International fragmentation: boon or bane for domestic employment?

Egger, H; Kreickemeier, U

Postprint available at:
http://www.zora.uzh.ch

Posted at the Zurich Open Repository and Archive, University of Zurich.
http://www.zora.uzh.ch

Originally published at:
International fragmentation: boon or bane for domestic employment?

Abstract

In this paper, we introduce the fairness approach to efficiency wages into a standard model of international fragmentation. This gives us a theoretical framework in which wage inequality and unemployment rates are co-determined and therefore the public concern can be addressed that international fragmentation and outsourcing to low wage countries lead to domestic job-losses. We develop a novel diagrammatic tool to illustrate the main labour market effects of international fragmentation. We also explore how preferences for fair wages and the size of unemployment benefits govern the employment effects of outsourcing and critically assess the role of political intervention that aims to reduce unemployment benefits under internationally fragmented production.
International Fragmentation: Boon or Bane for Domestic Employment?‡

Hartmut Egger§
University of Zurich
CESifo, Munich; GEP, Nottingham

Udo Kreickemeier¶
University of Nottingham
CESifo, Munich; GEP, Nottingham

Abstract

In this paper, we introduce the fairness approach to efficiency wages into a standard model of international fragmentation. This gives us a theoretical framework in which wage inequality and unemployment rates are co-determined and therefore the public concern can be addressed that international fragmentation and outsourcing to low wage countries lead to domestic job-losses. We develop a novel diagrammatic tool to illustrate the main labour market effects of international fragmentation. We also explore how preferences for fair wages and the size of unemployment benefits govern the employment effects of outsourcing and critically assess the role of political intervention that aims to reduce unemployment benefits under internationally fragmented production.

JEL-Classification: F11, F16
Key words: International Fragmentation, Unemployment, Fair Wages

‡We are grateful to Carl Davidson, Carsten Eckel, Josef Falkinger, Wilhelm Kohler, Oliver Lorz, Steven Matusz, Doug Nelson as well as participants at the Kiel Summer Workshop on Trade and Location and at research seminars at the Copenhagen Business School and the University of Göttingen for helpful comments and suggestions. The paper has also benefited from helpful comments of the editor, an associate editor and an anonymous referee. The usual disclaimer applies.

§University of Zurich, Socioeconomic Institute, Zurichbergstr. 14, 8032 Zurich, Switzerland.

¶Corresponding author. University of Nottingham, School of Economics, University Park, Nottingham NG7 2RD, United Kingdom. Phone: +44 115 951 4289, email: udo.kreickemeier@nottingham.ac.uk.
1 Introduction

The policy debate in industrialised economies on the international fragmentation of production is mainly driven by the concern over domestic job losses, reflecting the views of the general public on this issue.\footnote{The focus of the public debate on unemployment clearly follows from casual observation of the popular press on both sides of the Atlantic. For more evidence in the case of the U.S., see Scheve and Slaughter (2001).} In contrast, the academic literature looking at the economy-wide effects of international fragmentation has so far focused on its effect on relative factor rewards (Jones, 2000; Kohler, 2004). The effect on aggregate employment cannot be addressed in these models because of the assumption of perfectly competitive labour markets, leading to full employment in equilibrium. The aim of this paper is to develop a framework that bridges the gap between the policy debate and the theoretical analysis of international fragmentation. To this end, we build on a standard general equilibrium model of international fragmentation in a small open economy with perfect competition in goods markets (Jones, 2000; Jones and Kierzkowski, 2001) and modify it by allowing for labour market imperfections that lead to non-market-clearing wages and involuntary unemployment in equilibrium.

We consider a model with two primary inputs, skilled and unskilled labour, which are mobile between sectors in the economy, and potentially three sectors of production. Fragmentation of the production process can occur only in the sector with intermediate skill intensity, thereby capturing in a stylised way the idea that outsourcing is not equally prevalent in all sectors.\footnote{Throughout this paper, we use the two terms “fragmentation” and “outsourcing” synonymously.} In equilibrium, the economy will produce in at most two of the sectors, where the labour market effects of international fragmentation turn out to depend crucially on whether the active non-fragmented sector is more or less skill intensive than the sector in which fragmentation occurs. Assuming that outsourcing is restricted to the sector with intermediate skill intensity allows us to capture both possibilities in the simplest possible way.

The labour market imperfection is introduced by a variant of the efficiency wage model...
where the efficiency wage is derived from a *fairness* constraint (Akerlof, 1982, and Akerlof and Yellen, 1990), an approach for which there is empirical support from both experiments and surveys. In this framework, worker effort depends on the wage paid by the firm relative to some standard of reference that the workers perceive to be fair. We follow Akerlof and Yellen (1990) and assume that the fair wage is a weighted average of the income attainable outside the job and the wage of the other skill group (within the same firm), thereby allowing intra-group considerations and inter-group considerations to be present in workers’ fairness preferences. In equilibrium, the fairness constraint is binding for unskilled workers, giving rise to unemployment of this group, while skilled labour is fully employed in equilibrium. An important implication of the fair wage framework is that, ceteris paribus, higher unemployment makes unskilled workers more willing to accept a large skill premium because their outside option worsens.

The theoretical analysis in this paper shows how the employment and relative wage effects of international fragmentation are jointly determined by relative factor endowments, the skill intensity of the component for which production is retained domestically, preferences towards wage equality and the level of unemployment benefits. Contrary to common views but in line with earlier findings in the academic literature, our model suggests that international fragmentation and outsourcing of labour intensive production processes do

---

3Fehr et al. (1993) remark that their two-stage market experiment “may be viewed as (...) a test of Akerlof and Yellen’s efficiency wage approach” (p. 438), and find evidence for the validity of the fair wage-effort hypothesis. Fehr and Falk (1999) show that the fair wage mechanism survives in a highly competitive environment: the laboratory double auction market. Howitt (2002) and Bewley (2005) document evidence for the role of fairness in the wage setting decision of firms from interviews with managers, labour leaders, and employment counsellors. Finally, Agell and Lundborg (1995, 2003) find the same result from questionnaire surveys of Swedish firms.

4The negative equilibrium relationship between the unemployment rate of unskilled workers and the unskilled wage rate, which is essential for the labour market effects of international fragmentation in our paper, is not specific to the fair wage approach. Matusz (1994) for example combines an efficiency wage model à la Shapiro-Stiglitz (1984) with a standard two-factor two-sector trade model, where now capital and labour are the two primary inputs, and gets an analogous relationship. In his setting, workers provide full effort in equilibrium only because they lose their job if caught shirking. Higher unemployment makes the threat of being fired more severe, and hence workers are willing to accept a lower wage.
not necessarily harm unskilled workers (Arndt, 1997; Kohler, 2003; 2004). In particular, international fragmentation mitigates the unemployment problem and at the same time reduces the skill premium if home production is sufficiently skill intensive overall. The intuition is as follows: The active non-fragmented sector in this case is more skill intensive than the sector in which fragmentation occurs. Fragmentation therefore leads to an expansion of the labour intensive sector, increasing economy-wide demand for unskilled workers. The presence of involuntary unemployment in the model allows us furthermore to compare the effectiveness of reforms to the unemployment benefit system under integrated and internationally fragmented production, respectively. It is shown that the employment effects of a change in unemployment benefits may be smaller under fragmented production than under integrated production, thereby casting into doubt the popular claim that increased international outsourcing makes it necessary to scale down the welfare state in order to make it sustainable in a global economy.

There are to the best of our knowledge three previous papers that study international fragmentation in a setting with imperfect labour markets. In contrast to our model, all of these studies consider trade union activities as a source of labour market imperfection. Gaston (2002) investigates how outsourcing opportunities affect the nature of collective bargaining. Access to international fragmentation raises the outside options of firms and thereby worsens the bargaining position of unions. But international fragmentation does not occur in the bargaining equilibrium analysed in this paper. Egger and Egger (2003) consider bargaining on unskilled wages in a one-sector model but their analysis builds upon an ad hoc representation of the wage-setting curve without any details of the wage determination process. Skaksen (2004) presents an interesting model of international fragmentation in the presence of trade unions. However, two restrictive assumptions are imposed. First, there is only one sector of production, which rules out any intersectoral

\[\text{5Egger and Egger (2003) postulate (for a given skilled wage rate) a negative equilibrium relationship between the unemployment rate of unskilled workers and the unskilled wage rate. This feature of their analysis is well in line with the central labour market relationship in the present paper. Hence, we would expect that the unemployment and relative wage effects in our model are not specific to the assumption that an efficiency wage mechanism governs the labour market outcome.}\]
adjustments to international fragmentation and, second, there is only one type of labour, so that – in contrast to our study – skill premium and unemployment effects cannot be addressed simultaneously.

The remainder of the paper is structured as follows. Section 2 introduces a model of fair wages and international fragmentation and characterises the unemployment effects of outsourcing. Section 3 discusses how the effects of international fragmentation differ in egalitarian and non-egalitarian economies. Section 4 looks at the effects of changing unemployment benefits on wages and employment and compares these effects for the cases of integrated and internationally fragmented production. Section 5 concludes.

2 A Model of Fragmentation and Unemployment

2.1 Integrated Production

We look at a small open economy potentially producing the three goods $X$, $Y$ and $Z$. Product markets are perfectly competitive, and production functions in all sectors exhibit constant returns to scale. For simplicity, the production technology in all sectors is assumed to be Leontief. Furthermore, good $X$ is the good with the highest skill intensity and good $Z$ the one with the lowest skill intensity. There are two factors of production, skilled labour $H$ and unskilled labour $L$, both of which are supplied inelastically. Let $w_L$ denote the wage of unskilled labour, $w_H$ the wage of skilled labour, and $P_i$ the price of good $i$. In equilibrium, unit costs cannot be smaller than goods prices, i.e.

$$c_X(w_L, w_H) \geq P_X \quad c_Y(w_L, w_H) \geq P_Y \quad c_Z(w_L, w_H) \geq P_Z,$$

where the strict equality holds for those goods that are produced in equilibrium.

The conditions for non-positive profits are conveniently visualised using the Lerner-Pearce (LP) diagram in figure 1. $X$, $Y$ and $Z$ denote unit-value isoquants for the respective goods, i.e. combinations of $H$ and $L$ that give one Euro worth of output. The unit isocost line tangent to $X$ and $Y$ gives combinations of $H$ and $L$ that cost one Euro and are therefore compatible with zero profits in both sectors $X$ and $Y$. The inverses of the
resulting factor prices are given by the intersection points of the unit isocost line with the respective factor axis. Analogous reasoning allows us to determine the factor prices compatible with zero profits in the production of $Y$ and $Z$.

Figure 1: Unemployment in the LP diagram

The convex hull of $X$, $Y$ and $Z$, known as the Hicksian composite unit-value isoquant, together with the relative skill-to-labour endowment would suffice to determine production patterns and factor prices in the full employment model. In order to illustrate how the LP diagram can be used in the presence of unemployment, define $\bar{h} \equiv H/L$ as the endowment ratio between skilled and unskilled labour and $h$ as the respective employment ratio. As set out in the introductory section, the equilibrium of the present model is characterised by full employment of skilled labour, while there is unemployment of unskilled labour. Let the unemployment rate for unskilled labour be denoted by $U$. Then, the relation between
$\bar{h}$ and $h$ is given by

$$h = \frac{\bar{h}}{1-U},$$

(2)

and therefore we have $h > \bar{h}$ if $U > 0$. Denote the skill intensity of good-$i$ production by $h^i, i = X, Y, Z$. Then, the economy produces $X$ and $Y$ if $h^X(1-U) > \bar{h} > h^Y(1-U)$, and it produces $Y$ and $Z$ if $h^Y(1-U) > \bar{h} > h^Z(1-U)$. The economy specialises on producing good $Y$ if the endowment ratio equals $h^Y(1-U)$. No assumption has been made so far on how $U$ is determined and whether it is constant across regimes. For illustrative purposes however, assume for the moment an exogenous level of $U$ that is constant for all equilibrium factor prices. Using this assumption, the boundaries between production patterns are depicted in figure 1. In comparison with the full employment model, they are rotated clockwise with the extent of rotation depending on the rate of unemployment – consider the dotted lines $h^i(1-U)$ and their solid counterparts $h^i$. We now move to showing how in our model $U$ is determined in general equilibrium.

Following Kreickemeier and Nelson (2006), involuntary unemployment arises due to a variant of the fair wage mechanism used by Akerlof and Yellen (1990). Both types of workers are able to choose their effort at work, and due to fairness preferences a worker of type $k$ provides effort $\varepsilon_k$ according to

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

(3)

where $w_k^*$ denotes the fair wage for workers of group $k$. Eq. (3) implies that workers provide the normal level of effort, which is normalised to one, if they are paid at least their fair wage.\(^6\)

\(^6\)Equation (3) builds upon two assumptions. First, workers punish wages lower than those considered to be fair by providing lower effort, a behaviour which is often referred to by the term negative reciprocity. There is considerable support for the reciprocity of workers from experimental evidence (Fehr and Gächter, 2000) and surveys on manager interviews (Bewley, 2005). Second, workers do not increase their effort in response to overpayment. This hypothesis has been studied in psychological experiments. The respective findings can be summarized in the words of Akerlof and Yellen (1990): “These experimental results are consistent with the hypothesis that overpayment does not increase input” (p. 258). Bewley (2005) also gives (at least indirect) support to the second assumption by concluding from survey results that “productivity and morale do not increase with pay levels though they can be hurt by pay reductions.” (p. 309)
Firms are wage setters but they are assumed to treat the fair wage, which is determined in general equilibrium, parametrically. Under this assumption, 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 for each type of labour $k$ to minimise the wage paid for an efficiency unit, which is $w_k/\varepsilon_k$. 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. It can be seen from (3) that the wage rate for an efficiency unit of labour (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 wage of the respective other group of workers (within the same firm), and second the remuneration they could expect outside their own job, taking into account that they might be unemployed with a probability that is equal to the factor-specific rate of unemployment.\(^7\) Hence, we have

\begin{align*}
w^*_L &= \theta w_H + (1 - \theta)(1 - U_L)w_L \\
w^*_H &= \theta w_L + (1 - \theta)(1 - U_H)w_H \tag{4}
\end{align*}

where $U_L$ and $U_H$ are the factor-specific rates of unemployment, and $\theta$ is the weight attached to the remuneration of the other skill group in one factor’s determination of its fair wage. Equations (4) and (5) do not account for payments to the unemployed. The impact of redistributive measures like unemployment benefits is analysed in detail in section 4.

We assume that in a perfectly competitive labour market the wage for skilled workers

\(^7\)This features the idea of Akerlof and Yellen (1990) that the reference wage of workers comprises both a firm-internal and a firm-external component. Instead of the expected wage rate outside the job, Akerlof and Yellen (1990) use the (hypothetical) market clearing wage rate of the respective group as the firm-external 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, however, is more tractable in a multi-sector model.
would be higher than the wage for unskilled workers. Under this condition it is straight-
forward to see that the following must be true in equilibrium:

\[ U_L > U_H = 0 \]  \hspace{0.5cm} (6)
\[ w_H > w_H^* > w_L = w_L^* \]  \hspace{0.5cm} (7)
\[ \varepsilon_L = \varepsilon_H = 1 \]  \hspace{0.5cm} (8)

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 level of effort.

According to (6) and (7), equation (5) is not binding. By setting \( w_L = w_L^* \) in (4) and
solving for \( \omega \equiv w_L/w_H \), we get

\[ \omega = f(U, \theta) \equiv \frac{\theta}{\theta + (1 - \theta)U} \]  \hspace{0.5cm} (9)

Following Akerlof and Yellen (1990), the equilibrium relationship between the wage dif-
fferential and the rate of unemployment in (9) is called the *fair wage constraint*. For a
given value of \( \theta \), the fair wage constraint describes equilibrium combinations between the
rate of unemployment of unskilled workers and the relative wages of skilled and unskilled
workers. Partial differentiation gives \( \partial f/\partial U < 0 \) and \( \partial^2 f/\partial U^2 > 0 \), and hence the fair
wage constraint is negatively sloped and convex in \( \omega - U \)-space, i.e. higher rates of unem-
ployment 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 \( f(0, \theta) = 1 \) and \( f(1, \theta) = \theta \), respectively. 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.\(^8\) For future reference, we introduce the *inverse fair wage constraint*. It follows
from (9) as

\[ U = \tilde{f}(\omega, \theta) \equiv \frac{\theta}{1 - \theta} \frac{1 - \omega}{\omega} \]  \hspace{0.5cm} (10)

\(^8\)With perfectly competitive markets for both types of labour, \( \omega \) can vary between 0 and 1, assuming –
as we did – that under perfect competition skilled workers are paid the higher wage.
In order to describe the equilibrium production structure for the fair wage model in the case of integrated production, in figure 2 we introduce a novel four-quadrant diagram that merges a graphical representation of the fair wage constraint with the LP diagram of figure 1. The LP diagram is shown in the first quadrant, with the Hicksian composite unit-value isoquant traced out in bold.

Quadrant II depicts the function mapping the wage differential \( \omega \) into \( 1/w_H \). Trivially, it is a linear function with slope \( w_L \). Note however that \( w_L \), which can be determined as illustrated in figure 1, is specific to the specialisation pattern, so that a change in the specialisation pattern rotates this function. Quadrant III shows the fair wage constraint, while the linear function \( L = \bar{L} - LU \) in the fourth quadrant relates the level of employment...
for unskilled labour to the unemployment rate, for a given endowment $\bar{L}$. Together, quadrants II to IV allow us to depict both endowment and employment quantities in the LP diagram of quadrant I.

Note that factor prices in equilibrium have to be compatible with both the zero profit conditions and the fair wage constraint. Factor prices leading to zero profits in the production of $Y$ and $Z$ are compatible with the fair wage constraint for an unemployment rate equal to $U_1 = \hat{f}(\omega_{YZ}, \theta)$, where $\omega_{ij}$ is the relative wage rate compatible with zero profits in the production of goods $i$ and $j$. Hence, the economy specialises in the production of $Y$ and $Z$ if $h_1 = h^Y(1 - U_1) > \bar{h} > h^Z(1 - U_1)$.

On the other hand, with specialisation in the production of $X$ and $Y$, the unemployment rate is equal to $U_2 = \hat{f}(\omega_{XY}, \theta) < U_1$. Consequently, the economy produces these two goods whenever $h^X(1 - U_2) > \bar{h} > h^Y(1 - U_2) = h_2$. For endowment ratios between $h_1$ and $h_2$ the economy specialises in the production of $Y$. We call this region of specialisation on the good with intermediate skill intensity, which is shaded in figure 2, the cone of non-diversification (NDIV cone). Inside the NDIV cone, for each endowment ratio the equilibrium unemployment rate $\bar{U}$ follows from (2) as $\bar{U} = 1 - (\bar{h}/h^Y)$, and the wage differential is given by $\omega = f(\bar{U}, \theta)$, according to (9).

The existence of an NDIV cone as defined here is guaranteed only for sufficiently low values of the fairness parameter $\theta$, which – as shown earlier – is the lower bound of the wage differential compatible with the fairness constraint. More precisely, the NDIV cone exists if and only if $\theta$ is smaller than $\omega_{YZ}$ (see figure 2). For $\omega_{XY} > \theta > \omega_{YZ}$, there is an NDIV region (which is not a cone). The economy will in this case specialise in the production of $Y$ for $\hat{h} < h_2$. For $\theta > \omega_{XY}$, not even an NDIV region exists, and the economy specialises in the production of good $X$ for all relative factor endowments.

The fact that, irrespective of the relative skill endowment, labour-intensive production processes may become infeasible (if $\theta$ is sufficiently high) is an important feature of the fair wage model. However, since we are interested in the full set of general equilibrium

\footnote{With a more skill intensive production mix, zero profit conditions require a higher relative wage of unskilled workers, and hence a lower rate of unemployment is needed to make this relative wage compatible with the fair wage constraint.}
interactions between endowments and production patterns, we ignore the latter two cases by assuming that $\theta$ is sufficiently small to guarantee the existence of an NDIV cone.

### 2.2 Fragmented Production

Now we look at the situation where the production process for $Y$, the good with the intermediate skill intensity, can be split up into the production of components $A$ and $B$, which in turn can be assembled without incurring an additional cost. In our three-good setup, focusing on the fragmentation in the production process of good $Y$ – rather than the “extreme” goods $X$ or $Z$ – is arguably the most interesting case because it allows us to distinguish between two situations of diversified production: one where the fragmented production process as a whole is more skill intensive than the other good produced ($h_Y > h_Z$), and one where it is less skill intensive ($h_Y < h_X$). As it will turn out, this distinction is crucial for many of the results in this paper.

Let the world market prices for the two components be denoted by $P_A$ and $P_B$, respectively. In analogy to the integrated production case, the absence of positive profits requires

$$c_i(w_L, w_H) \geq P_i \quad \forall i \in \{A, B, X, Y, Z\}$$

where again the strict equality holds for those goods or components that are produced in equilibrium. In analogy to the other production processes, Leontief technology is assumed for the production of components $A$ and $B$. We restrict our analysis to the situation where

(i) production of one of the two components is retained domestically,

(ii) for relevant (zero-profit consistent) factor prices, fragmented production technology is strictly preferred over integrated production technology, once it is available,

(iii) both $X$ and $Z$ production remain viable for some $h$,

(iv) the skill intensity of the domestically produced fragment lies between $h_X$ and $h_Z$, and
(v) good $Y$ is produced in the pre-fragmentation equilibrium.

Conditions (i) to (v) serve the purpose of concentrating on what are arguably the economically interesting cases. In principle, it would be easy to specify world market prices for the two components such that the economy produces both or neither of them (see, e.g., Jones 2000). By condition (i) we exclude these cases from the analysis, as from the point of view of the home country neither of them involves international fragmentation of production, the phenomenon we are interested in. Without loss of generality, we assume it is component $A$ that is retained domestically. Condition (ii) excludes the borderline case of two technologies surviving in the $Y$ sector (Egger and Falkinger, 2003). Condition (iii) says that technology and price for the fragment produced domestically must not be such that either $X$ or $Z$ production is infeasible for all values of $h$.

Condition (iv) rules out the possibility of a change in the factor intensity ranking of sectors (Egger and Falkinger, 2003), so that production of good $X$ ($Z$) is the most (least) skill-intensive activity under both integrated production and international fragmentation of $Y$-manufacturing. Finally, the opportunity of international fragmentation may make production of component $A$ profitable although integrated production of $Y$ is unprofitable. However, given assumption (iv) it is obvious that in the case of full specialisation on skill-intensive good $X$ (labour-intensive good $Z$) in the pre-fragmentation equilibrium, international fragmentation and domestic production of one component of $Y$ would reduce (raise) overall employment ratio $h$ and therefore decrease (increase) the rate of unemployment. Since this result is straightforward, we exclude this scenario in the following analysis.

The equilibrium with international fragmentation is depicted in figure 3, which is constructed analogously to figure 2. The figure is drawn for a case where the skill intensity of fragment $A$ is higher than the skill intensity of the integrated production of good $Y$. The NDIV cone for the fragmentation scenario ($\text{NDIV}^F$), bounded by $h_3$ and $h_4$, is given by the shaded area. For comparison, the NDIV cone from the integrated production scenario ($\text{NDIV}^I$) is replicated as the region bounded by $h_1$ and $h_2$. It can be seen that diversified production of $X$ and $A$ yields a lower skill premium $1/\omega$ and a lower rate of unemployment.
than diversified production of $X$ and $Y$ in the pre-fragmentation equilibrium. On the other hand, diversified production of $A$ and $Z$ yields a higher skill premium and a higher rate of unemployment than diversified production of $Y$ and $Z$ in the pre-fragmentation equilibrium.

Figure 3: Equilibrium under fragmented production

This observation alone implies that fragmentation decreases unemployment for sufficiently high employment ratios (those that lead to production of $XA$ after fragmentation) and increases unemployment for sufficiently low employment ratios (those that lead to production of $AZ$ after fragmentation). While this result is useful as a first insight, it leaves a lot to be desired. First, it is stated in terms of employment ratios that are themselves endogenous. Second, it is not informative for the case of full specialisation on fragment $A$. Third, it gives no insight in the role – if any – played by the skill intensity of $A$.  

14
Further insights into these issues can be gained by writing the unemployment rates under integrated and fragmented production, $U^I$ and $U^F$, as a function of the endowment ratio $\bar{h}$. Considering $\theta < \omega_{X,A}$ (i.e., assuming that an NDIV cone under integrated and fragmented production exists), and noting assumptions (i)-(v), this gives:

$$U^I = \begin{cases} 
\hat{f}(\omega_{XY}, \theta) & \text{for } \bar{h} \geq h^Y(1 - \hat{f}(\omega_{XY}, \theta)) \\
1 - \frac{\bar{h}}{h^Y} & \text{for } h^Y(1 - \hat{f}(\omega_{XY}, \theta)) > \bar{h} > h^Y(1 - \hat{f}(\omega_{YZ}, \theta)) \\
\hat{f}(\omega_{YZ}, \theta) & \text{for } \bar{h} \leq h^Y(1 - \hat{f}(\omega_{YZ}, \theta))
\end{cases} \quad (12)$$

$$U^F = \begin{cases} 
\hat{f}(\omega_{XA}, \theta) & \text{for } \bar{h} \geq h^A(1 - \hat{f}(\omega_{XA}, \theta)) \\
1 - \frac{\bar{h}}{h^A} & \text{for } h^A(1 - \hat{f}(\omega_{XA}, \theta)) > \bar{h} > h^A(1 - \hat{f}(\omega_{AZ}, \theta)) \\
\hat{f}(\omega_{AZ}, \theta) & \text{for } \bar{h} \leq h^A(1 - \hat{f}(\omega_{AZ}, \theta))
\end{cases} \quad (13)$$

It is easily verified that both $U^I$ and $U^F$ are weakly decreasing in $\bar{h}$ and continuous. Furthermore, we have

$$\hat{f}(\omega_{AZ}, \theta) > \hat{f}(\omega_{YZ}, \theta) > \hat{f}(\omega_{XY}, \theta) > \hat{f}(\omega_{XA}, \theta), \quad (14)$$

irrespective of the relative size of $h^Y$ and $h^A$. This implies that there is a critical level of $\bar{h}$, labelled $\bar{h}^*$ and not necessarily unique, that separates endowment ratios for which international fragmentation increases unemployment from those where it decreases unemployment. In deriving a more specific result, the following observation is useful:

**Lemma 1.** The critical endowment ratio $\bar{h}^*$ lies inside NDIV$^F$.

**Proof.** From (12), $U^I$ lies between $\hat{f}(\omega_{YZ}, \theta)$ and $\hat{f}(\omega_{XY}, \theta)$. From (13) and (14), $U^F$ can only fall in this range if it is determined by $1 - (\bar{h}^*/h^A)$. This in turn is true if and only if $\bar{h}^*$ lies inside NDIV$^F$. \qed

In view of lemma 1, we can describe the properties of the critical endowment ratio $\bar{h}^*$ in more detail:

**Proposition 1.** The critical endowment ratio $\bar{h}^*$ is unique if and only if $h^Y \neq h^A$. For given $h^Y$, a higher $h^A$ is associated with a higher $\bar{h}^*$. 

15
Proof. We have to distinguish three possible regimes, namely the ones where $\bar{h}^*$ lies above, below, and inside NDIV$^I$. For $\bar{h}^*$ to be above NDIV$^I$, we must have $1 - (\bar{h}^*/h^A) = \tilde{f}(\omega_X Y, \theta)$ and hence $\bar{h}^* = h^A(1 - \tilde{f}(\omega_X Y, \theta))$. From (12), this implies $h^A > h^Y$. Analogously, we get $\bar{h}^* = h^A(1 - \tilde{f}(\omega_Y Z, \theta))$ for $\bar{h}^*$ below NDIV$^I$, with $h^A < h^Y$ in this case. In both regimes, $\bar{h}^*$ can be seen to be unique and increasing in $h^A$. With $\bar{h}^*$ inside NDIV$^I$, we have $1 - (\bar{h}^*/h^A) = 1 - (\bar{h}^*/h^Y)$ and hence $h^A = h^Y$. In this case, $\bar{h}^*$ is not unique but can take on any value inside NDIV$^I$. All $\bar{h}^*$ values consistent with $h^Y = h^A$ are strictly higher (lower) than $\bar{h}^*$ values consistent with $h^Y > h^A$ ($h^Y < h^A$).

Concerning the unemployment effects of fragmentation, we can state the following result:

**Proposition 2.** International fragmentation increases (decreases) unemployment for endowment ratios lower than (higher than) $\bar{h}^*$.

Proof. Proposition 2 follows from (12)-(14) and proposition 1.

The intuition for propositions 1 and 2 can be illustrated by means of figure 3, which depicts the critical endowment ratio $\bar{h}^*$ for the case where $h^A$ exceeds $h^Y$. As shown in the proof to proposition 1, it is given by $\bar{h}^* = h^A(1 - U_2)$, where $U_2 = \tilde{f}(\omega_X Y, \theta)$. As $\bar{h}^*$ lies above NDIV$^I$, an economy with endowment ratio $\bar{h}^*$ specialises on $X$ and $Y$ under integrated production. With the implied unemployment rate $U_2$, the average skill intensity of production is equal to $h^A$. Under fragmentation, as $\bar{h}^*$ lies in NDIV$^F$, the economy specialises in the production of $A$, and hence the skill intensity of production in this case is $h^A$ as well. This implies that the two unemployment rates are equal. For skill intensities exceeding $\bar{h}^*$ but still inside NDIV$^F$, the average skill intensity under integrated production exceeds $h^A$, while it is equal to $h^A$ under fragmented production. Hence, fragmentation in this case decreases the average skill intensity of production and unemployment of unskilled workers. Other cases can be illustrated using analogous reasoning. Note that decreasing $h^A$ rotates NDIV$^F$ clockwise and leaves NDIV$^I$ unchanged. As long as $h^A > h^Y$, $\bar{h}^*$ lies above NDIV$^I$. 

16
3 International Fragmentation in Egalitarian and Non-Egalitarian Economies

It is a view held by many economists that strong preferences for an egalitarian wage schedule are an important determinant of high European unemployment rates. However, the theoretical debate on the labour market implications of international fragmentation is usually based on the assumption of perfectly competitive labour markets, which makes a formal analysis of this factor impossible. Since wages and unemployment rates are co-determined in our model, we can address the interaction between international fragmentation and the attitude towards wage inequality and investigate its labour market consequences. To do this, we consider different values of the fairness parameter $\theta$. From (9) we have $\partial f/\partial \theta > 0$, which says that given the rate of unemployment a marginal increase of $\theta$ increases the value of $\omega$ which is needed in order to elicit the normal effort from unskilled workers. Hence, an increase in $\theta$ pivots the fair wage constraint outwards.

In order to isolate the impact that $\theta$ variations have in our model, we look at two small open economies that are identical in every respect but their preferences towards fairness. The economy that has a high value for $\theta$ ($\theta^e$) is labelled egalitarian, while the economy with a low $\theta$ ($\theta^{ne}$) is referred to as non-egalitarian. Using figure 4 it is easily verified that increasing $\theta$, by rotating the fair wage constraint clockwise, rotates both NDIV$^I$ and NDIV$^F$ clockwise as well (the NDIV cones have been omitted from figure 4 to avoid clutter). Hence, loosely speaking, a given endowment ratio is more likely to lie above NDIV$^I$ and NDIV$^F$ and therefore lead to specialisation on more skill intensive production in the egalitarian economy than in the non-egalitarian economy. This is so because at each relative factor price the egalitarian economy has higher unemployment of unskilled workers and therefore a higher employment ratio $h$. Hence, international fragmentation should more likely be beneficial in the egalitarian economy.

This presumption can be substantiated by using the critical endowment ratio $\bar{h}^*$ introduced in the previous section.

**Proposition 3.** With $h^A \neq h^Y$ (and $\theta$ sufficiently small) there is a non-empty interval
of endowment ratios for which international fragmentation increases unemployment in the
non-egalitarian economy and decreases unemployment in the egalitarian economy.

Proof. It has been shown above (in the proof to proposition 1) that $\bar{h}^*$ is a function of $\theta$, assuming $h^A \neq h^Y$. More specifically, in this case we have $\partial \bar{h}^*/\partial \theta = -h^A(\partial \tilde{f}/\partial \theta) < 0$, and therefore $\bar{h}^*(\theta^e) < \bar{h}^*(\theta^{ne})$, given $\theta^e < \omega_{AZ}$. Hence, if $\bar{h}$ satisfies
\[ \bar{h} \in (\bar{h}^*(\theta^{ne}), \bar{h}^*(\theta^e)) \] (15)
international fragmentation increases unemployment in the non-egalitarian economy, while it decreases unemployment in the egalitarian economy.

Figure 4: International fragmentation in egalitarian and non-egalitarian economies

As unemployment is higher in the egalitarian economy, we find that if $\bar{h}$ lies in the interval
specified in (15) international fragmentation leads to unemployment convergence between the egalitarian and the non-egalitarian economy. At the same time, there is international divergence in relative factor prices: In the egalitarian economy, international fragmentation compresses the wage differential, whereas the wage differential is widened in the non-egalitarian economy. Figure 4 illustrates these results for the case where \( h^A > h^Y \). The construction of the critical endowment ratios follows the reasoning described in section 2.\(^{10}\)

### 4 International Fragmentation and Unemployment Benefits

In the derivation of the fair wage constraint (9), it was assumed that unemployment benefits are equal to zero. We now introduce strictly positive unemployment benefits. This allows us to address an issue raised by many European policy makers, namely the argument that high unemployment benefits, by leading to higher wages, foster international fragmentation and thereby lead to domestic job losses.

Assuming that unemployment benefits are a fraction \( \gamma \in (0, 1) \) of the wage for each skill group, we can reformulate the fair wages of unskilled and skilled workers and obtain

\[
w^*_L = \theta w_H + (1 - \theta)[(1 - U_L) + \gamma U_L] w_L \\
w^*_H = \theta w_L + (1 - \theta)[(1 - U_H) + \gamma U_H] w_H,
\]

according to (4) and (5), respectively. And, accounting for (6) to (8), the fair wage constraint and the inverse fair wage constraint now equal

\[
\omega = g(U, \theta, \gamma) \equiv \frac{\theta}{\theta + (1 - \theta)(1 - \gamma)U},
\]

and

\[
U = \tilde{g}(\omega, \theta, \gamma) \equiv \frac{\theta}{(1 - \theta)(1 - \gamma)} \frac{1 - \omega}{\omega},
\]

\( ^{10}\)The intuition that a higher preference for fairness increases unemployment ceteris paribus, and thereby makes specialisation on skill intensive goods more likely, can be extended to the borderline case where the skill intensities of \( A \) and \( Y \) are identical. However, proposition 3 does not apply here because, from proposition 1, \( \bar{h}^* \) is not unique if \( h^A = h^Y \).
respectively. One can see that a higher replacement ratio $\gamma$ has qualitatively the same effect as a higher preference for an egalitarian wage schedule in that the fair wage constraint is pivoted outwards. Given the rate of unemployment, a marginal increase in the replacement ratio increases the value of $\omega$ needed to elicit the normal effort from unskilled workers. Conversely, a higher rate of unemployment is needed to support a given $\omega$ if the replacement ratio is higher.\textsuperscript{11}

A high value of $\gamma$ may consequently imply specialisation on skill-intensive goods $X$ and $Y$ for a country that would have specialised in the production of labour-intensive goods in the presence of a low replacement ratio. In direct analogy to our discussion of $\theta$ differentials above, international fragmentation in sector $Y$ may then have beneficial employment effects in the high $\gamma$ country and detrimental employment effects in the country with a low replacement ratio.\textsuperscript{12} Because of the analogy between $\gamma$ and $\theta$ in the present model, figure 4 can also be used to discuss the issue of unemployment benefits, where a decrease in $\gamma$ rotates the fair wage constraint counter-clockwise.

While the discussion so far has made use of similarities in the effects of $\theta$ and $\gamma$, an important difference lies in the fact that the replacement ratio is a policy variable. Therefore, we can discuss the effect of varying it, given the organisation of production. Under diversification (i.e. production of either $XY$, $YZ$, $XA$ or $AZ$) reductions of $\gamma$ that do not change the production mix leave relative factor prices constant and decrease the rate of unemployment. Conversely, in the case of full specialisation on $Y$ or $A$, a marginal decrease in $\gamma$ has no impact on the unemployment rate but increases the skill premium. Finally, reductions in the replacement ratio that are sufficiently large to impact on the mix of goods being produced reduce the unemployment rate and increase the skill premium.

\textsuperscript{11}In writing down equations (16) to (19) it is implicitly assumed that the financing of unemployment benefits does not impact on the determination of the fair wage of unskilled workers. This is correct under two alternative scenarios. Either the idea of workers on what constitutes a fair wage is related to gross wages, not net wages, or unemployment benefits are financed by a proportional tax on all workers, with the replacement ratio $\gamma$ defined in terms of net wages. For a discussion on the consequences of factor-specific tax rates, see our working paper, Egger and Kreickemeier (2005).

\textsuperscript{12}This does not imply, however, that the economy as a whole could gain from higher unemployment benefits. See the discussion on changes in $\gamma$ in the next paragraphs.
To compare the effects of a $\gamma$ change under integrated production with the respective effects under international fragmentation, we focus on situations with diversified production before and after the variation in $\gamma$. This leaves us with two cases, namely small $\gamma$ changes that leave the pattern of production unaffected and $\gamma$ reforms that have an impact on the output mix. Let us first consider a $\gamma$ variation that does not affect the production pattern. If the country produces two goods ($XY$, $YZ$, $XA$ or $AZ$), the effect of a change in the replacement ratio on the unemployment rate is given by the partial derivative

$$\frac{\partial \tilde{g}(\cdot)}{\partial \gamma} = \frac{U}{1 - \gamma},$$

(20)

because relative factor prices are constant as long as production remains diversified on the same set of goods. The unemployment effect in (20) depends on the size of $\gamma$ and the unemployment rate: the more generous the unemployment compensation scheme and the higher the (pre-reform) unemployment rate, the more effective is a marginal reduction of the replacement ratio. Of course, the organisation of production (integration or fragmentation) affects the size of the unemployment rate, but it exhibits no additional impact on the effectiveness of a marginal $\gamma$-reduction.

Consider next changes in the replacement ratio that lead to a switch in the output mix (from $XY$ to $YZ$ production or from $XA$ to $AZ$ production). In this case, reducing $\gamma$ has a stronger relative wage effect and a smaller unemployment effect under internationally fragmented production. The result on relative wage effects is easily verified by inspecting the difference in slopes of the respective Hicksian composite unit value isoquants in figure 4 for the cases of integrated and fragmented production, respectively. The result on the relative strength of the unemployment effects is less obvious – and perhaps more surprising. To see why it must hold, observe that for a given value of $\gamma$ unemployment is lower under $XA$ production than under $XY$ production, while it is higher under $AZ$ production than under $YZ$ production. Combining this observation with the fact that a $\gamma$-induced move to the less skill intensive production mix under a given regime (fragmentation/pre-fragmentation) decreases unemployment, it follows directly that the unemployment-reducing effect of a given decline in $\gamma$ is less pronounced under fragmented production.
In summary, the analysis in this section shows that no general result can be derived on whether reforms of the unemployment compensation system are more effective under integrated or fragmented production. However, we have demonstrated that $\gamma$-changes that lead to a switch from one diversified production regime to another definitely exhibit lower employment effects in a world with internationally fragmented production.

5 Concluding Remarks

This paper has addressed the labour market implications of international fragmentation in a setting with perfectly competitive goods markets and labour market imperfections due to fairness preferences of workers. Applying a novel diagrammatic tool that builds on the well-known Lerner-Pearce diagram, we have investigated how international fragmentation affects the skill premium and unemployment in a small open economy. In particular, we have shed light on the interaction of relative factor endowments, the skill intensity of the component for which production is retained domestically, preferences towards wage equality and the level of unemployment benefits in explaining the labour market implications of international fragmentation.

Although it is difficult to find direct empirical support for our theoretical hypotheses, our results at least give an economic intuition for recent (outsourcing-induced) labour market developments in the industrialised world. In this respect, four observations are particularly notable. First, there is considerable empirical evidence for a positive skill premium effect of international outsourcing in the U.S. and the U.K. (see Feenstra and Hanson, 1996, 1999; Hijzen et al., 2005; and Hijzen, 2003). This is consistent with the theoretical results in section 2, if international fragmentation leads from $YZ$ to $AZ$ production.  

13 This agnostic conclusion is reinforced if one adds to the picture changes of the replacement ratio that change the number of production processes undertaken at home. As discussed above, for some parameter values (with full specialisation on Y or A) a marginal reduction of $\gamma$ has no effect on the employment level, while for other parameter values (with diversification on $XY$, $YZ$, $XA$ or $AZ$) a marginal decline of $\gamma$ mitigates the unemployment problem. Since the two NDIV cones ($NDIV^I$ and $NDIV^F$, respectively) are not congruent, a given $\gamma$-reduction can change the pattern of integrated production but leave the pattern of fragmented production unaffected, and vice versa.
Second, Egger and Egger (2003) find a substantial increase in the relative employment of skilled labour and a moderate increase in the skill premium in the 1990s, due to better outsourcing opportunities of Austrian manufacturing industries to Central and Eastern Europe after the fall of the Iron Curtain. This labour market outcome can be rationalised by our theoretical model if international fragmentation leads from \( YZ \) to \( AZ \) production and the considered economy has a strong preference for an egalitarian wage structure. In this case, even a small change in the skill premium may lead to a considerable increase in the unemployment rate (see section 3).

Third, the analysis in section 4 makes clear that international fragmentation may increase unemployment in a country with low unemployment benefits, while it may decrease unemployment in a country with a generous compensation system. This provides an economic intuition for the observation (from OECD statistics) that a country like Italy, with relatively low unemployment benefit entitlements, suffered from an increase in unemployment in the globalisation process of the 1990s, while countries like Belgium or Denmark, with generous compensation schemes, experienced a decline in their unemployment rates in that period. Fourth, our results in section 4 show that a decline in the unemployment benefits may be less effective in reducing high unemployment rates if there is international fragmentation and outsourcing of component production to low-wage destinations abroad. This finding may help to explain why recent labour market reforms in Germany (with a substantial reduction in the unemployment benefit entitlements) had not the expected significant employment effects. In any case, the possible impact of international fragmentation on the effectiveness of labour market reforms should be taken into account by policy makers when redesigning the welfare state to meet the challenges of an integrated global economy.

References


Agell, J., Lundborg, P. (2003), Survey Evidence on Wage Rigidity and Unemploy-


