12. Modelling the link between skill biases in technical change and wage divergence through labour market extensions of Krugman's North–South model

Adriaan van Zon, Mark Sanders and Joan Muysken

1. INTRODUCTION

A growing problem in the OECD area over the recent past has been the position of low-skilled workers relative to their high-skilled counterparts. The employment and income perspectives of the former have deteriorated significantly over the past two decades owing to a drop in the relative demand for their services. Economic theory has tried to come to grips with the empirical observation that the effects of this drop in low-skilled labour demand differ widely between Europe and the USA. In fact, there are two distinct empirical observations which led us to the problem we wish to address in this chapter. First of all, the OECD (1994) and several independent academic researchers (Brauer and Hickok, 1995) have observed that in the Anglo-Saxon parts of the world wages for low-skilled workers have deteriorated in relative but in some cases even in absolute terms.

To explain this phenomenon economists have formed two hypotheses. The first attributes the effect to the factor price equalizing effects of increased trade with low-wage countries (Leamer, 1994, 1995; Burtless, 1994; Lawrence and Slaughter, 1993). The second hypothesis emphasizes the possibility of technological change causing a divergence between the productivity of high- and low-skilled workers and thus causing a drop in relative demand for low-skilled labour, together with wage divergence in line with productivity. Some notable references are Krugman (1995), Jackman (1995), Howell (1995) and Agenor and Aizenman (1996). The OECD (1994), however, emphasizes that this relative wage deterioration for the low-skilled is almost absent in
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continental Europe, although Europe and the USA have been exposed to roughly similar trade and technology circumstances over the past decades.

In Europe, therefore, the drop in demand must have a different cause. Some European writers (Drèze and Malinvaud, 1993; Groot and Maassen van de Brink, 1996; Laun, 1996; Beer, 1996) have suggested the crowding-out hypothesis, which claims that low-skilled workers are 'pushed' out of their jobs by their high-skilled colleagues. This hypothesis rests on the assumption that asymmetries in employment opportunities exist between skills, and it explains the observed deterioration in employment and unemployment rates in Europe (OECD, 1994). The latter are remarkably stable over time in the USA, Canada and Australia, although the assumed asymmetries in employment opportunities should also exist in these countries. We conclude, therefore, that the similarities between the technology and trade circumstances seem to contradict the disparity between the experience of Europe and the USA with regard to wage divergence and changing employment perspectives. The challenge then is to formulate a model which is able to cope with this apparent contradiction.

In this chapter we will present a model based on Krugman's North–South model (Krugman, 1979), that generates two distinct labour market regimes, each of them supporting one of the two broad classes of empirical observations described above. We show that countries with identical production structures and identical employment opportunity asymmetries, but (slightly) different attitudes with respect to innovative activity and labour market flexibility, may find themselves in, or moving towards, either a wage divergence regime, or a stable relative wage-cum-crowding-out regime, depending on the nature of the attitudes and the initial conditions. In constructing the model, we start from the stylized fact that employment opportunities for high- and low-skilled people are asymmetric: high-skilled people generally can execute the tasks which low-skilled people perform, but this is not necessarily the case the other way around. Moreover, if the production of new goods and services is high-skill biased, at least in the initial stages of production, we can imagine a situation where innovative activity makes high-skill people more scarce, while making low-skilled workers relatively less scarce at the same time (after all, product innovation means finding new products rather than old ones). In short, the process of product innovation aggravates the fundamental asymmetry between low- and high-skilled workers’ employment opportunities mentioned above through impulses from the demand side. Given these employment asymmetries, we are able to show that wage divergence and crowding-out are two ‘natural’ states of the model.

In the debate on the causes of asymmetries in employment in Europe, however, economists seem to have a tendency to put the blame on the existence of price rigidities and distortions in the European labour markets. It is
commonplace to argue for more flexible labour market institutions and to call in the help of market forces to equilibrate supply and demand. In our model a lack of labour market flexibility may indeed cause Europe and the USA to converge upon different types of equilibria explaining the divergence between Europe and the USA with respect to wages and employment by skill, but it is not clear that the suggested remedies actually help us very much.

The outline of the rest of the chapter is as follows. Section 2 will be devoted to a description of the Krugman (1979) model. In section 3 we add our labour market extensions, as well as a 'reduced-form endogenization' of technical change. Section 4 discusses the conditional predictions of the model regarding various possible regimes of wage divergence, while section 5 contains some concluding remarks.

2. THE KRUGMAN NORTH–SOUTH MODEL

Krugman assumes two countries, North and South, which differ from each other in the sense that North can produce new goods after inventing them, while South can produce those goods only after North has invented them. North therefore innovates, while South imitates: there is an intrinsic asymmetry in time in North's and South's technological capabilities.

The Demand for Goods

The Krugman model assumes that consumers show 'love of variety'; that is, a good being different from other goods already available will always contribute in a positive way to utility. Krugman simplifies this notion by assuming a symmetric additively separable utility function of the form:

\[ U = \int_0^n c_i^\alpha \, di \]  

(12.1)

where \( U \) represents total utility, and \( 0 - n \) is the 'width' of the continuous range of varieties produced and consumed; \( c_i \) is the level of consumption of variety \( i \); \( \alpha \) is a constant parameter which is positive and smaller than one. Note that the utility function is completely symmetric in the consumption of every single variety. Moreover, it is concave in the consumption of the varieties. If, as is the case in the Krugman model, prices of all varieties would be the same, the concavity in combination with the symmetry of the utility function ensures that utility would be maximized by distributing the total consumption budget evenly over all varieties. This follows directly from the first-order condition with regard to utility maximization:
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\[
\frac{c_i}{c_j} = \left( \frac{p_i}{p_j} \right)^{\frac{1}{1-\alpha}}
\]  

(12.2)

for all \(0 \leq i, j \leq n\). Equation (12.2) describes the relative demand for each variety, which depends negatively on the corresponding relative price.

The Supply of Goods

Each variety is produced in a situation of profit maximization under imperfect competition on the product markets (varieties are heterogeneous by assumption) and perfect competition on the labour market. Labour is the only factor of production distinguished in the model. The production functions for each variety are identical and linear homogeneous, which implies:

\[
\frac{x_i}{x_j} = \frac{l_i}{l_j}
\]

(12.3)

for all \(0 \leq i, j \leq n\), and where \(x_i\) represents the level of supply of variety \(i\), while \(l_i\) denotes the amount of labour used in sector \(i\). With perfect mobility between sectors (each sector produces one variety), labour would earn the same wage everywhere, and, with labour productivity set equal to one for all varieties, profit maximization would ensure that the prices of all varieties would be strictly proportional to the common wage rate (this follows from Amoroso–Robinson, which applies in the case of imperfect competition on the goods market):

\[
\Pi_i = p_i c_i - w l_i \Rightarrow \frac{\partial \Pi_i}{\partial p_i} = 0 \Rightarrow c_i \left( \frac{\partial c_i}{\partial p_i} \frac{p_i}{c_i} + 1 - \frac{w}{p_i} \frac{\partial l_i}{\partial p_i} \frac{\partial c_i}{\partial p_i} \frac{p_i}{c_i} \right)
\]

(12.4)

= 0 \Rightarrow p_i = \frac{w}{\alpha}

where we have made use of (12.2) and (12.3), and where we have assumed equilibrium between the demand for goods and the supply of goods. Equation (12.4) indicates that the profit-maximizing prices of all varieties will be the same, in which case the demand for all varieties will be the same as well (cf. (12.2)). Therefore labour will be equally distributed over the production of all varieties (cf. (12.3)).

Krugman now assumes that there are varieties which can be produced both by the North and by the South (‘old’ varieties) and varieties which can only be produced by the North (‘new’ varieties). If wage costs per worker in the South would be lower than in the North, the latter would have an incentive to
concentrate on the production of 'new' varieties, and to trade these for 'old' varieties produced by the South. The question Krugman then raises is who will be producing what, and which consequences this will have for relative wages earned in the North and in the South.

**Technology**

In the Krugman model, technical change takes the form of product innovation in the North and imitation by the South. Krugman assumes that the rate of innovation is exogenous:

$$ \hat{n} = \mu_0, \quad (12.5) $$

where a 'hat' over a variable denotes its proportional rate of change over time; $\mu_0$ is the constant and exogenous proportional rate of innovation. With respect to imitation, Krugman assumes that the rate of change in the number of 'imitated' varieties ($n^i$) is proportional to the number of 'new' varieties, that is, the number of varieties not yet imitated. This implies for the proportional rate of change in the number of imitations that:

$$ \hat{n}^i = \mu_1 \frac{n - n^i}{n^i}, \quad (12.6) $$

where $\mu_1$ is the propensity to imitate. It is easy to show that equations (12.5) and (12.6) define a steady-state value for the ratio of 'new' varieties and 'imitated' varieties:

$$ \hat{n} = \hat{n}^i \Rightarrow \mu_0 = \mu_1 \frac{n - n^i}{n^i} \Rightarrow \frac{n}{n^i} = 1 + \frac{\mu_0}{\mu_1}. \quad (12.7) $$

If this ratio exceeds its steady-state value, then equation (12.6) indicates that the rate of imitation will increase, which will lower the ratio of 'new' and 'old' varieties again, until the ratio has reached its steady-state value. If the ratio is lower than its steady-state value, the rate of imitation will decrease, thus raising the value of the ratio of 'new' and 'old' varieties again. Equation (12.6) therefore describes an adjustment process which converges to the steady state given by (12.7).

**Production and Trading Regimes**

In Krugman's model, the North has two options. The first is to produce both 'old' and 'new' varieties to satisfy internal demand, while the second is to concentrate on the production of 'new' varieties only and trade part of total
output for 'old' varieties produced by the South. The latter option would be chosen if the opportunity cost of obtaining 'old' varieties through trade would be lower than the opportunity cost of producing 'old' varieties by the North itself. This would be the case if the relative world price of 'new' varieties vis-à-vis 'old' varieties would be larger than one.2

Because of the linear and identical production technologies and the symmetry in the utility function, all goods produced by the South would have the same price. This also goes for all goods produced by the North. Hence, if the North ended up producing both 'old' varieties and 'new' varieties, both types of varieties would have the same price as well. However, if the North ended up producing 'new' varieties and the South produced 'old' varieties, then relative prices might change in favour of 'new' varieties, thus increasing the terms of trade in favour of the North.

Let \( L^N \) and \( L^S \) be the supply of labour in the North and in the South, respectively. Assume now that the North and the South have specialized completely in the production of 'new' varieties and 'old' varieties, respectively. Assume furthermore that North and South have identical consumer preferences. Then the average world supply of goods will be given by:

\[
\frac{x_N}{x_S} = \frac{L^N / (n - n^1)}{L^S / n^1}, \tag{12.8}
\]

where the subscripts and superscripts \( N \) and \( S \) refer to North and South, respectively. Relative world demand would still be given by equation (12.2). The steady-state long-run market-clearing relative price for 'new' varieties would therefore be given by equating (12.8) and (12.2) and substituting (12.7):

\[
\frac{p_N}{p_S} = \left( \frac{L^N}{L^S} \right)^{(1-\alpha)} \frac{n}{n^1} \left( \frac{n^1 - 1}{1 - \alpha} \right) \left( \frac{h_0}{\mu_1} \right)^{1-\alpha}. \tag{12.9}
\]

If \( p_N / p_S > 1 \), then North will gain from trade. Moreover, North will gain more from trade if its rate of innovation is relatively high, and if the propensity to imitate is low. Because of (12.4), equation (12.9) also describes the development of relative wages in the North. Hence a relatively large supply of labour in the North vis-à-vis the South increases the supply of 'new' varieties and therefore lowers the terms of trade for the North, but also relative wages.
3. LABOUR MARKET AND TECHNOLOGY EXTENSIONS

We now transform the Krugman model in three ways. First, we interpret North as the 'high-tech' production sectors in a country which produces 'new' varieties of goods. These new varieties of goods can be produced using high-skilled workers only. South represents the sectors that are able to produce 'low-tech' varieties of goods. In the production of those goods low-skilled workers and high-skilled workers can be used as perfect substitutes. Secondly, we assume that a high-skilled worker can replace a low-skilled worker in the production of 'low-tech' goods. We therefore assume that high-skilled workers are completely mobile within the economy, whereas low-skilled workers are not. This contrasts sharply with the Krugman model, where workers are immobile between countries, but completely mobile between sectors within a country. We thus introduce employment opportunity asymmetries between high-skilled and low-skilled workers. These asymmetries are associated with the relative importance of 'high-tech' and 'low-tech' production technologies within a country. Third, we assume that the rate of imitation present in the Krugman model now reflects the behaviour of the marginal entrepreneur who switches from a 'high-tech' to a 'low-tech' production technology. We will actually link the speed of adoption of 'low-tech' production technologies, the equivalent of the imitation rate in the Krugman model, to the profitability of such technologies relative to the 'high-tech' production technologies. At this stage, we do not provide the micro foundations for this behaviour, but focus on the consequences for employment and price and wage divergence of this technology adoption behaviour instead.

**Labour Market Extensions**

We now assume that high-skilled labour can move between the 'high-tech' and the 'low-tech' sectors. In that case, one would observe the simultaneous employment of high-skilled workers in both sectors only if the wages earned by a high-skilled worker in both sectors are the same. Assuming that wages earned by skill in the 'low-tech' sector reflect intrinsic productivity differences between different skills, we can now readily distinguish between two specialization cases. The case of complete specialization with respect to employment is associated with the situation in which wages for high-skilled workers in the 'high-tech' sector exceed wages for high-skilled workers in the 'low-tech' sector. In the case of incomplete employment specialization, wages for high-skilled workers are the same in both the 'low-tech' and the 'high-tech' sectors. In this case, one may observe employment of high-skilled workers in both sectors.
The case of complete specialization generates wage and price results which are completely analogous to the results obtained in the basic Krugman model. We will find high-skilled workers employed solely in the 'high-tech' sectors, and only low-skilled workers employed in the 'low-tech' sectors. This implies that relative prices for high-tech varieties and low-tech varieties are given by:

\[
\left( \frac{p_H}{p_L} \right)_{CS} = \left( \frac{w_H}{w_L} \right)_{CS} = \left( \frac{H^*}{L^*} \right)^{(1-\alpha)} \left( \frac{n_H}{n_L} \right)^{1-\alpha}, \tag{12.10}
\]

where \(H^*\) reflects the supply of high-skilled workers in a country, \(L^*\) is the supply of low-skilled workers, and \(n_H\) and \(n_L\) are the number of 'high-tech' varieties and the number of 'low-tech' varieties, respectively. The subscript \(CS\) refers to a labour market regime of complete specialization. Because of (12.4), relative wages are equal to relative prices. Equation (12.10) implies, as in Krugman's model, that an increase in the relative number of 'high-tech' varieties would drive up the relative price of those varieties, and hence the relative wages earned by 'high-skilled' workers. In the complete specialization regime, relative profits for the marginal entrepreneur who considers a switch from a 'high-tech' to a 'low-tech' production technology for a certain variety are given by:

\[
\left( \frac{\Pi_H}{\Pi_L} \right)_{CS} = \left( \frac{p_H}{p_L} \right)_{CS} \left( \frac{H^*}{L^*} \right)^{\alpha} \left( \frac{n_H}{n_L} \right)^{-\alpha}, \tag{12.11}
\]

where we have used (12.10) and (12.4). Equation (12.11) states that an increase in the number of high-tech varieties would decrease the relative profitability of continuing to produce relatively new varieties using high-tech production technology. The reason is that such an increase would drive up wage costs of high-skilled workers, thus providing an incentive to switch to low-tech technologies. In the case of complete specialization, the relative employment in the 'high-tech' sectors (\(H^*\)) and in the 'low-tech' sectors (\(L^*\)), both measured in efficiency units, is given by:

\[
\left( \frac{H^*}{L^*} \right)_{CS} = \frac{H^* - HL}{L^* + eHL} = \frac{H^*}{L^*}, \tag{12.12}
\]

where \(HL\) denotes the number of high-skilled workers employed in the 'low-tech' sectors. In the complete specialization case, \(HL\) is equal to zero.

The case of incomplete specialization can readily be derived from the condition that in such circumstances the wage rate earned by a high-skilled worker in the 'high-tech' sectors should be equal to the wage rate earned by a
low-skilled worker in the 'low-tech' sector, times the relative productivity of a high-skilled worker in that sector:

\[
\left( \frac{w_H}{w_L} \right)_{IS} = \varepsilon = \left( \frac{p_H}{p_L} \right)_{IS} = \left( \frac{H^e}{L^e} \right)^{(1-\alpha)} \left( \frac{n_H}{n_L} \right)^{1-\alpha} = \left( \frac{n_H}{n_L} \right)^{e^{-\frac{1}{\alpha}(1-\alpha)}}. \tag{12.13}
\]

Equation (12.13) shows that, in the incomplete specialization case, the employment in efficiency units of high-skilled labour in the high-tech sector will increase, with an increase in the number of high-tech varieties, as expected. An increase in the relative efficiency of high-skilled workers will increase the relative profitability of using high-skilled workers in the low-tech industry. This in turn will decrease the relative employment of high-skilled workers in the high-tech industry and increase low-tech employment in efficiency units. Using (12.4) and (12.13), relative profits in the case of incomplete specialization would be given by:

\[
\left( \frac{\Pi_H}{\Pi_L} \right)_{IS} = \frac{p_H (1-\alpha) (H^e / n_H)}{p_L (1-\alpha) (L^e / n_L)} = \varepsilon^{-\frac{1}{\alpha}(1-\alpha)}. \tag{12.14}
\]

**Technology Extensions**

As stated above, we now assume that the rate of change in the number of low-tech production technologies is driven by relative profits. The idea is that entrepreneurs have two options to produce a certain variety. A variety can be produced using a high-tech production technology which requires high-skilled workers only. After a while, the same variety could also be produced using a low-tech production technology. Entrepreneurs now have to decide whether to stick to their high-tech production technology (that is, the technology they had to use at the moment the new variety arrived) or to switch to a low-tech production technology. We assume that their decisions depend in part on the relative profitability of those two options. We would expect the number of entrepreneurs engaging in such a switch to be positively influenced by the relative profitability of low-tech production technologies. We furthermore assume, as in Krugman, that the rate of change is proportional to the number of high-tech production technologies present. We therefore essentially restate \( \mu_t \) in equation (12.6) and obtain:

\[
\hat{n}^L = \bar{\varepsilon} \left( \frac{\Pi_H}{\Pi_L} \right)^{\frac{1}{6}} \left( \frac{n_H}{n_L} \right), \tag{12.15}
\]
where $\xi$ and $\theta$ are positive and constant parameters. Note that equation (12.15) is completely comparable to equation (12.7), when the profit elasticity $\theta$ would be equal to zero. In that case $\xi = \mu_l$. For ease of exposition, we define $z = n^H / n^L$. In order for $z$ to be constant in the steady state, we should have $\mu_0 = \mu_1$, as before (cf. equation (12.7)). This implies that the steady-state value of $z$, that is, $z$, is given by:

$$
\bar{z} = \left( \frac{n^H}{n^L} \right) = \left( \frac{\mu_0}{\xi} \right) \left( \frac{\Pi_H}{\Pi_L} \right)^\theta.
$$

(12.16)

Note that $z$ depends positively on relative profits. Because relative profits are different for the two specialization cases, we will also have different steady-state values for $z$:

$$
\bar{z}_{CS} = \left( \frac{\mu_0}{\xi} \right) \left( \frac{H^*}{L^*} \right)^{\frac{1}{1/(a\theta^*)}}.
$$

(12.17a)

$$
\bar{z}_{IS} = \left( \frac{\mu_0}{\xi} \right) e^{-a\theta^*(1-\alpha)},
$$

(12.17b)

where (12.17a) and (12.17b) are obtained from (12.16), by substituting (12.11) and (12.14), respectively.

Finally, equation (12.13) can be used to find the critical value of $z$, that is $z^*$, for which there is a transition between the cases of complete and incomplete specialization. Since at the moment of the transition we should have $HL = 0$ (cf. equation (12.12)), equation (12.13) implies:

$$
z^* = \left( \frac{H^*}{L^*} \right) e^{1/(1-\alpha)}.
$$

(12.17c)

Any value of $z \geq z^*$ indicates that complete specialization will occur, while any value of $z < z^*$ indicates that incomplete specialization will prevail.

4. LABOUR MARKET REGIMES AND WAGE DIVERGENCE: EUROPE AND THE USA COMPARED

Using equations (12.17), it is easy to distinguish a number of constellations of technology and labour market 'parameters' which influence the occurrence of wage divergence in their own way. Basically, there are two classes of parameter constellations: those where $z_{CS} > z_{IS}$ (constellation A) and those
where $z_{CS} < z_{IS}$ (constellation B). However, it can be shown that the structure of the model implies that, if $z^* ≤ z_{CS}$, it must be the case that $z_{CS} ≤ z_{IS}$. Likewise, if $z_{CS} ≤ z^*$, it automatically follows that $z_{IS} ≤ z_{CS}$. In constellation A we have a case of 'globally stable' incomplete specialization. In constellation B we have a case of 'globally stable' complete specialization. Both cases are depicted in Figure 12.1.

In this figure, the relevant attractors are marked with a small circle, while the various threshold values and attractors of $z$ are marked by means of a small vertical line through the horizontal. The direction of an arrow indicates the movement of a point $z$ on the line segment containing the arrow. The text above a line segment denotes which attractor is relevant for points on the line segment under consideration. In order to understand how the adjustment processes work, consider a point on the right-most line segment of case A. Since the point is to the right of $z^*$, we must be in the complete specialization regime with the $z_{CS}$ attractor. This is indicated by $z_{CS}$ directly above the line segment containing the point $z$. In case A, the relevant attractor for $z$ lies to the left of $z^*$, and $z$ will start to move in that direction in accordance with (12.15). But once $z$ has arrived to the left of $z^*$ we are in the incomplete specialization regime, and $z_{IS}$ becomes the relevant attractor. Hence $z$ continues to move until it arrives at $z_{IS}$. Actually, any point $z$ in case A will move to $z_{IS}$. Likewise, in case B any point $z$ will move towards the $z_{CS}$ attractor.

Suppose now that a country can be categorized by means of its 'scores' on the labour market 'parameter' $H' / L'$ and the technology parameters $\xi$ and $\theta$. A country with a relatively high participation of low-skilled workers on the labour market will have a relatively low value of $H' / L'$, while a country with relatively high technological capabilities and/or a keen eye for profitable technological adoption opportunities will have relatively high values for $\xi$ and $\theta$. This has immediate consequences for the probability of a certain variant being relevant for a specific country.

For constellation A to be relevant for a country, we require $z_{CS} < z_{IS}$. Using equation (12.17b) to be able to drop the term $\mu_0 / \xi$ from equation (12.17a), we find:
Equation (12.18) defines \( \xi_{CS} \) as a concave function of \( \xi_{IS} \). Moreover, \( \xi_{CS} \) increases in \( H'/L' \). Hence, the probability that \( \xi_{CS} > \xi_{IS} \) increases with \( H'/L' \). Actually, it is fairly easy to show by using equations (12.17) that the ‘locus’ of labour market parameters and technology parameters which would result in \( \xi_{CS} = \xi_{IS} \) is given by:

\[
\frac{\mu_0}{\xi} = \lambda = e^{(1+1)/(1+\alpha)}(H'/L'),
\]

where the ratio \( \lambda = \mu_0 / \xi \) is actually equal to the steady-state ratio of ‘new varieties’ versus ‘old varieties’ in the Krugman model, that is, the ratio to which \( \lambda \) would converge when either profits would be the same in both cases, or \( \theta = 0 \). It can readily be verified that (12.19) also describes the ‘locus’ for which \( \xi_{IS} = \xi^* \). Note that equation (12.19) describes a line through the origin in the \( \lambda, H'/L' \) plane, which divides that plane into two parts. Given the nature of (12.19), the part of the plane above this line is associated with the situation where \( \xi_{IS} > \xi_{CS}, \xi_{IS} > \xi^* \) and \( \xi_{CS} = \xi^* \), that is, case B from Figure 12.1. The part of the plane below the line is associated with the situation where \( \xi_{IS} < \xi_{CS}, \xi_{IS} < \xi^* \) and \( \xi_{CS} < \xi^* \), that is, case A. Case B has complete specialization as its steady state, case A has incomplete specialization as its attractor. Note that the slope of the ‘locus’ depends positively on the profit-elasticity of technology adoption \( \theta \). A relatively high value of this elasticity would decrease the probability of finding the country in question in a situation of complete specialization (that is, after all, what adoption is supposed to do), ceteris paribus. Countries with a high value of \( \lambda \) will have a relatively high probability of being in or moving towards a situation of complete specialization. This causes high-skilled labour to become more scarce. Likewise, countries with relatively low values of the ratio \( H'/L' \), which is an indicator of the participation/availability of high-skilled labour vis-à-vis low-skilled labour, will also have a relatively high probability of being in or moving towards a situation of complete specialization for any value of their \( \lambda \). The above is summarized in Figure 12.2.

The problem now is to try to define the differences between Europe and the USA in terms of these parameters, and to see what a difference in characterization of Europe and the USA in terms of these parameters would imply for wage divergence. The idea is that the USA has a ‘comparative advantage’ in innovative activity, that is, a relatively high value of \( \lambda \), while Europe has a relatively high value of \( H'/L' \), for the same actual skill composition of the labour force. A relatively high value of \( \lambda \) would increase the probability of finding a country in or moving towards the complete specialization labour
market regime, for any value of $H^* / L^*$. Likewise, a relatively high value of $H^* / L^*$ would increase the probability of finding a country in or moving towards the incomplete specialization regime. With the characterization of the USA and Europe suggested above, we would expect the USA to be more likely in a situation of complete specialization, and hence to experience relatively large movements in relative wages by skill, whereas the opposite would be more likely to hold for Europe. We see then that, even though production technologies are the same by assumption, differences in technological capabilities and/or labour market participation rates between countries may actually cause wage developments to be different. For countries with fairly low participation rates of the low-skilled, one would not expect to find wage divergence as often as in countries with high “forced” participation of low-skilled workers. In relatively innovative countries, one would expect to find wage divergence more often than in less innovative countries.

An interesting possibility occurs for constellations of parameters close to the dividing line given by (12.19). Small random fluctuations in the profit-elasticity of the rate of adoption, theta, the value of epsilon, the relative efficiency of high-skilled workers on low-tech jobs, the elasticity of demand, alpha, or the relative labour participation ($H^*/L^*$) can cause regime shifts. However, employment by skill would not be affected by construction. Thus we could observe fluctuations in relative wages by skill, without any noticeable fluctuations in relative employment by skill.
5. SUMMARY AND CONCLUSION

In this chapter we have addressed the issue of divergence in wages and employment opportunities by skill between Europe and the USA. We have shown that a simple stylized fact regarding asymmetries in employment opportunities between high-skilled and low-skilled workers, in combination with a high-skill bias in innovative activity, may be used to construct a model in which the US case of wage divergence and the European case of stable wages with crowding-out are two 'natural' states of that model. Which state will actually materialize depends on both technological and labour market characteristics of a particular country.

The model is a simple 'love of variety' product innovation model, based on Krugman's North–South model of international trade. In the model we have two types of varieties: 'new, high-tech' varieties which can be produced using high-skilled labour only, and 'old, low-tech' varieties for which the production process has been standardized. This enables producers to use both low-skilled workers and high-skilled workers as perfect substitutes in the production of low-tech varieties. We assume that high-skilled workers enjoy the same wage rate in both sectors, whenever they are employed in both sectors. However, a relatively high rate of innovation biases the demand for labour in favour of high-skilled workers, who then leave the 'low-tech' sector, until employment of the high-skilled is fully concentrated in the high-tech sector, and employment of the low-skilled is concentrated in the low-tech sector. In that case, the labour market is completely specialized, and wages by skill will diverge as a consequence of innovative activity. We have shown that the relative profitability of using high-skilled workers in a high-tech production process, and using low-skilled workers after switching to low-tech production techniques, may be used to define two possible steady states in the model: one in which the labour market will be specialized completely and where relative wages will continue to diverge, and one in which relative wages are stable and where low-skilled workers and high-skilled workers compete for the same jobs. We show that these possible steady states depend on certain technology and labour market parameter constellations, such that the USA is more likely than Europe to experience wage divergence.

The results which the model generates depend on asymmetries in employment opportunities by skill, which become more pronounced in situations where innovative activity is high. The latter makes high-skilled workers more scarce than low-skilled ones, almost as a matter of principle. Relative income prospects as well as employment prospects for the low-skilled may be bleak in these circumstances, since they would have to face a permanent fall in their relative wages for each increase in innovative activity. Nonetheless, the latter
would also raise total utility and total real income by increasing the number of varieties.

NOTES

1. This section closely follows Krugman (1979).
2. By assumption, the South has the same production technology as the North.
3. This interpretation resembles Vernon’s life-cycle hypothesis (Vernon, 1966). According to the life-cycle hypothesis, new goods tend to be produced in developed countries first, and then, after the production technology has been standardized, by less developed countries making use of their comparative advantage with regard to low-skilled workers.
4. For a similar approach in a somewhat different setting, see van Zon et al. (1997).
5. The latter reflects the assumption that wage differentials by skill reflect intrinsic productivity differences.
6. The term ‘low-tech’ may be somewhat misleading, in that it refers to the possibility of using low-skilled workers instead of high-skilled workers to produce a certain variety. This might well entail sophisticated standardization activities, which renders a production process only seemingly low-tech.
7. We do not specify how such a low-tech production technology actually comes about. This is left for future extensions of the model.
8. This is because this increase in the profit-elasticity would rotate the dividing line in a counter-clockwise direction, thus increasing the area of the plane associated with incomplete specialization at the expense of the area associated with complete specialization.

REFERENCES

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