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Michael C Burda and Barbara Dluhosch

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Centre for Economic Policy Research
90–98 Goswell Rd
London EC1V 7DB
Tel: (44 171) 878 2900
Fax: (44 171) 878 2999
Email: cepr@cepr.org

This paper examines the linkage between trade and the dismal state of labour markets in Europe. On the face of superficial evidence, the nexus is weak and is overshadowed by more compelling evidence of skill-biased technical change. Yet a complete dismissal of globalization is inconsistent with current opinions of businessmen, policy-makers and workers in globalized industries. We propose an alternative model in which globalization – defined as the increase in world trade relative to other indicators of real economic activity – occurs along with deterioration of labour market prospects, especially for the less-skilled. As an alternative or complement to conventional trade and technology explanations, we model both the fragmentation of production and resulting reallocation of economic activity across national boundaries as equilibrium responses to trading opportunities as well as the technology of production. Increasing integration is therefore linked to both trade as well as pervasive skill-biased technical change. The model's predictions are consistent with a number of outstanding empirical puzzles in the trade-wages debate and can also explain the bimodal growth in services (high and low skill) observed in all OECD countries, and especially those with deregulated labour markets.

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Michael C Burda
Wirtschaftswissenschaftliche Fakultät
Humboldt Universität zu Berlin
Spandauer Strasse 1
10178 Berlin
GERMANY
Tel: (49 30) 2093 5638
Fax: (49 30) 2093 5696
Email: burda@wiwi.hu-berlin.de

Barbara Dluhosch
Wirtschaftspolitisches Seminar
Universität zu Köln
Robert-Koch-Strasse 41
50931 Köln
GERMANY
Tel: (49 221) 470 3448
Fax: (49 221) 470 5187
Email: bdluhosch@uni-koeln.de

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American countries and for persistent unemployment in continental Europe. While these labour market developments have sparked intense research on the contribution of trade and technology in the United States in particular, neither explanation has been entirely convincing. Trade explanations usually adopt a North-South perspective and place Stolper-Samuelson and Rybczynski effects at the heart of recent labour market developments. Increases in the world supply of goods with low-skill content – originating from developing countries – should raise the relative price of skill-intensive goods and induce skill-abundant developed countries such as the United States and most of Europe to shift resources towards skill-intensive production. As a result, relative wages for skilled labour and the employment of both factors in skill-intensive industries should rise. Yet the majority of studies have found little evidence in favour of this factor-proportion explanation. More importantly, the underlying Heckscher-Ohlin Samuelson (HOS) model predicts that firms should substitute away from skilled labour as it becomes more expensive when compared to less-skilled labour. Yet despite rising relative wages, skilled-unskilled ratios rose in most industries within countries and in the same industries across different countries.

While somewhat more cogent, the technology-based explanation of deteriorating labour market prospects for the less-skilled is also unsatisfactory. It is inconsistent with the traditional trade-theoretic result that factor bias of technological change should not *per se* affect wages and employment of those factors. In addition, any explanation of labour market difficulties appealing to either trade or technological factors cannot ignore a number of related developments in OECD countries. Not only has there been a general shift in employment from manufacturing to services, but employment growth within services itself has been markedly bimodal; particularly countries with flexible labour markets have been characterized by an expansion of employment in both low-wage and high-wage services. At the same time, an explanation of deteriorating labour market prospects should also be capable of accounting for cross-country differences in earnings distributions and employment performance between Anglo-American and continental European countries.

manufacturing firms engage in cost-competition by fragmenting production processes more extensively. Despite increased resource costs of coordinating an increasingly disintegrated production process, overall labour productivity may be higher. The trade-off may be associated with a wide range of phenomena such as outsourcing, a higher intermediate intensity of production, and/or a finer division of labour within the firm. Induced technical change can in turn be linked to relative labour demand for various skill groups as well as the sectoral composition of the work force. While labour market disruptions appear to be caused by exogenous technical change in manufacturing, they can be traced back in fact to either trade liberalization or productivity advances in business services as production methods in this framework are endogenously chosen. Empirically, it may be difficult or impossible to disentangle the two.

Using this framework, we examine the impact of an increase in the productivity in the business services sector (due for instance to a decline in communication costs) as well as an increase in business opportunities (due for instance to trade liberalization), on production modes and labour demand. Both exogenous changes imply an enlarged market which either sustains more firms or longer production runs. An increase in the productivity of business services lowers the price of coordinating economic activities (although wages in the business services sector may rise) and thereby affects the equilibrium extent of fragmentation. Under fairly general assumptions, the relative demand for skilled workers in business services increases, as does the relative demand for employment in low-wage consumer services; employment of both types of workers in manufacturing declines. The impact of induced technical change on labour demand thus cuts across HOS-lines as both skilled and unskilled labour exit manufacturing. The model is also consistent with a number of other important empirical observations in major OECD-countries, such as the increase in intermediate-intensity of production, the growing fraction of globally sourced intermediates, and the fact that shifts in labour demand have occurred primarily within rather than between industries. In continental Europe with its rigid labour markets, this process is accompanied by unemployment, which under currently plausible parameter constellations is biased against the less-skilled but may also occur among skilled workers. Similarly, the model can be used for examining how integration and trade affect the mode of production, labour demand in various skill groups, and the sectoral distribution of employment.

mosaic of trader states already specialized to a large extent, and has been moving as fast as if not faster than in other trading blocks; the completion of the single market and the introduction of a common currency will only accelerate this trend. Expanding trade is the result not only of specialization and sharper division of labor in final goods production, but also of an increasing percentage of trade in intermediate inputs (OECD (1996a)).

At the same time, a marked increase in income inequality can be observed in the United States (see Levy and Murnane (1992)) while in Europe, high and rising unemployment has been the more pressing problem (Figure 1).

<Figure 1 >

Both phenomena have been increasingly attributed to the same cause, namely a decline in the relative demand for unskilled workers (Bertola/Ichino (1995a), Freeman (1995), Krugman (1995), Davis (1996), Blau/Kahn (1996), Nickell/Bell (1995, 1996)). The received wisdom is simple: whereas flexible wages led primarily to an adjustment of factor prices in the US, labor market rigidities in Europe prevented wages from falling, raising unemployment instead. Figure 2, which compares changes in wage dispersion and standardized unemployment in countries with available OECD data, lends support to this claim. Interestingly, the sole outlier from a remarkably tight relationship – Sweden – has joined the line in the aftermath of its crisis in the early 1990s, suggesting that its large state sector offers little protection from the risks of rigid labor markets.

(FPE) should occur among nonspecialized economies, so lower relative prices for goods with low skill content will induce lower wages for low-skilled labor (the Stolper-Samuelson Theorem), giving North-South trade a potential role in shaping the relative demand for skill groups. High unemployment in Europe has been blamed on virtually everything, so why not globalization and trade? In the popular press, this hypothesis has received considerable attention if not academic support (Forrester (1996)).

Yet the claim that Europe has suffered excessively from globalization is difficult to substantiate. Generally speaking, there is little decisive evidence which singles out trade as the main cause for labor market disruptions in OECD-countries. In the United States, the decline in demand for the less-skilled has motivated much research on the role of trade and openness in that development, especially since the mid-1980s.[1] The majority of studies from the perspective of both trade volumes[2] and prices have found

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[1]On methodological issues of various approaches see Deardorff/Hakura (1994), Lawrence (1994), Bhagwati/Dehejia (1994), and Freeman (1995).

[2]See Sachs/Shatz (1994) and Cooper (1994)); but also Wood (1994, 1995), Leamer (1994, 1996), and Saeger (1997). Borjas/Freeman/ Katz (1992) attribute the widening of the earnings distribution to the US trade deficit; Borjas/Ramey (1994a,b) blame the durable goods deficit. Sachs/Shatz (1996) see both technology and trade at work, although they find that the two are not easily disentangled. Employing a CGE HOS model, Minford et al. (1997) found that both trade and technology (technology spreading from North to South via FDI) have contributed roughly equally to the malaise of unskilled workers in the North.

More importantly, a key implication of HOS-theory has been falsified by the data. In a factor-proportions perspective of trade, increases in the global supply of unskilled labor should cause advanced economies to reduce the skilled-unskilled ratio in skill-intensive industries while at the same time shifting resources towards them. This predicted pattern of substitution stands in contrast to actual developments: in the United States, the ratio of unskilled to skilled labor fell in virtually *all* industries, despite declining relative wages. This and other evidence is now widely regarded as favoring the technology explanation of the immiseration of unskilled labor (Krugman/Lawrence (1993: 13); Berman et al. (1994); Topel (1997: 61)).

A number of important puzzles remain, however. First, invoking technical change contradicts the well-established trade-theoretic result that, at least in a small open economy, only sector bias should affect domestic factor prices, not factor bias *per se*.[4] Berman, et al. (1997) therefore stress *pervasive* skill biased technical change as the main reason for the shift in relative demand. Technical change, however, has little to

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[3]See especially Lawrence/Slaughter (1993), Sachs/Shatz (1994), and Lücke (1998). According to most studies, at best 10-20 percent of the actual widening of the earnings distribution in the US can be traced to HOS-driven trade with developing countries. See, for instance, Krugman/Lawrence (1993), and the surveys by Burtless (1995), Freeman (1995), Lawrence (1996), Gaston/Nelson (1997), and Slaughter/Swagel (1997). Freeman (1995) and Bhagwati/Dehejia (1994) have stressed that the HOS-framework rests on very restrictive assumptions, implying in particular that domestic labor market developments do not per se affect labor market outcomes.

[4]See Haskel/Slaughter (1998). On sector versus factor bias in open economies, see Berman/Bound/Griliches (1994), Krugman (1995), and Freeman/Katz (1995). Jones/Engerman (1996) have proposed alternative ways of reconciling theory and facts i.e. local factor bias affecting factor prices in an open economy.

computer programming, business and legal consultancy, and financial services. In addition, many studies take little account of consumer services, which have also expanded sharply and account for a large component of low-paid jobs in the US (Krugman/Lawrence 1993; Rowthorn/Ramaswamy 1997). How can the apparent employment shift in industrialized countries – especially those with flexible labor markets – from manufacturing to services and the distinctly bimodal distribution of employment growth within services occupations be explained with reference to globalization and/or technical change?

Third, there is considerable cross-country variance in unemployment and employment performance as well as in the evolution of industrial and occupational structure. Differences are particularly striking between the US and Europe, but there are also substantial differences among European countries. Despite being exposed to similar environments, a number of OECD countries have survived waves of technical change and globalization while maintaining low or stable unemployment rates (US, Japan, Canada). Others were able to lower their unemployment rates after implementing consequent reforms over longer periods of time (UK, Netherlands, New Zealand). Related to this is the question whether labor market outcomes can be traced

American and continental European experiences. Our model is consistent with a view of both trade *and* technology choice as endogenous in the light of deep changes in fundamentals of production methods and opportunities, namely costliness of and returns to depth in the value-added chain. While labor market disruptions appear caused by exogenous technical change, they in fact can be triggered either by trade liberalization or changes in the technology of doing business, as production methods in this framework are endogenously chosen.

Following Krugman (1995), Francois (1990a), Jones/Kierzkowski (1990, 1997) and Kierzkowski (1998), we stress the fragmentation or disintegration of production processes as a concomitant phenomenon of globalization. Larger markets imply longer production runs, which allow for a finer vertical division of labor and higher labor productivity at each step. We go further by explicitly modeling this disintegration process as an endogenous choice of cost-competitive firms in a general equilibrium model. The key feature of the model is that firms compete by investing in cost-reduction, which occurs by fragmenting production processes more extensively. The fragmentation may be associated with a wide range of phenomena: it can imply an increase in global sourcing, but also a generally higher intermediate intensity or a more extensive division of labor within a firm and as such is not necessarily restricted to multinational enterprises (MNEs). Changes in the "depth" of production patterns are in

towards services observed in almost all OECD-countries as well as the observed variance within the service sector, broadly defined. Domestic labor market institutions – and labor market rigidities in particular, taken as a catch-all for regulations and distortions – will play a key role in managing structural change associated with the globalization of production.

In order to focus on European trade, the paper intentionally ignores North-South (and HOS-) issues. In contrast to studies by Feenstra/Hanson (1996a,b) and Deardorff (1998) in which outsourcing and the international allocation of intermediates-production is driven by factor proportions or Ricardian differences, our model is couched in terms of a monopolistic competition, intraindustry trade framework. This is consistent with the fact that, especially in the European Union, trade and foreign direct investment are mostly intra- rather than interregional, suggesting that the internationalization of production and factor market consequences are less due to cross-country differences in factor proportions. By stressing the division of labor, our

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[5]In Jones/Kierzkowski (1990), as well as in Francois (1990a), production structures are driven by an assumed expansion of the scale of production (see also Stigler (1961), Ippolito (1977) and Leijonhufvud (1986) on the theory of the division of labor) while in our case the scale of production as well as the number of firms in the market are endogenously determined as opportunities and costs of doing business change. Francois (1990a) assumes a single, instantly adjusting labor market while in Francois (1990b) trade in producer services is the main focus. Markusen (1989) explores normative

opportunities and productivity of workers in business services determine the price for these services and therefore the equilibrium extent of fragmentation.

2. A Model of Cost Competition and Technological Choice under Monopolistic Competition[6]

2.1. Product Market Structure

Demand and Supply

The economy consists of three distinct sectors, which employ two primary factors plus an intermediate input to produce two types of final output. Consumer services y serve as the numeraire good, while a large number of differentiated varieties of manufactured goods x_i for i=1,...,n are available at price p_i. Sub-preferences of the representative consumer over manufactured goods are a standard Dixit-Stiglitz symmetric CES function, which is nested in turn in Cobb-Douglas utility with expenditure shares of μ and $(1-\mu)$ on manufactures and services respectively. Given income Y, utility maximization gives rise to the familiar demand functions

$$(1) \qquad x_i = \left(\sum_{j=1}^{n} p_j^{1-\eta} \right)^{-1} \mu Y p_i^{-\eta} \qquad \eta>1,$$

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issues of trade in producer services as intermediate inputs; Deardorff (1998) focuses more directly on the link between outsourcing and FPE.

[6] In what follows, we outline only key features of the model without presenting detailed derivations, and invite interested readers to consult a companion paper for more details (Burda/Dluhosch (1998)).

(2) $$y = (\alpha / w_L)^{\alpha/(1-\alpha)}.$$

A second sector uses skilled labor to produce business services, an intermediate input employed to manage vertically integrated firms in manufacturing. Business services are produced in quantity K and sold at price p_K by perfectly competitive firms, according to the production function $K = AH_S^{\beta}$, with $0<\beta<1$. The term A captures exogenous productivity of skilled workers in this sector. Labor demand by the producer services sector is $H_S = (\beta A p_K / w_H)^{1/(1-\beta)}$ where w_H denotes the wage in terms of consumer services, so the equilibrium supply of producer services is

(3) $$K = A^{1/(1-\beta)}(\beta p_K / w_H)^{\beta/(1-\beta)}.$$

Final manufactured output is supplied by n identical monopolistically competitive firms which have some influence over their own costs by choosing the number of stages or *nodes* of production, K. Since we allow for noninteger values, it is best to think of K as an index of "disembodiment" of production.[7] Each node is associated with fixed and variable costs of production as well as with "fragmentation" or "vertical disintegration" costs p_K incurred in establishing and maintaining a production structure

[7]Since our model applies largely to industry or economy-wide phenomena and not to the firm, ignoring the integer problem will not be an important issue here.

with $v'<0$, $v''>0$, and parametric fixed costs $\overline{F}$. In contrast to fixed costs, variable costs are assumed to be subadditive across production sites. This is consistent with Adam Smith's (1776) idea of "the extent of the market," that the degree of specialization can reduce variable costs associated with each stage of production. We assume a functional form which is iso-elastic in excess of a minimum level $\overline{K}: v(K) = \frac{\overline{v}}{(K-\overline{K})^{\gamma}}$, for $K > \overline{K}$, with $0<\gamma<1/(\eta-1)$. Total production costs are then given by $\overline{F} + \frac{\overline{v}}{(K-\overline{K})^{\gamma}} x + p_K K$, of which direct costs are $\overline{F} + \frac{\overline{v}}{(K-\overline{K})^{\gamma}} x$. The latter – while measured in terms of the numeraire – originate in factor payments to skilled labor H_P and unskilled labor L_P and are generated by the efficient use of a constant returns technology $f(H_p,L_p)$ which possesses the usual properties.[8]

Under these assumptions, profits of the representative firm i in manufacturing can be written as the difference between total revenues and total production costs:

$$p_i x_i - \left[\overline{F} + \frac{\overline{v}}{(K_i - \overline{K})^{\gamma}} x_i + p_K K_i \right] \tag{5}$$

[8]That is, f_H , f_L >0; f_{HH}, f_{LL} <0; f_{LH}>0. One way of thinking about this is to regard the cost input as being supplied by a perfectly competitive manpower industry to the manufacturing sector in the form of a composite of the two labor types at minimum cost conditions, given factor prices.

which can be combined with the demand function (1) above for each firm i to obtain the firm's optimum production depth, scale of output, and price as a function of $\bar{v}$, p_K, γ, $\overline{K}$ and η. Note that for sufficient scale of operation $x_i > p_K/(\gamma\bar{v})$, exceeding the minimum allowable production depth ($K_i > \overline{K}$) becomes a profitable option.

Product Market Equilibrium

Since firms produce their differentiated goods with identical technologies, it is expedient to proceed directly to market equilibrium. Manufactured goods enter utility symmetrically and are produced under identical cost conditions, so it must be the case that $p_i=p_j=p$ and $K_i=K_j=K$ for all i and j in {1,...,n}. It follows that

(8a) $$p = \left(\frac{\eta}{\eta-1}\right)^{1+\gamma}\left(\frac{p_K n}{\gamma\mu Y}\right)^{\gamma}\bar{v}$$

(8b) $$x = \left(\frac{(\eta-1)\mu Y}{\eta n}\right)^{1+\gamma}\left(\frac{\gamma}{p_K}\right)^{\gamma}/\bar{v}$$

(8c) $$K = \frac{(\eta-1)\gamma\mu Y}{\eta n p_K} + \overline{K}$$

Note that for positive product variety n, $\gamma<1/(\eta-1)$, which was assumed. Finally, (9) can be inserted into the equilibrium conditions (8) to obtain

(10a) $$p=\left(\frac{\eta}{\eta-1}\right)^{1+\gamma}\left(\frac{p_K[1-\gamma(\eta-1)]}{\gamma\eta(\overline{F}+p_K\overline{K})}\right)^{\gamma}\overline{v}$$

(10b) $$x=\left(\frac{(\overline{F}+p_K\overline{K})(\eta-1)}{[1-\gamma(\eta-1)]}\right)^{1+\gamma}\left(\frac{\gamma}{p_K}\right)^{\gamma}/\overline{v}$$

(10c) $$K=\frac{\overline{K}}{1-(\eta-1)\gamma}+\frac{(\eta-1)\gamma\overline{F}}{[1-(\eta-1)\gamma]p_K}$$

Note that while p_K has an unambiguously negative effect on K, the relation between p_K and x (the scale of operation for the representative firm) is ambiguous. This also applies to the equilibrium price of manufactures p. The ambiguity stems from the fixed node requirements of production and will in general depend on their importance in the total cost structure.

Equilibrium costs of disintegration are related to factors ranging from the institutional (e.g. non-tariff trade barriers, legal infrastructure), to the technological (costs of distance, i.e. of coordinating dispersed production in terms of quality, quantity, time and place; the communication costs associated with global sourcing

relations in x, p, K, n, p_K and Y. To close the model, the labor market is required. Its functioning will be essential in determining how an increase in the efficiency of skilled workers in business services can lead to fragmentation, changes in wages and employment of various skill groups, and the sectoral reallocation of the work force. Assuming perfect competition, it is relatively easy to illustrate this using a graphical apparatus, so we leave most formal details of the model for our companion paper (Burda/Dluhosch (1998)).

Labor is supplied inelastically to the market in its two forms, skilled (H) and unskilled (L). In both versions of the model, intersectoral mobility is assumed to be costless, so that the demand curve for each type of labor in each sector is the "supply price" to the other.[10] It follows that two equilibrium conditions are the equality of wage and value marginal product for both types of labor (measured in terms of consumer services):

$$\alpha L_S^{\alpha-1} = f_L(\overline{H} - H_S, \overline{L} - L_S) \tag{11}$$

$$p_K \beta A H_S^{\beta-1} = f_H(\overline{H} - H_S, \overline{L} - L_S). \tag{12}$$

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[9] Some of these channels have been stressed by Harris (1993, 1995), and more recently by Arndt (1996) and Dluhosch (1997). Becker/Murphy (1992) argue that coordination costs are more important than the size of the market.

$$(14) \qquad \frac{(\eta-1)\gamma\mu Y}{\eta} + np_K\overline{K} = (Ap_K)^{1/(1-\beta)}(f_H/\beta)^{-\beta/(1-\beta)}.$$

We now have a closed system consisting of eight equations in the eight unknowns x, p, K, n, p_K, Y, H_S, and L_S.

We will focus on a graphical representation of the model and will consider two polar cases for labor markets. The first case -- in the spirit of the traditional trade literature -- assumes labor market-clearing; the other assumes wage rigidity, at least in the market for unskilled and possibly also for skilled workers. Real wage rigidity is a stand-in for a host of labor market impediments known to characterize continental European labor markets cited in, for example, the OECD Jobs Study (OECD (1994)). Wage rigidity may exist because of explicit arrangements (legislated minimum wages, binding collective bargaining arrangements) or implicit lower bounds on wages (social safety net, poor supervision of unemployment benefit recipients, generous benefits).

Equilibria in the two cases are depicted in Figures 3 and 4. In the first panel of each figure, unskilled labor is allocated between manufacturing and consumer services; the thin two curves depict value marginal product in the respective sectors (measured in terms of consumer services, the numeraire). The second panel depicts the labor

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[10]For examples of models which consider mobility costs between sectors, see Bertola/Ichino (1995b) and Bertola (1998).

or outsourcing technology related, for instance, to declining communication costs documented in Baldwin/Martin (1999). In the first instance, an increase in A shifts out the curve MPL_H in the respective figures. In the case of clearing labor markets, the consequences can be summarized as follows: an increase in high-wage employment in the production services sector; an increase in employment in low-wage consumer services, and a shrinkage of employment of both types of labor in manufacturing. In the standard case, an increase in A induces an equilibrium decline in p_K and an outward shift of labor demand in the business services sector (the thicker curves in Figures 3 and 4). This raises K at given income; at the same time, however, value added in terms of nontraded consumer services declines. The effect on value added in manufacturing, including the number of products, is ambiguous.

<Figure 3>

The effect of labor market rigidities is illustrated in the panels of Figure 4. With a constant wage floor, the decline of demand in manufacturing for unskilled labor is compounded by the failure of wages to decline. Complementarity in production between H and L leads to a further decline in the demand for skilled labor; in the end, rigidities tend to accelerate the contraction of the manufacturing sector. If the elasticity

manufacturing output can be associated with generalized layoffs and restructuring which cut across HOS lines, as layers of both white and blue collar workers are displaced. There is thus no general presumption for patterns of skilled and unskilled unemployment; situations might arise in which both skill groups are suffering from unemployment as in Figure 4 (see Nickell/Bell (1995) for evidence on this). However, for currently plausible parameter constellations, changes in technology are associated with a bias of globalization in favor of the skilled.

2.3. Trade and Globalization

Horizontal and Vertical Globalization

How can the model be used to think about international trade? Our framework is somewhat special in that it *only* admits intraindustry trade; it is explicitly rigged to produce answers that are not related to the factor proportions model. Trade in conventional models with differentiated goods can be used to think about the effect of opening up closed economies of similar development to trade (e.g. Brander (1981), Krugman (1980, 1981)). Since Dixit-Stiglitz preferences presume a boundless appetite for variety, the number of available goods will increase. Yet the striking fact about globalization noted in Section 1 is the dramatic increase in trade in intermediate inputs and the disintegration of the value-added process, associated with "global sourcing" (Campa/Goldberg (1997)).

higher volumes to economize on variable costs by investing in production sites; in equilibrium the effect on n is indeterminate. In our framework, *vertical globalization* will reflect the process by which the disintegration of production occurs across international boundaries.

Trade between two countries of comparable industrialization is related to the structure of production in two ways. First, an enlarged market for a given country, *ceteris paribus*, induces an increase in the depth of production processes. In this sense, trade drives an endogenous evolution of technology. Second, an exogenous development (i.e. an increase in A) could also spur increased disintegration of production (more production nodes and outsourcing) and more trade in intermediate output. If the assumed increase in A occurs globally rather than locally, a factor bias associated with the reorganization of production can affect the distribution of factor incomes in an open economy just as in the closed economy. From this perspective, international trade occurs to optimize production of a given output line, i.e. holding final goods export and import patterns constant. In this sense technology drives trade.

the production factors of a neighboring region as a proportional and exogenous expansion of the home market.[12] Due to decreasing returns in services (as opposed to the production activities of the manufacturing sector), this distinction will be of importance. In the case of simple opening up of identical nations with identical products starting from equilibrium, labor demand will remain unchanged, as there is no reason for new entry or increased scale of operations. More interesting is the imperialistic variant, depicted in Figures 5 and 6. Here, new markets generate demand which is partially met from existing capacities (for simplicity, Figure 6 assumes full employment at the outset). Constant returns in manufactured goods implies that all new labor could be absorbed at given wages; yet the increased demand for services and market clearing requires lower real wages and productivity, and higher prices in equilibrium. In the end this may or may not lead to increased dispersion of income (it will depend on the slopes of the curves) as is the case with unemployment when labor markets are rigid.

<Figures 5, 6>

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[11] For a formal derivation similar to that in the Appendix, see Burda and Dluhosch (1998).

[12] The model could also be extended in a straightforward way to include a North-South dimension. In particular, outsourcing could occur in either advanced (North) or industrializing (South) countries, at two distinct relative prices p_K^N and p_K^S. A plausible assumption is that prices in less developed countries will tend to be high, due to poor education and technological infrastructure; in recent years the development of these countries has been associated with dramatic improvements however. In our framework, an exogenous rise in A^S generates a decline in p_K^S/p_K^N and an increase in K^S. For plausible parameter assumptions, the impact would be an increase in value-added generated in these countries and an increase in intermediate trade.

respectively, Rowthorn/Ramaswamy (1997, Table 2); see also OECD (1996b)).

Second, it is capable of tracking the bifurcation in employment growth within services: especially in the US (but less so in Europe) employment growth in services has been strongest at the upper (business and professional services) and the lower end (retail trade, personal services) of the income distribution (Freeman (1997)). Table 1 confirms this pattern for all countries examined, but it is also evident that the two countries with deregulated labor markets – the US but also the Netherlands – are way out in front.

<Table 1>

Third, our model suggests that the share of purchased intermediates (proxied by K) in total output should increase (or the ratio of value added to gross output should decline) due to improvements in communication, coordination, consulting, etc. Indeed, since the 1970s all major developed countries (except Japan) have witnessed a decline in the ratio of value added to production in most industries with an increasing fraction internationally sourced. Studies by Campa/Goldberg (1997), Hummels/Rapoport/Yi (1997) and Ishii/Yi (1997) document a substantial expansion of outsourcing and

throughout the early 1970s to early 1990s.[14] OECD (1996a) input-output data document that for pharmaceutical products, computers and automobiles in particular, the ratio of value added to gross output has declined and the fraction of inputs purchased internationally has risen since the 1970s. Although data is incomplete,[15] there is evidence that many industries underwent structural change of this type. The decline in the ratio of value added to production and the rise in global sourcing suggests that the deepening of integration was accompanied by reconfiguration of production modes. Our model is also consistent with findings of Cortes/Jean (1997), who relate higher import penetration rates in a given industry to higher skilled/unskilled employment ratios and faster labor productivity growth, and empirical work by Feenstra/Hanson (1996a,b) and Sachs/Shatz (1996) suggesting that outsourcing broadly defined has contributed to an increase in relative demand for skilled labor.[16]

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[13]Ishii/Yi (1997) and Hummels, et al. (1997) use a more narrow measure to document the vertical trade which involves sequences of different countries and also find an increase in their sample. Kol/Rayment (1990) and Irwin (1996) also find a substantial increase in the slicing of the value added chain since the 1980s by proxying trade related to intermediates or vertical specialization by that in capital goods.

[14]Campa/Goldberg (1997) employ input-output data of a single year as a benchmark (i.e. keeping structure of production constant) while measuring the evolution of import penetration in intermediates.

[15]Most of the studies consider country-specific evidence with reference to particular industries. Naturally, case studies must be interpreted with caution as trade policy (local content etc.) and other regulations can have a distortionary impact on modes of production and the vertical division of labor. In addition disaggregated data is usually in nominal terms.

[16] Their definition of outsourcing is intermediate imports as a share of total purchase of non-energy materials, in contrast to Lawrence (1994) and Slaughter (1995) et al., who only focus on purchases by

in business services (A) or increasing trade is consistent with within-industry labor demand shifts.[18]

To study shifts in labor demand in European industries, we examine 1-digit sectoral data reported by the International Labor Organization (ILO) using somewhat finer occupational categories than those reported in Table 1. Let θ_{ij} denote the share of workers in industry i, L_i, who belong to occupation j. Thus $\theta_{ij} = L_{ij}/\Sigma_j L_{ij}$ and the aggregate share of workers in occupation j is $\theta_j = \Sigma_i s_i \theta_{ij}$, where s_i denotes the employment share of industry i in the national total. A shift-share decomposition of the changing aggregate proportion of workers in an arbitrary occupational category j in employment is given by:

$$\Delta\theta_j = \Sigma_i \bar{\theta}_{ij} \Delta s_i + \Sigma_i \bar{s}_i \Delta\theta_{ij} \tag{15}$$

---

multinational corporations from foreign subsidiaries and who did not find much of an impact on the skill ratio of labor demand. Note that our model also lends itself to a more general interpretation of outsourcing. In our model, fragmentation of production can involve any kind of reorganization increasing the number of production steps.

[17]According to their studies, employment in production workers in US manufacturing (considered unskilled) declined by 15 percent between 1979 and 1989, while non-production employment rose by 3 percent.

[18]This is also in line with Lücke (1998) who finds evidence of changes in labor demand due to labor-saving technical change based on value-added price data of manufacturing industries in 11 OECD countries. However, Doms/Dunne/Troske 1997 find that with the exception of computation, the skill-level of firms' workforces has not increased with the adoption of new technologies.

meaning that reallocation has occurred primarily across industries.

<Table 2>

The table shows that the evolution is not as uniform over time or occupation groups as described by Berman et al. (1997) for the United States, but certainly consistent with the hypothesis that within-industry shifts towards skilled labor (here categories "professional, technical and related workers" and "administrative and managerial workers", but not "clerical and related workers") have accelerated in these countries. In the United States these shifts have been most pronounced, and, absent labor market rigidities, this is what one would expect. The similarly impressive Dutch experience is consistent with the general success of their recent labor market reforms.

4. Conclusions

Trade and technology are generally seen as competing explanations of labor market distress in OECD countries and especially in Europe. In our view, both could be part and parcel of the same phenomenon: trade and skill-biased technical change need not be mutually exclusive causes of labor market disruption, but are both symptomatic of fundamental underlying changes in the way firms conduct business. Consequently, it may be difficult if not impossible to disentangle the two effects empirically. While other researchers have also made this point, we are not aware of models which explicitly endogenize technology implementation in response to changes

most European countries. The distinction applies not only to Europe vis-à-vis the US, but also within Europe, where the dividing line appears to be the degree of labor market flexibility.

The trade-off between rising inequality (or more generally lower average real wages) and unemployment emerging from our analysis holds everything else constant, however. There are a number of policy measures which can soften the impact of globalization on income distribution. Deregulation of consumer services is one example. With higher productivity, this sector could absorb former production workers and, vitiate the tendency towards increasing income inequality, since wages in consumer services would tend to rise in flexible labor markets. Other longer term supply-side measures include the upgrading of the labor force skills, in particular as producer services become increasingly tradeable, and the reduction of the costs of intersectoral mobility which also contribute to laggard structural adjustment.

(10a-10c) in the main text.

The model can be simplified to three equations in three unknowns after substituting for n from (9) and eliminating Y:

(A1) $$\alpha L_S^{(\alpha-1)} = f_L(\overline{H} - H_S, \overline{L} - L_S) .$$

(A2) $$p_K \beta A H_S^{\beta-1} = f_H(\overline{H} - H_S, \overline{L} - L_S) .$$

(A3) $$\frac{(\eta-1)\gamma\overline{F} + p_K\overline{K}}{\left(\frac{\eta}{(\eta-1)} - \gamma\right)\overline{F} + p_K\overline{K}} = (Ap_K)^{\frac{1}{1-\beta}}\left(\frac{f_H}{\beta}\right)^{\frac{-\beta}{1-\beta}}(\eta-1)/f$$

where the expression on the left-hand side is strictly smaller than unity. Logarithmic differentiation and setting $\hat{\overline{H}} = \hat{\overline{L}} = 0$ yields the following system of three equations in $\hat{p}_K$, $\hat{H}_S$, and $\hat{L}_S$ (hat denotes percentage change):

(A4) $$\hat{L}_S = \frac{\sigma s_{HP}\rho_H \hat{H}_S}{1-\alpha+\sigma s_{HP}\rho_L}$$

(A5) $$\hat{A} = -p_K + (1-\beta+\sigma s_{LP}\rho_H)\hat{H}_S - \sigma s_{LP}\rho_L \hat{L}_S$$

(A6) $$\hat{A} = -[Z(1-\beta)+1]\hat{p}_K - [(1-\beta)s_{HP} - \beta\sigma s_{LP}]\rho_H \hat{H}_S - (1-\beta+\sigma\beta)s_{LP}\rho_L \hat{L}_S$$

where σ is the (local) elasticity of substitution in f (in direct production of manufactures), ρ_H (ρ_L) is the ratio of high (low) skilled workers employed in services

(A6)
$$\begin{bmatrix} -[Z(1-\beta)+1] & \beta\sigma s_{LP}\rho_H(1-\alpha)-s_{HP}\rho_H(1-\beta)(1-\alpha+\sigma\rho_L) \\ -1 & (1-\beta)(1-\alpha+\sigma s_{HP}\rho_L)+(1-\alpha)\sigma s_{LP}\rho_H \end{bmatrix} \begin{bmatrix} p_K \\ \hat{H}_S \end{bmatrix} = \begin{bmatrix} \hat{A} \\ \hat{A} \end{bmatrix}$$

which can be solved for $\hat{H}_S$ using Cramer's Rule:

(A7)

$$\hat{H}_S = \frac{-Z(1-\beta)}{\beta\sigma s_{LP}\rho_H(1-\alpha)-s_{HP}\rho_H(1-\beta)(1-\alpha+\sigma\rho_L)-[Z(1-\beta)+1][(1-\beta)(1-\alpha+\sigma s_{HP}\rho_L)+(1-\alpha)\sigma s_{LP}\rho_H]}\hat{A}$$

Sufficient (but not necessary) conditions for $\hat{A}$ and $\hat{H}_S$ to have the same sign (i.e. so that increases in the productivity of skilled workers in business services increases that sector's employment in general equilibrium) are

(A8) $$-Z(1-\beta)>1$$

and

(A9) $$\sigma > \frac{s_{HP}(1-\beta)(1-\alpha)}{s_{LP}\beta(1-\alpha)-(1-s_{LP})(1-\beta)\rho_L} = \frac{1}{\frac{s_{LP}\beta}{s_{HP}(1-\beta)}-\frac{\rho_L}{(1-\alpha)}}$$

The intuition for the latter condition is that the elasticity of substitution in direct manufactures production must be sufficiently high, so that an increase in the high-skilled wage does not release too much low-skilled employment in manufacturing to

production is to constant returns in service sectors), and the smaller is the share of value added of skilled workers s_{HP}. For sufficiently large values of ρ_L (the proportion of low-skilled workers already in services) the condition will always obtain, since σ is positive.

Bertola, G. (1998). Labor Demand, Institutions and Tenure Length. Presented at the LSE conference "Job Tenure and Labour Reallocation" mimeo, April 1998.

Bertola, G. and A. Ichino (1995a). Wage Inequality and Unemployment: United States vs. Europe. NBER Macroeconomics Annual, Cambridge: MIT, 13-53.

Bertola, G. and A. Ichino (1995b). Crossing the River A Comparative Perspective on Italian Employment Dynamics. *Economic Policy* 21:359-420.

Bhagwati, J. and V. Dehejia (1994). Free Trade and Wages of the Unskilled: Is Marx Striking Again? In *Trade and Wages*, ed. by J. Bhagwati and M. Kosters, Washington, D.C.: AEI, 36-75.

Blau, F.D. and L.M. Kahn (1996). International Differences in Male Wage Inequality: Institutions versus Market Forces. *Journal of Political Economy* 104:791-837.

Borjas, G.J. and V.A. Ramey (1994a). Time Series Evidence on the Sources of Trends in Wage Inequality. *American Economic Review* (PP) 84:10-16.

Borjas, G.J. and V.A. Ramey (1994b). The Relationship between Wage Inequality and International Trade. In *The Changing Distribution of Income in an Open U.S. Economy*, ed. by J.H. Bergstrand et al., Amsterdam: Elsevier, 217-41.

Borjas, G., R. Freeman and L. Katz (1992). On the Labor Market Effects of Immigration and Trade. In *Immigration and the Work Force*, ed. by G. Borjas and R. Freeman, Chicago: University of Chicago Press and NBER, 213-44.

Brander, J. (1981). Intra-Industry Trade in Identical Commodities. *Journal of International Economics* 11:1-14.

Burda, M.C. and B. Dluhosch (1998). Cost Competition, Fragmentation and Globalization. Mimeo, July.

Burtless, G. (1995). International Trade and the Rise in Earnings Inequality. *Journal of Economic Literature* 33: 800-816.

Campa, J. and L.S. Goldberg (1997). The Evolving External Orientation of Manufacturing: A Profile of Four Countries. *FRBNY Economic Policy Review*, 53-81.

Cooper, R. (1994). Foreign Trade, Wages, and Unemployment. In H. Giersch (ed.), *Fighting Europe's Unemployment in the 1990s,* Berlin: Springer, 93-117.

Cortes, O. and S. Jean (1997). International Trade Spurs Productivity. Paper presented at the 1997 EEA Annual Meeting in Toulouse.

Davis, D.R. (1996). Technology, Unemployment, and Relative Wages in a Global Economy. *NBER Working Paper* 5636.

Deardorff, A.V. (1997). Factor Prices and the Factor Content of Trade Revisited: What's the Use? Manuscript: University of Michigan.

Deardorff, A.V. (1998). Fragmentation in Simple Trade Models. Paper presented at the 1998 Meeting of the North American Economics and Finance Association.

Deardorff, A.V. and R. Staiger (1988). An Interpretation of the Factor Content of Trade. *Journal of International Economics* 24:93-107.

Deardorff, A.V. and D.S. Hakura (1994). Trade and Wages -- What are the Questions? In *Trade and Wages: Leveling Wages Down?*, ed. by J. Bhagwati and M.H. Kosters, Washington, D.C.: AEI Press, 76-107.

Dluhosch, B. (1997). Trade Liberalization, Technological Change, and the Economics of Outsourcing. Mimeo: Cologne.

Doms, M., T. Dunne, and K.R. Troske (1997). Workers, Wages, and Technology. *Quarterly Journal of Economics*, 253-90.

Ethier, W. (1982). National and International Returns to Scale in the Modern Theory of International Trade. *American Economic Review* 72:389-405.

Feenstra, R.C. and G.H. Hanson (1996a). Globalization, Outsourcing, and Wage Inequality. *American Economic Review Papers and Proceedings* 86:240-45.

Competition. *Canadian Journal of Economics* 23:109-124.
Freeman, R.B. (1995). Are Your Wages Set in Beijing? *Journal of Economic Perspectives* 9:15-32.
Freeman, R.B. (1997). Low Wage Employment: Is More or Less Better? Manuscript: Harvard, NBER and CEP.
Freeman, R.B. and L.F. Katz eds. (1995). *Differences and Changes in Wage Structures.* Chicago: University of Chicago.
Gaston, N. and D. Nelson (1997). Globalisation and Wages in OECD Economies: Linking Theory with Evidence. Paper prepared for OECD/CEPR-Symposium on Globalisation and Employment Patterns, Gold Coast & New Orleans.
Harris, R.G. (1993). Globalization, Trade, and Income. *Canadian Journal of Economics* 26:755-76.
Harris, R.G. (1995). Trade and Communications Costs. *Canadian Journal of Economics* 28, Special Issue, November, 46-75.
Haskel, J.and M.J. Slaughter (1998). Does the Sector Bias of Skill-Biased Technical Change Explain Changing Wage Inequality? Mimeo.
Hummels, D., D. Rapoport and K.-M. Yi (1997). Globalization and the Changing Nature of World Trade. Mimeo: FRBNY.
Ippolito, R.A. (1977). The Division of Labor in the Firm. *Economic Inquiry* 15:469-92.
Irwin, D.A. (1996). The United States in a New Global Economy? A Century's Perspective. *American Economic Review* 86:41-46.
Ishii, J. and K.-M. Yi (1997). The Growth of World Trade. Manuscript: FRBNY.
Jones, R.W. and S.L. Engerman (1996). Trade, Technology, and Wages: A Tale of Two Countries. *American Economic Review* (PP) 86:35-40.
Jones, R.W. and H. Kierzkoswki (1990). The Role of Services in Production and International Trade: A Theoretical Framework. In *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*, ed. by R.W. Jones and A.O. Krueger, Cambridge and Oxford: Basil Blackwell, 31-48.
Jones, R.W. and H. Kierzkowski (1997). Globalization and the Consequences of International Fragmentation. Paper prepared for the Festschrift in Honor of Robert A. Mundell, Washington, D.C.: The World Bank MC12-121.
Kierzkowski, H. (1998). Trade Restructuring and Globalization: New Challenges for the Transition Economies. Report prepared for the WTO, Geneva.
Kol, J. and P. Rayment (1990). Allyn Young Specialization and Intermediate Goods in Intra-Industry Trade. In *Intra-Industry Trade: Theory, Evidence, and Extensions*, ed. by P.K.M. Tharakan and J. Kol, London: Macmillan, 51-68.
Krugman, P. (1980). Scale Economies, Product Differentiation and the Pattern of Trade. *American Economic Review* 70:950-59.
Krugman, P. (1981) Intraindustry Specialization and the Gains from Trade. *Journal of Political Economy* 98:959-973.
Krugman, P. (1995). Growing World Trade: Causes and Consequences. *Brookings Papers on Economic Activity* 327-77.
Krugman, P. and R. Lawrence (1993). Trade, Jobs, and Wages. *NBER Working Paper* 4478.
Lawrence, R.Z. and M.J. Slaughter (1993). International Trade and American Wages in the 1980's: Giant Sucking Sound or Small Hiccup? *Brookings Papers on Economic Activity* (Microeconomics) 161-210.
Lawrence, R.Z. (1994). Trade, Multinationals, and Labor. *NBER Working Paper* 4836.
Lawrence, R.Z. (1996). *Single World, Divided Nations? International Trade and OECD Labor Markets*, Washington, D.C.: Brookings Institution Press/Paris: OECD Development Centre.
Leamer, E.E. (1994). Trade, Wages, and Revolving-Door Ideas. *NBER Working Paper* 4716.
Leamer, E.E. (1996). In Search of Stolper-Samuelson Effects on U.S. Wages. *NBER Working Paper* 5427.
Leijonhufvud, A. (1986). Capitalism and the Factory System. In *Economics as a Process: Essays in the New Institutional Economics*, ed. by R.N. Langlois, Cambridge: Cambridge University Press, 203-23.
Levy, F. and R.J. Murnane (1992). U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations. *Journal of Economic Literature* 30:1333-81.

Rowthorn, R. and R. Ramaswamy (1997). Deindustrialization: Causes and Implications. *IMF WP/97/42.*
Sachs, J. and H.J. Shatz (1994). Trade and Jobs in U.S. Manufacturing. *Brookings Papers on Economic Activity* 1:1-69.
Sachs, J. and H.J. Shatz (1996). U.S. Trade with Developing Countries and Wage Inequality. *American Economic Review* (PP) 86:234-39.
Saeger, S.S. (1997). Globalization and Deindustrialization: Myth and Reality in the OECD. *Weltwirtschaftliches Archiv* 133:549-608.
Slaughter, M.J. (1995). Multinational Corporations, Outsourcing, and American Wage Divergence. *NBER Working Paper* 5253.
Slaughter, M.J. and P. Swagel (1997). The Effect of Globalization on Wages in the Advanced Economies. *IMF WP/97/43.*
Smith, A. (1776). *An Inquiry into the Nature and the Causes of the Wealth of Nations*. ed. by R.H. Campbell and A.S. Skinner (1976), Oxford: Clarendon Press.
Stigler, G.J. (1951). The Division of Labor is Limited by the Extent of the Market. *Journal of Political Economy* IX:185-202.
Topel, R.H. (1997). Factor Proportions and Relative Wages: The Supply-Side Determinants of Wage Inequality. *Journal of Economic Perspectives* 11:55-74.
Wood, A. (1994). *North-South Trade, Employment and Inequality*. Oxford: Oxford University Press.
Wood, A. (1995). How Trade Hurt Unskilled Workers. *Journal of Economic Perspectives* 11:57-80.

United States (1979-94)	0,79	0,63	0,27	-0,05	1,83
Netherlands (1979-94)	1,14	0,56	0,37	-0,18	2,31
Germany (1979-89)	0,39	0,22	0,06	-0,22	0,48
Sweden (1980-94)	0,29	0,28	-0,32	-0,61	-0,52
Denmark (1980-94)	0,48	0,24	-0,04	-0,31	0,58

[a]Professional workers are defined as professional, technical and related workers; managerial workers are defined as managerial and administrative workers

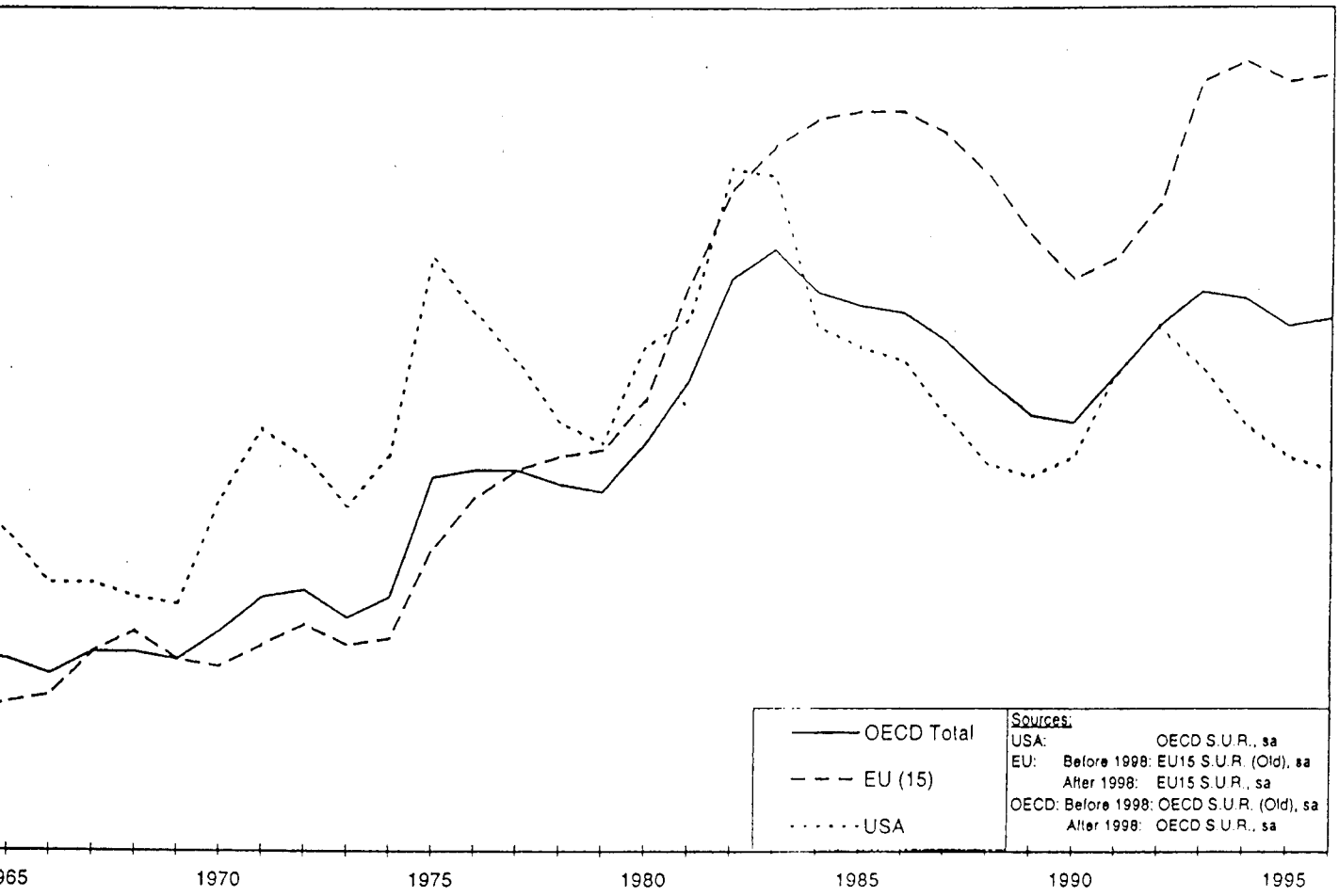
[b]Production workers are defined as production and related workers, transport equipment operators and laborers.

Source: ILO Yearbooks, various issues.

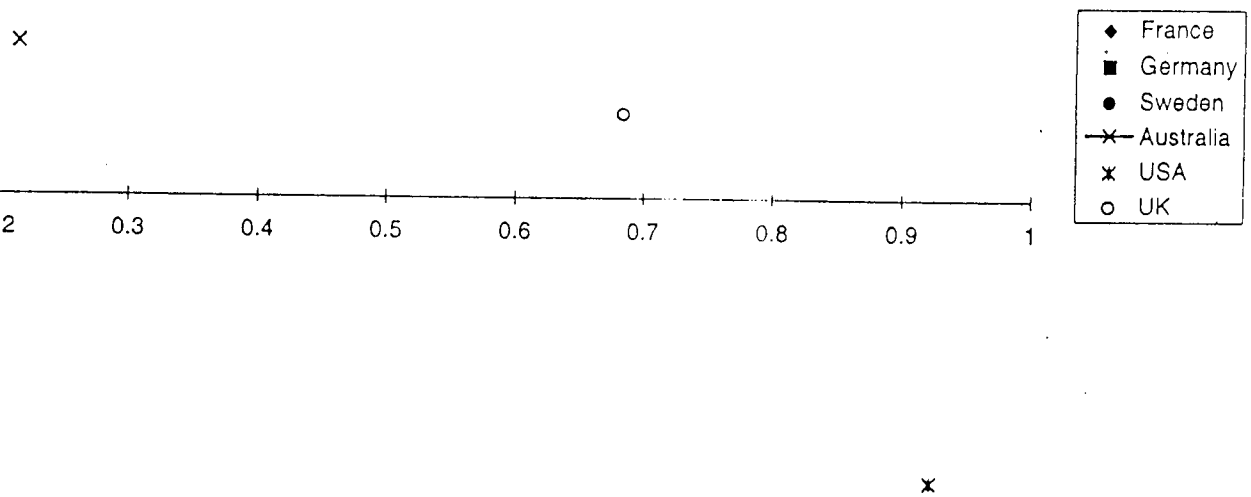
1979-94							
Between	3,05	-0,11	2,19	0,99	2,03	-6,38	-1,77
Within	2,40	1,93	-2,42	-1,05	-0,35	-4,86	4,35
Germany (West)							
1979-91							
Between	1,13	0,14	1,53	0,50	1,08	-2,41	-1,96
Within	2,20	0,09	-0,20	-0,12	-0,89	-2,50	1,42
Sweden							
1980-94							
Between	2,61	0,16	1,24	0,26	1,90	-4,24	-1,93
Within	5,87	-2,31	2,87	1,14	-4,78	-2,69	-0,11
Denmark							
1984-93							
Between	-0,21	0,14	1,10	0,19	-0,05	-0,09	-1,08
Within	3,02	1,49	-1,32	1,77	-1,63	-6,14	2,80

Source: ILO Yearbooks and authors' computations.

ardized Unemployment Rates, 1960 - 1996



rnings Dispersion and Unemployment in the 1980s



Change in Earnings Dispersion (D9/D1) from 1980 to 1990
979-1989, Sweden: Earnings Dispersion from 1981-1991

(OECD 1994)

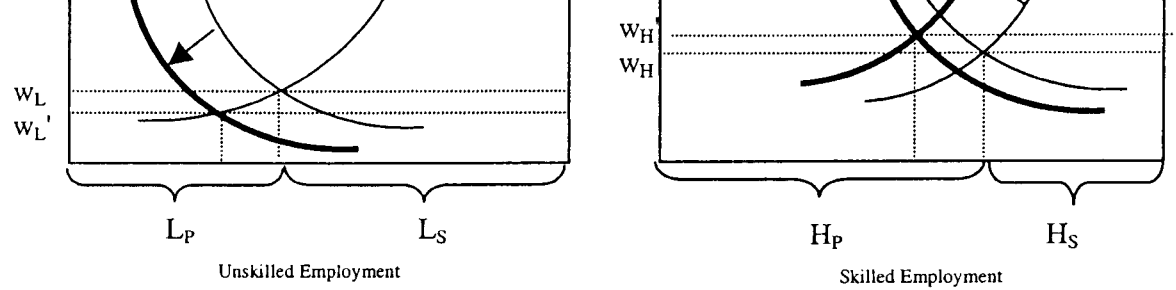
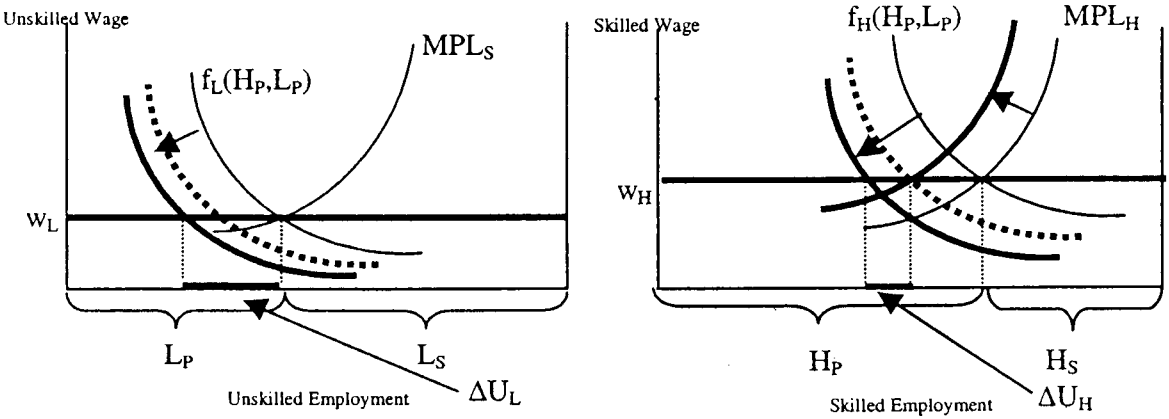


Figure 4. The effects of an increase in *A* when wages are rigid



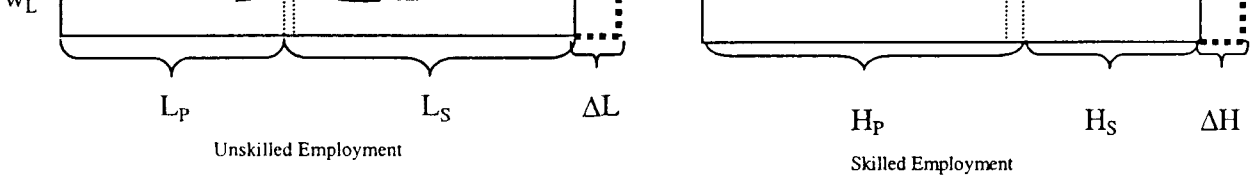


Figure 6. The effects of an equiproportional increase in $\bar{H}$ and $\bar{L}$ when wages are rigid