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Fair Wages and Unemployment in a Small Open Economy

by

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Abstract

In this paper we develop a model of a multi-sector multi-factor small open economy with involuntary unemployment due to fair wages. The model is used *inter alia* to analyse the labour market effects of changes in unemployment benefits and the domestic labour supply. Our analysis covers both the case where factor prices do not react to endowment changes – as in the Heckscher-Ohlin model – and the case where they do. Results are sensitive to this distinction, thereby emphasizing the benefit of employing a general production structure that encompasses both cases.

JEL classification: F11, F16

Keywords: Fair Wages, Unemployment, Small Open Economy

Outline

Non-Technical Summary

The competitive general equilibrium model of a small open economy with many goods and factors has been an important tool of analysis in fields like public sector economics, environmental economics or international trade and migration. While popular among economists, this model – by assuming fully flexible factor prices – is ill-equipped to analyse questions that involve involuntary unemployment. However, in each of the fields mentioned there are important economic policy questions for which employment effects are important: The general public is typically interested in the employment effects of trade liberalisation or immigration, environmental (or "green") tax reforms are scrutinised as to whether they could yield employment gains, and more generally the likely employment effects are important in the political arena whenever the design of tax systems is discussed. In order for a model to be informative in those circumstances, a mechanism generating involuntary unemployment needs to be part of it.

In this paper we develop a model of a multi-sector multi-factor small open economy with involuntary unemployment due to fair wages. The model is used among other things to analyse the labour market effects of changes in unemployment benefits and the domestic labour supply. Results depend crucially on whether or not the economy is characterised by factor price insensitivity (FPI), i.e. whether endowment changes lead to factor price changes. This in turn depends on whether the number of factors is larger than or equal to the number of goods, thereby highlighting the benefit of employing a production structure that encompasses both cases.

We explore the issue of FPI further by comparing the multi-sector fair wage model to the multi-sector minimum wage model and the competitive labour market model, respectively. In a comparative study of the latter two frameworks, Neary (1985) has shown that in the minimum wage economy the factor price effect of endowment changes of fully employed factors is smaller than in the flexible wage economy. As pointed out by Neary, this can be interpreted as a move towards FPI: As more and more factor prices in an economy are fixed, the response of the remaining flexible ones to endowment changes becomes smaller and smaller. We show a complementary, previously unexplored aspect of this "move towards FPI": Our model, which exhibits partial factor price rigidity, brings the economy closer to FPI, but not as close as the analogous minimum wage model.

1 Introduction

The competitive general equilibrium model of a small open economy with many goods and factors has been an important tool of analysis in fields like public sector economics, environmental economics or international trade and migration.[1] While popular among economists, this model – by assuming fully flexible factor prices – is ill-equipped to analyse questions that involve involuntary unemployment. However, in each of the fields mentioned there are important economic policy questions for which employment effects are important: The general public is typically interested in the employment effects of trade liberalisation or immigration, environmental (or "green") tax reforms are scrutinised as to whether they could yield employment gains, and more generally the likely employment effects are important in the political arena whenever the design of tax systems is discussed. In order for a model to be informative in those circumstances, a mechanism generating involuntary unemployment needs to be part of it.

In one of the few papers in this literature that allows for involuntary unemployment, Kreickemeier (2005) looks at the welfare effects of trade liberalisation in the presence of a binding minimum wage. The biggest advantage of the minimum wage model in a framework with many goods and factors lies in the simplicity with which unemployment can be introduced into an otherwise quite complicated analytical framework. On the other hand, the assumption of an exogenous wage rate above the market clearing level precludes the analysis of at least two issues that are of potential interest in the context of policies in the above mentioned fields. First, real-world changes in the tax and transfer system would in many cases involve changing the level of unemployment benefits – in particular if labour market effects of the reform are an issue. However, in the standard minimum wage model the level of unemployment benefits leaves the market wage unchanged and hence has no direct impact on the level of unemployment – provided, of course, that the benefits are lower than the minimum wage. Second, a change in the labour supply of a country, which is of interest for example in the analysis of international migration, has no direct

[1] Examples include Abe (1992), Copeland (1994), Keen and Ligthart (2002), Michael (2003), and Turunen-Red and Woodland (2004).

effect in the presence of minimum wage unemployment. This is because the equilibrium only determines the *number* of employed people rather than the *rate* of employment (or unemployment), making the labour supply of the economy a non-binding constraint.[2]

In this paper, we take a simple model of equilibrium unemployment and apply it in the otherwise standard framework of the competitive small open economy with many sectors and factors. Despite its simplicity, the model is rich enough to allow a meaningful discussion of the issues just mentioned. There are a number of different labour market models that would meet this last criterion, among them the insider-outsider/union models, implicit contracts, search, and efficiency wage models.[3] 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, where the focus is on a general production structure with many goods and factors, tractability of the labour market model is an important issue. We therefore opt for a variant of the fair wage model, which has its origin in the papers by Akerlof (1982) and Akerlof and Yellen (1990).[4] As in all efficiency wage models, firms are induced to pay wages above the market clearing wage, resulting in equilibrium unemployment. In the fair wage model, they do so because they expect work morale, and hence effort, to suffer if employees consider their pay too low relative to some standard of reference, the so-called fair wage.

There is considerable microeconomic evidence as well as experimental evidence in favor of the fair wage model. Much of the evidence stems from surveys where business managers were asked about their firms' compensation policy. For example, Agell and Lundborg (1995b, 2003) for Sweden and Bewley (1999) for the U.S. report that there existed underbidding of going wage rates on behalf of job applicants, but in most cases managers refused to accept these offers in order to keep work morale high. Fehr and Falk

[2]Both a change in unemployment benefits or domestic labour supply can have an *indirect* effect on unemployment in the presence of a redistributive welfare state that relies on distortionary taxation.

[3]Davidson (1990) provides a clear discussion of these alternatives.

[4]Agell and Lundborg (1995a) introduce a variant of the fair wage model into a two-sector Heckscher-Ohlin model of a small open economy. Kreickemeier and Nelson (2006) use the Akerlof and Yellen (1990) model in a two country Heckscher-Ohlin model where countries differ in their fairness preferences.

(1999) examined the same question in the labouratory, with similar results.[5]

We aim at deriving general results that show the basic properties of the model and thereby its potential for applications in the analysis of more specific policy changes. In doing so, the main emphasis is on the comparative static effects of changes in unemployment benefits and labour endowment, respectively. This is done to throw into high relief the practical contribution our framework makes in comparison to the minimum wage model, which does not allow a meaningful analysis of these effects. It turns out that our results crucially depend on whether the economy exhibits factor price insensitivity (FPI) or not, i.e. whether or not factor prices of fully employed factors are responsive to changes in their endowments (Leamer, 1995). This underscores the importance of allowing for a general production structure that encompasses cases with and without FPI.

We explore the issue of FPI further by comparing the multi-sector fair wage model to the multi-sector minimum wage model and the competitive labour market model, respectively. In a comparative study of the latter two frameworks, Neary (1985) has shown that in the minimum wage economy the factor price effect of endowment changes of fully employed factors is smaller than in the flexible wage economy. As pointed out by Neary, this can be interpreted as a move towards FPI: As more and more factor prices in an economy are fixed, the response of the remaining flexible ones to endowment changes becomes smaller and smaller. The case of FPI – where endowment changes have no factor price effects at all – is thus seen as a borderline case where the number of flexible price factors in an economy relative to the number of traded goods becomes sufficiently small. We show a complementary, previously unexplored aspect of this “move towards FPI”: Our model, which exhibits partial factor price rigidity, brings the economy closer to FPI, but not as close as the analogous minimum wage model.

Our analysis proceeds by introducing the general model in section 2 and deriving its comparative static properties in section 3. Section 4 discusses the relationship between FPI and factor price rigidities. Section 5 concludes.

[5] Recent reviews of the evidence can be found in Howitt (2002) and Bewley (2005).

2 The Model

Consider a small open economy producing and consuming $n+1$ goods. One good, labelled "0", serves as the *numéraire*, and its domestic production is denoted by y_0. The production of the non-*numéraire* goods and their domestic prices are denoted by the vectors y and p, respectively.[6] Goods markets are assumed to be perfectly competitive. There are $m+k$ factors of production, which are internationally immobile and supplied inelastically. The vector v comprises m factors for which fully flexible factor prices r ensure full employment of the exogenously given respective endowments in perfectly competitive markets. There remain k factors, interpreted as different types of labour, for which involuntary unemployment exists in equilibrium because profit maximising firms pay workers a wage above the market clearing level. The labour endowment vector is given by $\bar{l}$, the employment vector by l, and the vector of wage rates by w.

As in Akerlof and Yellen (1990), we assume that employees are able to choose their effort, and that due to fairness preferences a worker of type j provides effort ε_j according to

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

where w_j^* is the fair wage for a type-j worker. Hence, workers provide less than the full effort, normalised to one, if and only if their wage falls short of what they consider fair.

Firms are wage setters but due to the atomistic market structure no individual firm has the capability to influence the fair wage. The latter is determined in general equilibrium and treated parametrically by all firms. In this situation, profit maximisation 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 such as to minimise the wage rate for type-j labour in efficiency units, w_j/ε_j. In step two, they hire workers up to the point where the value marginal product of type-j labour (VMPL$_j$) is equal to the wage set in step one. It can be seen from (1) that the wage the firm has to pay for an efficiency unit of labour is equal to the fair wage for all $w_j \in (0, w_j^*)$ while it is equal to w_j for $w_j > w_j^*$. As workers

[6] All vectors are column vectors, transposes are denoted by a prime.

cut their effort in proportion to a wage cut below their fair wage but do not increase effort in response to wage increases above the fair wage, a profit maximising firm will never pay more than w^*, but is indifferent between paying w^* and paying a positive fraction of it. We assume that in a situation where doing so does not harm its profits, the firm chooses to pay the fair wage, and hence $w_j = w_j^*$.[7] For simplicity, we assume that the effort function is the same across workers and sectors. With intersectorally mobile labour, this will lead to a situation with a single market wage w_j for labour of type j.

We take the workers' fair wage to be strictly positive markup on 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.[8] When unemployed, workers of type j receive the benefit $\bar{w}_j$ which is financed via a lump-sum tax on the fully employed factors. Formally, the fair wage is therefore given by

$$w_j^* = \gamma \left[w_j \frac{l_j}{\bar{l}_j} + \bar{w}_j \frac{(\bar{l}_j - l_j)}{\bar{l}_j} \right] \tag{2}$$

where $\bar{l}_j$ and l_j are the economy's endowment and employment, respectively, of labour type j. The assumption of a strictly positive markup on the expected wage rate translates into the condition that γ be larger than one.

This condition implies that in order to provide the full effort workers require to be better off than an individual drawn randomly from the population of (unemployed and employed) workers outside his own firm. This can be rationalised in at least two ways. First, an employed worker might attach a probability to being unemployed that is lower than the rate of unemployment and therefore require a positive markup in order to match his subjective expected wage outside the firm. Second, the worker might expect the firm to enter into a gift exchange, with the firm paying a positive markup on the worker's expected outside option and the worker reciprocating by providing the full effort.

In equation (2), we model the workers' behaviour as being driven by *intragroup fairness* considerations. This is in line with the argument put forward in Akerlof (1982, p. 555) that most individuals would compare themselves to persons who are similar to themselves

[7] The same assumption is used in Akerlof and Yellen (1990).

[8] Hence, we use the same determinants of the fair wage as Akerlof (1982, p. 557).

when assessing whether they are treated fairly. To be sure, it is plausible that *intergroup fairness* considerations that are modelled Akerlof and Yellen (1990) play a role as well. However, we choose to focus on intragroup fairness considerations in the present paper. In a model with a potentially large number of factors intergroup fairness considerations cannot be introduced in a straightforward way because it would be unclear in this case the price of which of the many other factors should serve as a point of reference for the workers. Setting $w_j = w_j^*$ in (2) and solving for w_j gives

$$f^{wj}(l_j, \bar{l}_j, \bar{w}_j) = \frac{\gamma \bar{w}_j(\bar{l}_j - l_j)}{\bar{l}_j - \gamma l_j}, \tag{3}$$

where $f^{wj}(\cdot)$ is the wage rate for labour of type j compatible with profit maximisation as a function of the employment level l_j, given the labour endowment and the unemployment benefit. Following Akerlof and Yellen (1990), (3) is called a *fair wage constraint* (FWC). There are k of them, one for each type of labour. Formally, the FWC vector is given by

$$f^{w}(l, \bar{l}, \bar{w}) = (f^{w1}(l_1, \bar{l}_1, \bar{w}_1), \ldots, f^{wk}(l_k, \bar{l}_k, \bar{w}_k))' \tag{4}$$

Alternatively, we can solve (3) for l_j to get the *inverse fair wage constraint* (IFWC)

$$f^{lj}(w_j, \bar{l}_j, \bar{w}_j) = \frac{\bar{l}_j(w_j - \gamma \bar{w}_j)}{\gamma(w_j - \bar{w}_j)}, \tag{3'}$$

with the IFWC vector given by

$$f^{l}(w, \bar{w}, \bar{l}) = (f^{l1}(w_1, \bar{w}_1, \bar{l}_1), \ldots, f^{lk}(w_k, \bar{w}_k, \bar{l}_k))'. \tag{4'}$$

Below, the FWC and the IFWC will be used interchangeably to derive comparative static results, depending on whether the effect of parameter changes on l or on w is the focus.

It can be seen from (3) that the maximum level of employment for labour of type j in the economy that is compatible with $w_j > 0$ is strictly smaller than $\bar{l}_j/\gamma$. Partial differentiation of $f^{wj}(\cdot)$ with respect to the level of employment yields $f^{wj}_{l_j} = \bar{w}_j \bar{l}_j \gamma(\gamma - 1)/\left(\bar{l}_j - \gamma l_j\right)^2 > 0$ and $f^{wj}_{l_j l_j} = 2\bar{w}_j \bar{l}_j \gamma^2(\gamma - 1)/(\bar{l}_j - \gamma l_j)^3 > 0$.[9] Hence the fair wage constraint for labour of type j is upward sloping and convex in w_j-l_j space. The positive

[9]Subscripts are used to denote partial derivatives.

slope is due to the fact that with a lower factor-specific rate of unemployment workers attach a lower weight to the unemployment benefit in determining their fair wage. As the unemployment benefit is lower than the equilibrium wage rate, doing so increases their fair wage. Given that firms pay the fair wage in equilibrium, there is a feedback effect increasing the fair wage further. The latter effect explains the convexity of the fair wage constraint. The minimum wage level (at $l_j = 0$) is equal to $\gamma \bar{w}_j$. The model therefore exhibits *constrained wage flexibility* or alternatively *partial factor price rigidity*, setting it apart from both the model with perfectly competitive labour markets, where wages are fully flexible, and the minimum wage model, where wages are exogenously fixed.

After setting w in step one such as to minimise the wage rate for labour in efficiency units, the production sector chooses labour inputs as well as output quantities, treating parametrically the equilibrium prices of goods and factors, including w. The second stage of profit maximisation can alternatively be described by two variants of the restricted profit function (Cornes 1990). First, we can write

$$\pi^0(p, l, v) = \max_{y_0, y} \Big\{ y_0 + p'y \,|\, (y_0, y, l, v) \text{ feasible} \Big\}, \tag{5}$$

which looks identical to a standard GDP function used to describe the production sector of the full employment model. Note however that here the employment vector l is determined in general equilibrium. Following standard practice, we assume that π^0 is twice differentiable in all its arguments. For this assumption to hold, the number of factors has to be at least as great as the number of goods, i.e. $m + k \geq n + 1$.

Alternatively we can define

$$\pi^1(p, w, v) = \max_{y_0, y, l} \Big\{ y_0 + p'y - w'l \,|\, (y_0, y, l, v) \text{ feasible} \Big\}, \tag{6}$$

which looks identical to the *factor-price constrained revenue function* in Neary (1985), used to describe the production sector of the minimum wage model. However, while w is a parameter vector in the minimum wage model, it is determined in general equilibrium here. The functional value of $\pi^1(p, w, v)$ gives the income of the flexprice factors, in contrast to the functional value of $\pi^0(p, l, v)$ which gives national income. As both w and l are endogenous in the fair wage model, there is no obvious choice of preferring one of the two variants of the restricted profit function in general.[10] Depending on the context, we will use either of the two below. As pointed out by Neary (1985), the requirements for π^1 to be twice differentiable are stricter than those for the differentiability of π^0. In particular, we have to assume that the number of flexprice factors is at least as great as the number of goods, i.e. $m \geq n+1$. Whenever we use $\pi^1(\cdot)$ below, we assume that this condition holds.

As the firms are price takers in the goods and flexprice factor markets, and take the fair wage vector given as well, all the standard results on the derivative properties of restricted profit functions hold (see, e.g., Cornes (1990)). In particular, we have

$$\pi_l^0(p, l, v) = w^0 \tag{7}$$

$$\pi_p^0(p, l, v) = y^0 \tag{8}$$

$$\pi_v^0(p, l, v) = r^0 \tag{9}$$

$$\pi_w^1(p, w, v) = -l^1 \tag{10}$$

$$\pi_p^1(p, w, v) = y^1 \tag{11}$$

$$\pi_v^1(p, w, v) = r^1 \tag{12}$$

Furthermore, the matrix $\pi_{ll}^0(p, l, v)$ is negative semidefinite, whereas $\pi_{ww}^1(p, l, v)$ is positive semidefinite. Equations (8) and (9) give goods supplies and flexprice factor demands for given employment levels, while (11) and (12) give goods supplies and flexprice factor demands for given wage levels. In a model with perfectly competitive labour markets, equations (7) and (10) would have to be interpreted as general equilibrium (inverse) demand functions for the different types of labour. With wage setting firms, this interpretation is not strictly appropriate. Rather, the equations give combinations of w and l for which the wage equals the respective VMPL, provided that labour is paid not less than the fair wage.

Equilibrium in the labour market(s) is then determined by the condition that labour

[10] Similarly, in a model with endogenous factor supplies the restricted profit function can be written alternatively as a function of the factor prices or as a function of the employment levels for the endogenously supplied factors (Woodland (1982, 239-40)).

is being paid both its value marginal product and its fair wage:

$$\pi_l^0(p, l, v) = f^w(l, \bar{l}, \bar{w}) \tag{13}$$

Alternatively, using the IFWC, we can write the labour market equilibrium condition as

$$-\pi_w^1(p, w, v) = f^l(w, \bar{l}, \bar{w}) \tag{13'}$$

The determination of equilibrium for labour of type j is illustrated in figure 1. The equilibrium values of the wage rate and the level of employment are denoted by $\widetilde{w}_j$ and $\widetilde{l}_j$, respectively. The slope of the VMPL curve in w_j-l_j space for a constant goods price vector, but taking into account optimal reallocation of all factors between sectors, is given by $\pi^0_{l_j l_j}$.

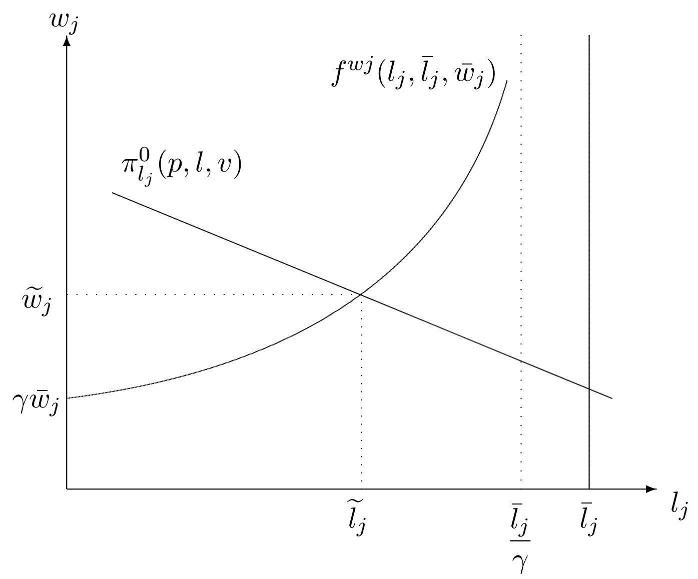

Figure 1: Labour Market Equilibrium

The VMPL curve is strictly downward sloping in the neighbourhood of the equilibrium, i.e. the main diagonal elements of π^0_{ll} are negative, if the number of factors exceeds the number of goods produced in the small open economy. With an equal number of factors and goods, the economy is characterised by FPI: Factor prices are locally independent of endowments, and therefore π^0_{ll} is the zero matrix in this case.[11] Inspection of figure 1 shows that in our model involuntary unemployment necessarily occurs in general equilibrium. In the case where the VMPL curve is downward sloping, as drawn, this is accompanied by the equilibrium wage being higher than it would be in an economy with a perfectly competitive labour market. In contrast, with an equal number of goods and factors (and therefore an infinitely elastic VMPL curve), involuntary unemployment is accompanied by a wage that is the same as in an economy with a perfectly competitive labour market.

3 Comparative Statics

Crucial for all comparative static effects is the labour market equilibrium in either version (13) or version (13′). Total differentiation yields

$$\left(f^w_l - \pi^0_{ll}\right) dl - \pi^0_{lp} dp - \pi^0_{lv} dv + f^w_{\bar{l}} d\bar{l} + f^w_{\bar{w}} d\bar{w} = 0 \tag{14}$$

and

$$\left(f^l_w + \pi^1_{ww}\right) dw + \pi^1_{wp} dp + \pi^1_{wv} dv + f^l_{\bar{l}} d\bar{l} + f^l_{\bar{w}} d\bar{w} = 0, \tag{14′}$$

respectively. Below, (14) is used when the employment effects of parameter changes are of interest, while (14′) is used when the interest is on the wage effects of parameter changes. We are now in a position to derive the comparative static effects of interest to us, starting with the effect of unemployment benefits on the labour market equilibrium:

Proposition 1. *An increase in the unemployment benefit for type j labour leads to an increase in this factor's unemployment rate, and under FPI it furthermore leaves all other unemployment rates constant. In the absence of FPI an increase in the unemployment benefit for type j labour leads to a less than proportionate increase in its wage. Under FPI any change in unemployment benefits leaves wages unchanged.*

Proof. Setting dp, dv, and $d\bar{l}$ equal to zero (more precisely, equal to the zero vectors of appropriate dimension) in (14) and solving for dl gives

$$dl = -\left(f^w_l - \pi^0_{ll}\right)^{-1} f^w_{\bar{w}} d\bar{w}, \tag{15}$$

[11] Neary (1985, p. 557) refers to this as the *local factor-price equalisation property.*

with $(f_l^w - \pi_{ll}^0)^{-1}$ positive definite and $f_{\bar{w}}^w$ being a positive diagonal matrix. Therefore we have $dl_j/d\bar{w}_j < 0$. Under FPI, the coefficient of $d\bar{w}$ in (15) collapses to $-\left(f_l^w\right)^{-1} f_{\bar{w}}^w$, which is a negative diagonal matrix. Therefore, the effects on employment of other types of labour is zero in this case. This proves the first sentence of the proposition.

In order to prove the second sentence, set dp, dv and $d\bar{l}$ equal to zero in (14′) and solve for dw to get

$$dw = -\left(\pi_{ww}^1 + f_w^l\right)^{-1} f_{\bar{w}}^l d\bar{w}, \tag{16}$$

From differentiating (4′), we have $-(f_w^l)^{-1} f_{\bar{w}}^l = D(w/\bar{w})$, where $D(x)$ denotes a diagonal matrix with element x_j in row j. Therefore, if π_{ww}^1 was equal to zero we would have $dw_j/d\bar{w}_j = w_j/\bar{w}_j$. Given that π_{ww}^1 is positive semidefinite, it follows from (16) that

$$\frac{w_j}{\bar{w}_j} \geq \frac{dw_j}{d\bar{w}_j} > 0, \tag{17}$$

and hence in the absence of FPI an increase in unemployment benefits leads to a less than proportionate wage increase for the respective type of labour.

Under FPI we can differentiate (7) to get

$$dw = \left(\pi_{l\bar{w}}^0 + \pi_{ll}^0 \frac{dl}{d\bar{w}}\right) d\bar{w} \tag{18}$$

With $\pi_{l\bar{w}}^0$ and π_{ll}^0 equal to zero, $dw_j/d\bar{w}_j = 0$ follows immediately. □

The intuition behind proposition 1 is as follows. An increase in unemployment benefits, by increasing the value of the outside option for workers of the respective type, leads to an increase in their fair wage. Firms in all sectors respond by cutting employment to bring the fair wage in line with the value of the marginal product for this type of labour. In the absence of FPI, decreasing employment increases the VMPL, and the respective equilibrium wage increases. With FPI, this effect is absent, and employment falls until the increase in unemployment brings the fair wage back in line with the unchanged market wage. In figure 1, the respective effects can be seen by noting that an increase in $\bar{w}_j$ shifts the fair wage constraint of labour type j upwards proportionally (from (3)), with no effect on the VMPL curve.

With equilibrium effort always at its full level, the value of GDP is the obvious welfare measure in our small open economy. It is therefore of interest to see how GDP changes with a change in unemployment benefits:

Proposition 2. *A proportional reduction in unemployment benefits for all types of labour increases the value of GDP. With FPI, any reduction in unemployment benefits increases the value of GDP.*

Proof. Differentiating (5) with respect to $\bar{w}$ and taking into account that $\pi^0(\cdot)$ equals the value of GDP, gives

$$d\text{GDP} = \pi_l^0 \frac{dl}{d\bar{w}} d\bar{w} = -\pi_l^0 \left(f_l^w - \pi_{ll}^0\right)^{-1} f_{\bar{w}}^w d\bar{w} \tag{19}$$

From differentiating (4), we have $f_{\bar{w}}^w = D(w/\bar{w})$. A proportional reduction in all unemployment benefits is given by $d\bar{w} = -a\bar{w}$, where a is a positive scalar. Substituting for $d\bar{w}$, $f_{\bar{w}}^w$ and π_l^0 in (19) gives

$$d\text{GDP} = aw' \left(f_l^w - \pi_{ll}^0\right)^{-1} w, \tag{20}$$

which is a multiple of a quadratic form in a positive definite matrix and therefore positive. This proves the first sentence of the proposition.

Under FPI, (19) collapses to

$$d\text{GDP} = -\pi_l^0 \left(f_l^w\right)^{-1} f_{\bar{w}}^w d\bar{w}. \tag{21}$$

The coefficient of $d\bar{w}$ is now a negative diagonal matrix, which proves the second sentence of the proposition. □

The first sentence of proposition 2 is reminiscent of proposition 5 in Neary (1985), where it is shown that a proportionate reduction of all minimum wage rates increases the value of GDP. It is straightforward to see why in the case of FPI *all* types of reductions in unemployment benefits increase GDP: As factor prices are unaffected by changes in unemployment benefits in this case, marginal products of all factors are unchanged as well, and employment increases triggered by reductions in unemployment benefits unambiguously increase GDP.

A second type of comparative statics we look at is the effect of labour endowment changes on unemployment. An obvious source of an increase in labour endowment would be immigration, and it is in this interpretation that the following result is arguably most interesting:

Proposition 3. *With FPI, increasing the endowment of type j labour leaves unemployment rates for all types of labour constant. In the absence of FPI, an increase in the endowment of type j labour leads to an increase in this factor's rate of unemployment.*

Proof. Setting dp, dv and $d\bar{w}$ equal to zero in (14) and solving for dl gives

$$dl = -\left(f_l^w - \pi_{ll}^0\right)^{-1} f_{\bar{l}}^w d\bar{l}, \tag{22}$$

where $(f_l^w - \pi_{ll}^0)^{-1}$ is positive definite and $f_{\bar{l}}^w$ is a negative diagonal matrix. In the case of FPI, π_{ll}^0 is the zero matrix, and (22) collapses to

$$dl|_{\text{FPI}} = -\left(f_l^w\right)^{-1} f_{\bar{l}}^w d\bar{l} = D\left(\frac{l_j}{\bar{l}_j}\right) d\bar{l}, \tag{22'}$$

where the second equality follows directly from partially differentiating (4) w.r.t. l and $\bar{l}$. Hence, in the FPI case any change in labour endowments leaves all unemployment rates unchanged.

Comparing the employment effects in the presence and absence of FPI in (22) and (22′), we have

$$dl|_{\text{FPI}} - dl = -\left[\left(f_l^w\right)^{-1} - \left(f_l^w - \pi_{ll}^0\right)^{-1}\right] f_{\bar{l}}^w d\bar{l}, \tag{23}$$

where the term in square brackets is positive semidefinite as it is the difference between the inverses of two positive definite matrices whose direct difference is negative semidefinite.[12] Hence, as $f_{\bar{l}}^w$ is a negative diagonal matrix, we get

$$\left.\frac{dl_j}{d\bar{l}_j}\right|_{\text{FPI}} = \frac{l_j}{\bar{l}_j} \geq \frac{dl_j}{d\bar{l}_j} > 0, \tag{24}$$

and in the absence of FPI an increase in the labour endowment $\bar{l}_j$ leads to a (weak) increase in the unemployment rate of this factor.[13] □

[12]See Horn and Johnson (1990, p. 471)

[13]Note that in the absence of FPI the effect of endowment changes on the unemployment rates of *other* types of labour depend on the off-diagonal elements of π_{ll}^0, which cannot be signed in general.

In the discussion of this result we focus on the interpretation of $d\bar{l} > 0$ as immigration. We then get the intuitively plausible result that whether or not the economy is characterised by FPI, immigration increases the level of employment for the respective type of labour in the economy, and hence at least some of the immigrants find employment. The rate of unemployment increases in the absence of FPI because immigration decreases the respective VMPL, and only at a higher rate of factor-specific unemployment is the resulting lower wage compatible with the respective workers' fair wage. With FPI, immigration has no effect on the VMPL, and hence domestic employment rises proportionally with immigration, leaving the rate of unemployment unchanged. Our results contrast sharply with those from the multi-sector minimum wage model, where the number of employed workers is fixed and therefore not a single immigrant finds employment (assuming no job turnover between natives and immigrants).

4 Factor Price Rigidities and Factor Price Insensitivity

The comparative static results derived so far have been shown to depend on whether the production sector exhibits FPI or not. In this section we explore the issue of FPI more directly. In the context of the minimum wage model, Neary (1985) derives two important results that are related to the issue of FPI: First, Neary shows that in an economy where FPI is absent increasing the number of factors for which prices are exogenously fixed – e.g. by introducing a binding minimum wage – diminishes the factor price effect of endowment changes of the remaining flexprice factors.[14] Adding factor price rigidities therefore in a sense moves the economy closer to FPI. Second, fixing an additional factor price in a small open economy that is already characterised by FPI drives this economy to specialisation. We proceed to check whether for our model, which exhibits partial wage rigidity due to workers' fairness preferences, analogous results hold.

First look at an endowment change of flexprice factors, and compare the induced factor price effects in the fair wage economy to those in otherwise identical flexible wage and

[14] One of the contributions of Neary (1985) is to show that the source of the factor price rigidity does not matter for this result. International mobility of the factor in question is an alternative possibility.

minimum wage economies, respectively. In this context, "otherwise identical" is supposed to mean that in the original equilibrium the employment levels and wages in the respective economies are identical.[15] With FPI, the induced factor price effects would be zero in all three economies, hence we have to restrict the analysis to a situation where FPI is absent. We then have the following:

Proposition 4. *In the fair wage economy without FPI factor prices of the fully employed factors are*

(i) less responsive to endowment changes than in a corresponding flexible wage economy and

(ii) more responsive to endowment changes than in the corresponding minimum wage economy.

Proof. Differentiating (9) with respect to v gives

$$dr = \left(\pi^0_{vv} + \pi^0_{vl}\frac{dl}{dv}\right) dv \tag{25}$$

where dl/dv denotes the matrix with elements dl_i/dv_j. From (9) $dr^0 = \pi^0_{vv}dv$ denotes the effect of endowment changes of flexprice factors on their prices at constant employment levels. Using (14), we get

$$dr - dr^0 = \left[\pi^0_{vl}\left(f^w_l - \pi^0_{ll}\right)^{-1}\pi^0_{lv}\right] dv. \tag{26}$$

The matrix in square brackets is positive semidefinite, which proves the first part of the proposition. Differentiating (12) with respect to v gives

$$dr = \left(\pi^1_{vv} + \pi^1_{vw}\frac{dw}{dv}\right) dv \tag{27}$$

where dw/dv denotes the matrix with elements dw_i/dv_j. Using (14′) as well as $dr^1 = \pi^1_{vv}dv$ (from (12)), we get

$$dr^1 - dr = \left[\pi^1_{vw}\left(f^l_w + \pi^1_{ww}\right)^{-1}\pi^1_{wv}\right] dv. \tag{28}$$

[15]This in turn means that the labour endowments of the fair wage economy and the minimum wage economy are necessarily larger than in the flexible wage economy.

where the matrix in square brackets is positive semidefinite, proving the second part of the proposition. □

Hence, introducing partial factor price rigidities due to fair wage constraints brings the economy closer to FPI (or, loosely speaking, factor price equalisation), but not as close to it as complete rigidity of the same factor prices due to minimum wages.

In analogy to the reasoning in Neary (1985), proposition 4 can be interpreted as illustrating a modified Le Châtelier principle: Replacing a vector of vertical labour supply functions by fair wage constraints with strictly positive elasticity means a loosening of labour input constraints for the production sector of the SMOPEC, thereby making flex-price factor demands more elastic. The fixed wages in effect generate factor supplies that are infinitely elastic, thereby loosening the factor input constraints further and making flexprice factor demands even more elastic than in the fair wage model. Note that proposition 4 refers to *inverse* factor demands, which by the Le Châtelier logic have to become *less* elastic when labour input constraints are loosened.

Turn now to the second of the FPI-related results from the minimum wage model: Introducing another factor price rigidity into an economy already exhibiting FPI drives this economy to full specialisation. In the words of Neary (1985), this illustrates the "knife-edge" property of FPI in a small open economy. Does an analogous result hold in the fair wage model, which only exhibits *partial* factor price rigidity? It is is straightforward to see that the answer is "no". The fundamental difference between partial and full factor price rigidity for the issue of specialisation in a small open economy can be seen by considering the zero profit conditions $c_j(w, r) = p_j$, $j = 0, \dots n$, where $c_j(\cdot)$ stands for the unit costs in the production of good j. Now look at the case where the number of goods equals the number of factors, which is the case where the unconstrained economy is characterised by FPI. In the minimum wage model, the vector w is exogenous, and hence there are now more zero profit conditions than endogenous variables, i.e. flexible factor prices. Consequently, the flexible factor prices r are overdetermined, and the economy ceases to produce a subset of the goods. In the fair wage model, with an equal number of goods and factors the vector w (along with r) is determined by goods prices, exactly as in the model with perfectly competitive labour markets. In this case, the role played by the fair wage constraints is simply to determine the unemployment rates that make the fair wages equal to w.

5 Conclusion

This paper has shown how involuntary unemployment and constrained price flexibility for a subset of factors can be introduced into an otherwise standard model of a competitive small open economy with many goods and factors. Due to the fact that the modelling of involuntary unemployment, while more complex than in the minimum wage model, is still relatively simple, we are able to describe the comparative statics of the model in terms of restricted profit functions with an added equation for labour market equilibrium. This allows us to derive comparative static results for this general framework that are of obvious policy relevance, but that cannot addressed in the multi-sector minimum wage model, namely the wage and unemployment effect of changes in unemployment benefits and the employment effects of changes in labour endowment that could, e.g., be due to immigration.

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