage for unskilled workers, skilled labour is fully employed in equilibrium while there is unemployment of unskilled labour, both types of labour provide full effort, skilled labour receives a wage in excess of its fair wage, and unskilled labour is paid its fair wage.[15] The resulting framework is simpler than the prototype model because

[15]Hence, while in principle the fair wage mechanism is operating for both types of labour, it is effective

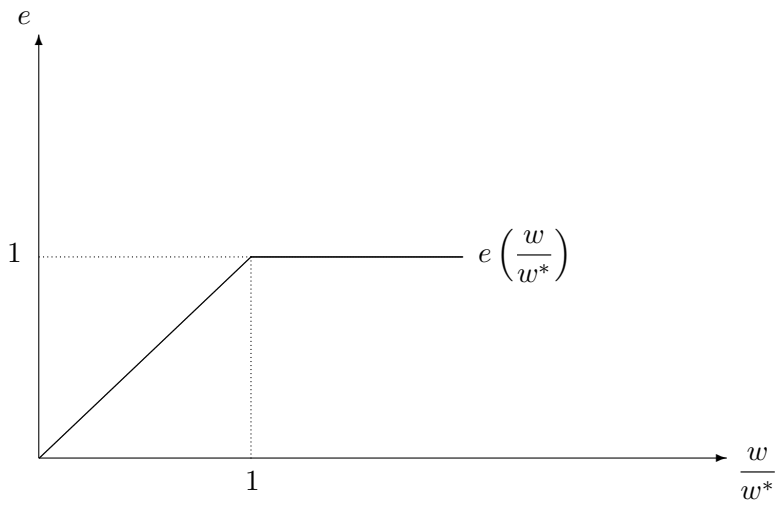

Figure 5:

there is neither an intersectoral wage differential nor variable effort, and hence $L^e = L$. Solving Eq. (6) for L shows the level of employment in the economy as a function of the relative wage $\omega \equiv w/r$:

$$L = \frac{\omega - \theta}{\omega} D \tag{8}$$

where $D \equiv (1-\theta)^{-1}\bar{L}$. It is easily checked that $\partial L/\partial\omega > 0$. Eq. (8) is the analogue to Eq. (4) from the prototype model. Replacing w^* in Figure 4 by ω, the graphical representation of Eq. (8) gives the FW locus of this model.[16] The model then behaves qualitatively like the prototype model. Due to the simplifications stated above, the analogue to figure 4 for the model from Kreickemeier and Nelson (2006) can furthermore be used to determine the employment effect for physical labour (rather than for efficiency units only, normalised or otherwise).

only for unskilled workers. Formally, Eq. (7) is a non-binding constraint while Eq. (6) is binding. See the discussion in Akerlof and Yellen (1990) and Kreickemeier and Nelson (2006).

[16] Invoking standard Heckscher-Ohlin reasoning, it is easily checked that the zero profit locus in quadrant II is downward sloping in $\omega - p$ space, just as it is in $w^* - p$ space.

4 An Asymmetric Three-Country World

The previous sections have featured analysis of a two-country world, consisting of Home and the rest of the world (ROW), and asked the question what effects globalisation, i.e. opening up to trade with ROW, has on Home. The analysis in section 2.3 shows that – and in what way – this depends on the labour market regime in Home. One question that economists have been interested in and that cannot be answered with the help of this two-country framework is the following: Assume Home is made up of two countries that trade freely with each other but have different labour market regimes. What is the effect on each of these countries if they open up to trade with a third country? The present section shows how the minimum wage framework and the prototype fair wage framework, respectively, can be modified to analyse this question. For concreteness, in each case Home is labelled "OECD", and it is assumed to consist of the two countries "Europe" and "America", which differ in their labour market characteristics. Consumer tastes and production technology are assumed identical between the countries, they both produce both goods and trade them freely with each other. Using standard Heckscher-Ohlin logic, this implies that factor prices between Europe and America are equalised. The third country is labelled "China", and it is assumed to be a net exporter of the labour intensive good.

4.1 The Minimum Wage Model

Davis (1998) looks at the case where Europe has a binding minimum wage, while the wage in America is fully flexible.[17] He then considers the effect on European and American labour markets if the OECD opens up to trade with China, assuming that both OECD countries continue to produce both goods. The comparative static effects can be shown with the help of figure 6, which is a modified version of figure 1 adapted to allow the analysis of the three-country case.

The GMZP locus in quadrant I gives combinations of $1/w$ (common to Europe and

[17] Davis considers the two factors to be skilled and unskilled labour. In analogy with the previous sections, we stick with capital and labour.

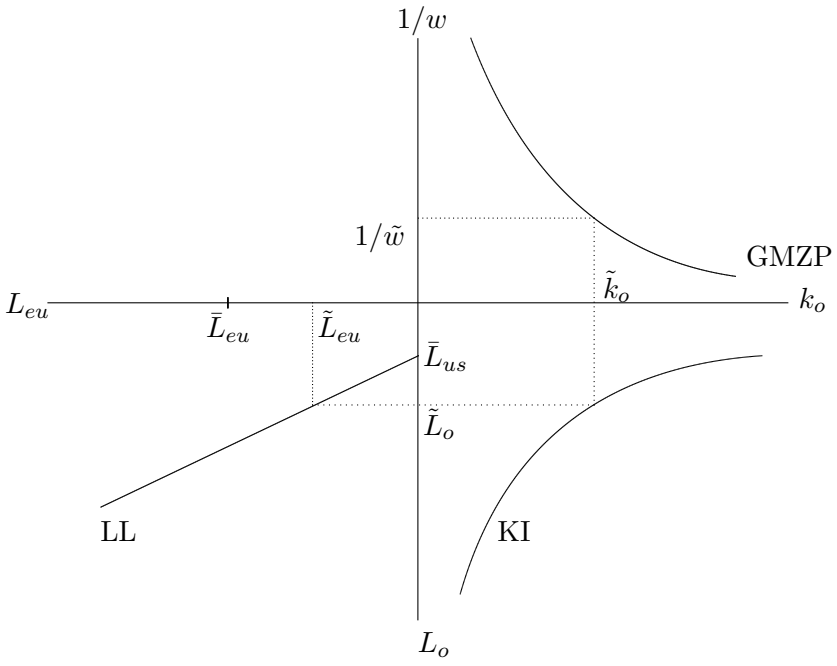

Figure 6: The Two-Country Equilibrium with Minimum Wages

America) and the aggregate capital intensity k_o of the OECD that are compatible with goods market equilibrium and the zero profit conditions in both sectors.[18] It follows immediately from the arguments used in the explanation of figure 1 that the GMZP locus is downward sloping. In analogy to the above, the KI locus is the graphical representation of the definitory relation $k_o \equiv K_o/L_o$, where K_o and L_o are the aggregate capital stock and the aggregate employment of the OECD, respectively. Fixing the minimum wage in Europe at $\tilde{w}$ implies an aggregate capital intensity $\tilde{k}_o$, and an aggregate employment level in the OECD of L_o. LL in quadrant IV shows how OECD employment is distributed across Europe and America. Because labour markets in America are fully flexible, American employment equals the endowment $\bar{L}_{us}$. European employment $\tilde{L}_{eu}$ is then simply the difference between OECD employment and American employment. Formally, LL is simply given by $L_o = \bar{L}_{us} + L_{eu}$.

Opening up to trade with China shifts the GMZP locus to the right and leaves all other

[18] Quadrants I and II of figure 1 have been merged to make room for one new quadrant.

loci in figure 6 unchanged. Given the European minimum wage $\tilde{w}$, the capital intensity in the OECD $\tilde{k}_o$ increases and employment $\tilde{L}_o$ falls. This translates one-for-one in a decrease in European employment $\tilde{L}_{eu}$, while labour in America remains fully employed. This is (one facet of) the "insulation result" emphasised by Davis (1998): The minimum wage in Europe insulates America from the consequences of the globalisation shock.[19] Davis thereby highlights the effect that labour market institutions in third countries (Europe) can have on the effects of economic integration between two countries (America and China).

4.2 The Prototype Fair Wage Model

Kreickemeier and Nelson (2006) revisit the setup used by Davis, but assume a less stark asymmetry between Europe and America. In their model, there is unemployment in both countries due to the fair wage mechanism described earlier, but the fair wage constraints – and therefore the unemployment rates – differ between countries. In this section, I show how the prototype fair wage model from section 3 can be used in a setup of asymmetric fair wage constraints to derive the country specific effects of globalisation.

Figure 7 is a modified version of figure 4, and the analogue in the fair wage model to figure 6 from the minimum wage model. The GMZP and KI loci are identical to those in figure 6, while FW_{eu} is the European fair wage constraint, relating European employment to the European reference wage, in analogy to the FW locus in figure 4. In order to close the model one needs – as in the minimum wage model – a function relating European employment and OECD employment, which in this framework is measured in normalised efficiency units. As shown, this is trivial in the asymmetric minimum wage model because employment in America does not change, and a change in European employment goes hand in hand with a change in OECD employment of the same magnitude. Things are more complicated here because employment is endogenous in both countries: $L_o^e = L_{eu}^e + L_{us}^e$ as before, but L_{us}^e is variable.

The employment levels in both countries are linked, however, by the condition that

[19] Meckl (2006) shows that the insulation result breaks down if workers differ in their ability, and the minimum wage fixes the hourly wage, rather than the wage for an effective unit of labour.

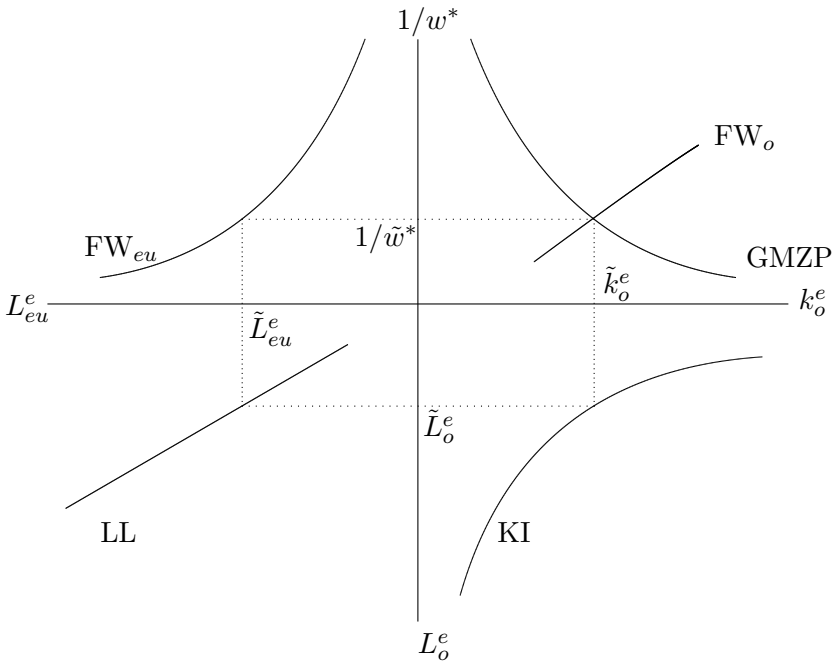

Figure 7: The Two-Country Equilibrium with Fair Wages

factor prices for capital and NEUs of labour are equalised between them. We therefore have fair wage constraints like (4) for both countries, where k and C are country-specific, but w^* is not.[20] Using this information, one can express L^e_{us} as a function of the model parameters as well as the European employment level. OECD employment is then given by

$$L^e_o = L^e_{eu} + (L^e_{eu})^\kappa \, C^{-\kappa}_{eu} C_{us} \tag{9}$$

where $\kappa \equiv [k_{eu}(1-k_{us})]/[k_{us}(1-k_{eu})] > 0$ and $C_i \equiv A^{-1/k_i}\bar{L}_i$. One can immediately see that L^e_o increases with L^e_{eu}. The graphical representation of eq. (9) in figure 7 is the LL locus. Eq. (9) shows that the position of LL is determined by the fair wage parameters and labour endowments of both countries. Together, FW_{eu}, LL and KI imply the upward sloping FW_o locus in quadrant II, and its intersection with GMZP determines wages and employment levels in the OECD countries.

Opening up to trade with China shifts GMZP to the right, and the OECD adjusts to a new equilibrium along FW_o. It is easily checked that this reduces the wage rate in the OECD, and it furthermore reduces employment measured in NEUs of labour in Europe and America. The insulation result of Davis (1998) therefore turns out to be specific to the minimum wage model he considers. At a more general level, however, the basic insight stressed by Davis that labour market institutions in one country so have effects on the results of globalisation in another country if goods markets between those two countries are integrated, survives the transition to an alternative model of the labour market. For the simple fair wage model without intersectoral wage differentials, this is shown in Kreickemeier and Nelson (2006).

5 Unemployment and Intra-Industry Trade

While the majority of contributions to the trade and unemployment literature uses the Heckscher-Ohlin framework, there are some exceptions. In this section I briefly describe

[20] Wages for physical labour units (i.e. workers) can vary across countries if q is country specific.

two models that introduce labour market imperfections into standard models of intra-industry trade and analyse the effect of trade on welfare and unemployment.

Matusz (1996) combines the standard model of intra-industry trade in intermediate products by Ethier (1982) with an efficiency wage model of the labour market. International Trade in this framework increases the number of intermediate products that are available in each market: Producers in both countries specialise in non-overlapping sets of intermediates, and it is profitable for all firms to export part of their output. Final good producers benefit from the increase in the number of intermediates due to the "love of variety" effect standard in this literature. Aggregate output of the final good increases in both countries. For a given level of employment, this would lead to an increase in the wage rate, because all income in the economy is wage income. With a higher wage, the outside option of being unemployed (and thereby getting nothing) becomes relatively less attractive. This situation is not an equilibrium because firms (who have wage setting power) now pay more than is necessary to elicit the profit maximising effort. Rather than increase wages by an amount compatible with constant employment, firms will therefore increase wages by less, triggering additional entry into the intermediates sector and increasing aggregate employment. This improves the outside option of the workers, and in the new equilibrium firms again just pay the wage that is necessary to make workers supply the profit maximising effort. The trading equilibrium therefore features both a higher wage rate and lower unemployment than the autarky equilibrium.

Egger and Kreickemeier (2006) develop an alternative model of intra-industry trade in intermediate products in the presence of efficiency wages that builds on the heterogenous firm model by Melitz (2003). As in the model by Matusz (1996), international trade raises aggregate output, but at least in part for a reason that is absent in the Matusz model: As in all models of the Melitz-type, intermediate good producers are assumed to have different productivities and there are fixed cost to exporting that only the most productive firms find worthwhile bearing. High productivity firms therefore expand and produce a larger share of aggregate output. In addition, the least productive firms are forced to exit the market due to increased import competition. As a consequence, the average labour productivity of

active firms goes up, and so does aggregate output. There are now two opposing effects on aggregate employment: Higher aggregate output c.p. increases employment, while higher average labour productivity c.p. reduces employment. In contrast to the model by Matusz (1996), where the productivity of all firms is identical and therefore the second effect is absent, in the model by Egger and Kreickemeier (2006) unemployment may rise or fall as a consequence of globalisation. In the benchmark specification of their model welfare, average firm profits, average wages and unemployment all increase, thereby pointing to distributional conflicts of globalisation that have not been accounted for in the previous literature.

6 Conclusions

This chapter has focused on the presentation of an easily tractable framework for the analysis of involuntary unemployment in international trade models. The prototype Heckscher-Ohlin Fair Wage model allows a rich set of comparative statics in either the two-country or three-country setting, using the respective four-quadrant diagrams presented here. The same graphical tool also allows the straightforward comparison between models of the fair wage (or more generally efficiency wage) type and the traditional minimum wage model of Brecher (1974) that is still popular among trade theorists modelling unemployment in open economies, as well as with the standard Heckscher-Ohlin model with flexible wages.

The key contribution of this chapter was to show that the comparative static properties of a broad range of Heckscher-Ohlin type trade models with efficiency wage unemployment that are used in the literature can be inferred if one analyses changes in the employment level of a single key variable, normalised efficiency units (NEUs) of labour. I have derived a simple condition under which a negative shock to (unskilled) labour, defined as a shock that would decrease the wage in a standard Heckscher-Ohlin model, decreases employment of NEUs of labour. This happens if and only if as a consequence of a negative shock the reference wage of workers decreases by less than the average wage in the economy (taking into account those who are unemployed). This condition is relevant because the average wage itself as an indicator of the workers' outside options can be expected to play a

role in the determination of the reference wage – in fact, in Albert and Meckl (2001) it is the *only* determinant of the reference wage. A less than proportionate adjustment in the reference wage (the case on which I focus on in this chapter) occurs for example if the remuneration of the second factor (capital or skilled labour) plays a role in the determination of the reference wage, implying that there is an intergroup fairness motive present in the workers' fair wage preferences (Akerlof and Yellen, 1990).

International trade in the Heckscher-Ohlin framework with efficiency wages influences aggregate unemployment because it influences the sectoral structure of production. Wage setting firms that have to consider the incentive effect wages have on worker effort find it not profit maximising to adjust wages to the full extent necessary to keep aggregate employment constant, and part of the adjustment occurs on the employment margin. Losses from trade are possible if employment falls by too much. In models of intra-industry trade there are typically gains from trade, and the value of output increases. With identical firms this translates into an increase in employment, while in the presence of heterogenous firms employment may fall as a consequence of trade because aggregate productivity in the industry increases, and hence – at least ceteris paribus – the labour requirement falls.

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