# Skilled-Unskilled Wage Differentials, Unemployment and Hours of Work: The Case of America and Europe

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## Abstract

*In our analysis we follow Davis (1998a) and consider the consequences from trade between a flexible-wage America and a rigid-minimum-wage Europe. The minimum wage implies a certain level of unemployment in Europe, whereas factor price equalisation guarantees the same wage in America, albeit at full employment levels. We then use a process of endogenous human capital accumulation, together with a lower schooling productivity for the American unskilled workers to explain the larger skilled-unskilled wage differential in America. Moreover, we show that unskilled workers in America will work more hours than their European counterparts.*

*Keywords*:    Wage differentials, human capital, unemployment

*JEL-codes:*    J21, J24, J31

# 1      Introduction

The issue of wages and unemployment plays an important role in economic analysis. Special attention is often given to the lower end of the wage distribution since the accompanying high incidence and duration of unemployment culminate to a degree such as to make economic policy considerations highly important. Since the early nineties, the institutional framework has been introduced as a separate element in economic analysis, for instance by comparing America and Europe. The institutional difference between both economies has been aptly summarised by Krugman (1995) under the phrase "Moneyless America, Jobless Europe". It hints at several stylised facts that distinguish the European situation from that in America. First of all America is characterised by a free labour market, guaranteeing full employment, whereas the European labour market displays certain rigidities. This induces unemployment in Europe, which is the second difference. The third difference concerns the large wage differentials in America, when compared to Europe.

These three stylised facts have been well documented in the literature – e.g. next to Krugman (1995): Freeman and Katz (1995), Card, Kramarz and Lemieux (1996), Berman, Bound and Machin (1998) and Machin and Van Reenen (1998). The usual way to characterise the European situation is to introduce the notion of binding minimum wages or wage bargaining – which then explains European unemployment. Wage divergence predominantly is explained by technical change. The impact of technical change has been discussed extensively, in particular for the United States.[2] In this context Leamer (1995) depicted the US as a small country with local technological change, whereas both Krugman (1995) and Freeman and Katz (1995) emphasise the global nature of technological change and depict the US as a large country. In both cases it is emphasised that in a trading world global conditions do matter. However, the impact of trade is not thoroughly investigated.

This deficiency is remedied by Davis (1998a) who considers the consequences from trade between a flexible-wage America and a rigid-minimum-wage Europe. He shows that moving from autarky to free trade doubles European unemployment while at the same time raising American wages through factor price equalisation. Full employment in America will nonetheless prevail. However, the differences in wedge between skilled and unskilled wages in Europe and America remain unexplained. This is accounted for by differences in local technological change in Davis (1998b) – in line with the discussion above. Dinopoulos and Segerstrom (1999) elaborate the notion of local technological change in a two-country trade model where relative prices remain constant. In both countries monopolistic competition prevails with quality leaders who have monopoly power till a new innovation occurs. Trade liberalisation opens up markets and makes skill-intensive R&D more profitable. This favours skilled workers, hence their wages will increase.

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[2] See the introductions to Davis (1998b) and Dinopoulos and Segerstrom (1999).

An alternative or complementary explanation for the above mentioned different experiences in America and Europe can be sought in differences in human capital accumulation. This line of research has been hardly pursued, however.[3] An exception is Davis and Reeve (1997) who explain the difference in wedge between America and Europe by the impact of unemployment on skill formation. Since unemployment decreases the reservation wage for the unskilled, it will increase skill supply in Europe. Thus, relative wages will be lower in Europe when compared to America. However, wage divergence will be due to a relative increase in skilled wages in America, and not to a relative decrease in unskilled wages.

The latter is in conflict with a fourth stylised fact which usually gets less attention in the literature, although it is pointed out in Davis (1998b) as a stylised fact too: The relative wage of the unskilled declined in the United States while it was unchanged in Europe.[4] Related to this, a fifth stylised fact is that the number of hours worked in America is much higher than in Europe - in particular low-paid individuals often have to work more hours than 'normal' (or have more jobs) in order to earn a decent living.[5] This might also be related to the final difference between America and Europe that unskilled persons in America are less productive when compared to Europe, which is related to a less productive educational system in America for unskilled persons.[6] Since these stylised facts are less well-known, we will elaborate on them later.

In the present analysis we further investigate the human capital explanation in an attempt to explain all six stylised facts. In line with Davis (1998a) we analyse the consequences from trade between a flexible-wage America and a rigid-minimum-wage Europe. Moreover, we follow Davis and Reeve (1997) by incorporating endogenous human capital accumulation. While they consider only a one-stage education process where individuals are either skilled or unskilled and where the level of skills is determined by the number of individuals taking an education, we focus on skill formation for all individuals. The level of skills is directly linked to the productivity of the educational process. We will use the notion that schooling is less productive for the unskilled in America than for their European colleagues. Then the American unskilled workers will have a lower productivity and hence earn a lower hourly wage rate. Thus, contrary to Davis and Reeve (1997), the wage differential between Europe and America is explained by differences in the unskilled wage rather than in the skilled wage. Moreover, we explain the stylised fact that American unskilled workers have to work more hours in order to earn the same yearly wage as their European colleagues.

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[3] Dinopoulos and Segerstrom (1999) also model endogenous human capital formation, but do not discuss asymmetric behaviour between the two countries, nor do they allow for unemployment.

[4] See Phelps (1998) and Freeman and Katz (1995).

[5] This fact is emphasised, for instance, strongly in Phelps (1998). Cf. also OECD (1999, p.90) which shows PPP-comparisons of low skilled wages. The yearly US wage is clearly below the European average, and if we correct these figures for hours worked, a rough comparison shows that the European average is 9.4 compared to 6.4 in America ($ per hour, 1997).

[6] Cf. OECD (1998a, 1998b).

This paper contains 5 parts. Section 2 describes the basic model which aims at explaining the difference in unemployment between America and Europe. Section 3 introduces endogenous skill formation in the context of the trading equilibrium between America and Europe. In section 4 the low schooling productivity for unskilled workers in America is shown to be of crucial importance to explain the stylised facts. Section 5 concludes.

## 2 The basic model: exogenous labour supply

We set out with the description of a standard two-goods, two-factor general equilibrium model and show how the introduction of a minimum wage can lead to unemployment. Then we demonstrate how Davis (1998a) uses this model to explain the simultaneous existence of unemployment in Europe and full employment in America. Finally we conclude that the model should be amended to explain wage differences.

### 2.1 The general structure

We distinguish between skilled labour $H$ and unskilled labour $L$ as factors of production, with prices $w_H$ and $w_L$, respectively. The relative price is $w = w_H/w_L$. Total supply is $H^F$ and $L^F$, respectively, and relative supply is given by $h^F = H^F/L^F$. Moreover, two goods are produced under constant returns to scale: a skill-intensive good $X$ and a skill-extensive good $Y$, where $P$ is the relative price of $X$ to $Y$, i.e. $P = P_X/P_Y$. In the further analysis, $Py$ will be taken as the numeraire.

Let consumers have the following utility function:

$$U = \left[ X^\rho + Y^\rho \right]^{1/\rho},$$  (1)

with $0 < \rho < 1$. Maximisation of utility subject to the budget constraint $I = P_X \cdot X + P_Y \cdot Y$, with $I$ denoting income, yields:

$$\frac{X}{Y} = \left[ \frac{P_X}{P_Y} \right]^{\frac{1}{\rho-1}},$$  (2)

which shows that the relative consumption of skill-intensive to skill-extensive goods is inversely related to the relative price, since $1/(\rho-1) < 0$.

The production of goods is represented by a Cobb-Douglas production function:

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$$X = (H_X)^\alpha \cdot (L_X)^{1-\alpha}$$

$$Y = (H_Y)^\beta \cdot (L_Y)^{1-\beta} \quad , \qquad 0 < \beta < \alpha < 1 \tag{3}$$

with $H_i$, $L_i$ denoting the use of production factors $H$ and $L$ in the production of good $i$. Furthermore $\beta < \alpha$ indicates that $X$ is the skill-intensive and $Y$ the skill-extensive good.

Maximisation of the profit function

$$\Pi = P_X \cdot X + P_Y \cdot Y - w_H(H_X + H_Y) - w_L(L_X + L_Y) \tag{4}$$

subject to equations (3) yields:

$$\frac{w_H}{w_L} = k_1 \cdot \left[ \frac{P_x}{P_y} \right]^{\frac{1}{\alpha-\beta}} \quad \Rightarrow \quad w = k_1 \, P^{1/(\alpha-\beta)}, \tag{5}$$

where $k_1 > 0$ is a constant.[7] This implies that at equilibrium on the goods market, the skilled wage will be higher, the higher the supply price of skill-intensive goods is.[8] The implied positive relation between $w$ and $P$ draws out the Stolper-Samuelson curve in the second quadrant of Figure 1 below.

Aggregate demand for labour is given by:

$$H = H_X + H_Y$$

$$L = L_X + L_Y \tag{6}$$

Arbitrage between sectors, given the consumption behaviour implied by equation (2), then results in a negative relation between relative wages $w$ and relative demand for labour $h \equiv H/L$.[9] The demand curve for skilled relative to unskilled labour will be downward sloping for two reasons. First a higher relative wage implies that skilled workers become more expensive, hence they will be demanded less in the production of both goods. Second, apart from this direct effect, there also is an indirect effect. A higher relative wage means that the skill-intensive good becomes more expensive (compare the Stolper-Samuelson curve) and therefore consumer demand will shift towards the skill-extensive good. Hence demand for skilled workers will decline for that reason too. The resulting downward sloping demand curve $h^D$ is presented in the first quadrant of Figure 1.

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[7] This is elaborated in the Annex.
[8] An interpretation of this relation is that when the relative price $P$ increases, it is easier to make profit on $X$. Therefore, skills will be lured away from $Y$ to $X$ and $w = w_H/w_L$ will increase.
[9] This is elaborated in the Annex.

The simultaneous equilibrium on both the labour and goods market is represented in Figure 1, for a given relative factor endowment $h^F$.[10] Labour market equilibrium at full employment $h^F$ fixes relative wages $w$ at $w^F$ - cf. point E on the demand curve for labour in the first quadrant. The equilibrium wage $w^F$ should also be consistent with goods market equilibrium at $P^F$ – cf. the Stolper-Samuelson curve in the second quadrant.

*Figure 1          Equilibrium, minimum wages and unemployment*
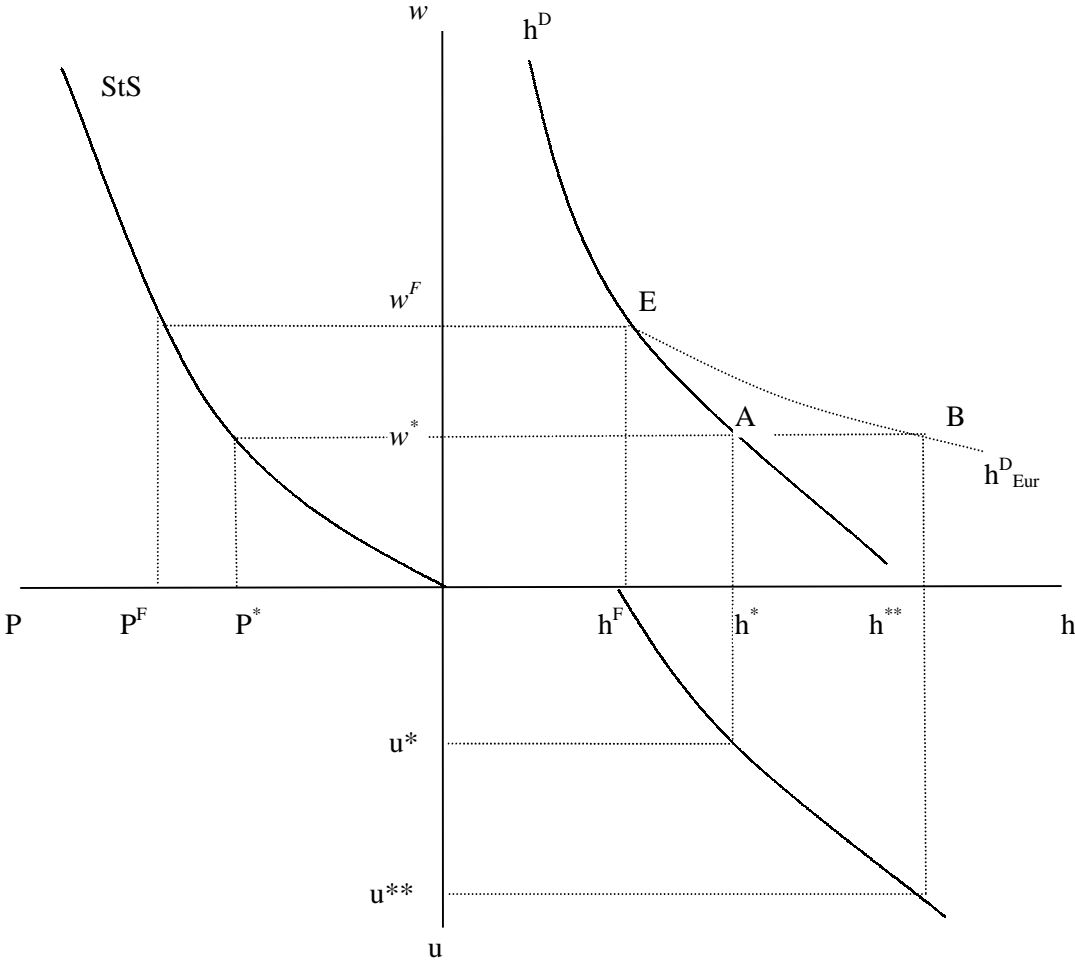


## 2.2    Unemployment in Europe

The foregoing may be extended to account for unemployment. As in Davis (1998a) we assume that skilled workers are always fully employed, hence unemployment is concentrated amongst the unskilled. Because skilled workers are always fully employed, whenever the relative wage $w$ is below its full-employment level $w^F$ the demand for unskilled workers equals:

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[10] In the Annex it is shown that all prices can be solved relative to $P_Y$.

$$L = H^F / h^D (w) \qquad w < w^F \tag{7}$$

Where $h^D (w)$ represents the demand curve for labour. As a consequence the rate of unemployment of unskilled workers $u$ is given by

$$u = 1 - h^F/h(w). \tag{8}$$

This relation is represented in the fourth quadrant of Figure 1.

In line with Davis (1998a) we also assume a fixed minimum wage $w_L^*$ above the equilibrium level $w_L^F$ - where both are relative to the output price $P_Y$. It can be easily seen that unemployment will occur because the relative wage then is fixed at $w^*$ below the equilibrium level $w^F$ in Figure 1.[11] Since the unskilled wage is 'too high', good $Y$ will be relatively expensive. Hence the relative price of good $X$ will be below its equilibrium level, i.e. $P^* < P^F$. Moreover, relatively more skilled workers will be used in production, which implies that $h^* > h^F$. As a consequence the employment of unskilled workers equals $H^F/h^*$ and the rate of unemployment of unskilled workers is $u^* = 1 - h^F/h^*$, cf. equation (8). As one can see from the figure, unemployment is decreasing in $w^* < w^F$ and hence increasing in the minimum wage.[12]

Davis (1998a) uses the above framework to explain the diverging unemployment experiences in America and Europe. Assume that both 'countries' are identical in endowments, preferences and technology. Let Europe have a binding minimum wage $w_L^*$, then European unskilled unemployment will be equal to $u^*$ in absence of free trade, as indicated by point A in Figure 1 above. However, America has flexible wages guaranteeing full utilisation of both skilled and unskilled workers. In the case of free trade, then factor price equalisation will set the unskilled wage in America at $w_L^*$ too. The excess demand for skilled workers which results from the higher unskilled wage is essentially realised in Europe, through the import of skill-intensive goods by America. This will shift the demand curve for labour in Europe towards $h^D_{Eur}$ in Figure 1. As a consequence unemployment in Europe will increase, because this means a higher production of skill-intensive goods and hence a lower demand for unskilled workers. Since America has a flexible labour market, Europe bears the brunt of maintaining the higher minimum wage in America by accepting a higher unemployment – compare point B in Figure 1. Davis (1998a) shows that European unemployment will increase to $u^{**} = 2u^*$.[13]

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[11]  This is elaborated in the Annex. Of course $w^F > w^* > 1$ should hold.

[12]  Assuming wage bargaining in stead of the minimum wage would yield a similar result. Cf. Muysken, Sanders and van Zon (1999).

## 2.3    No wage differentials?

From the above we have seen that European unskilled unemployment doubles upon setting a minimum wage and allowing for free trade. At the same time American unemployment remains at zero. Wage differentials though are not accounted for. Still it is a well-established fact that the wedge between skilled and unskilled wages is by far larger in America than it is in Europe and that it has been ever increasing during the past decades.

Davis (1998a) offers several possible explanations for this diverging wage experience. He observes that differences in the evolution of trade and fiscal policy, as well as specialisation can cause factor price equalization to break down. An other aspect is the role of technical change, which has been considered in Davis (1998b). There he shows how in particular local differences in technological change can lead to wage divergence. This has been elaborated in a different way in Dinopoulos and Segerstrom (1999) for free trade under monopolistic competition – and without unemployment.

As indicated in the introduction, we want to investigate an alternative explanation, which can be complementary to that of technological change, and focuses on human capital formation.[14] We shall pursue this line in the following section.

# 3    Human capital accumulation and wage formation

In this section we introduce the role of human capital formation in order to explore possible causes of wage divergence. We assume that the distribution of abilities over the population is given, while the educational system transforms these abilities into skills. Every individual can choose to follow a lower education, while higher education is restricted to those having a minimum ability level. This decision is modelled in the traditional human capital theory fashion. Equilibrium between demand and supply of labour then determines simultaneously skilled and unskilled wages and the amount of schooling of each individual.

## 3.1    The general structure

Assume there are $N$ individuals born in every period that all have a life span equal to $T$. All individuals will spend $\underline{t}$ periods in school and then they make an irrevocable choice between two career paths. $E$ of the school leavers seek a higher education, while the remaining $(N - E)$ seek jobs. The former will

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[13] This argument relies on the integrated equilibrium concept (cf. Dixit and Norman, 1980). It basically establishes an isomorphism between the closed economy model presented above and a trading world in which one economy imposes a minimum wage while the other maintains a flexible wage.

spend $\bar{t} - \underline{t}$ additional periods in school, and will then work as a skilled worker for the remaining $(T - \bar{t})$ periods of life. On the other hand, those seeking jobs will work as unskilled workers for $(T - \underline{t})$ periods. Thus, at any point in time, *(N - E)* $(T - \underline{t})$ man years are available for unskilled work and $E(T - \bar{t})$ man years for skilled work.

We assume that the skill of a worker depends on both the ability of that worker and on his or her education. All individuals will follow lower education. Then starting from a certain level of ability, individuals will also follow higher education and become skilled workers. For simplicity we assume that ability *a* is uniformly distributed over all individuals on the interval *[a,A]*. The marginal individual that will actually follow higher education has an ability *ã*. Then

$$(N - E) \equiv \int_{\underline{a}}^{\tilde{a}} da \qquad \text{and} \qquad E \equiv \int_{\tilde{a}}^{A} da \qquad \qquad (9)$$

define the amounts of unskilled and skilled persons, respectively. To see how *ã* is determined we have to look at skill formation.

## 3.2 Skill formation

The skills of a worker depend on the ability of the worker and his or her education. We assume that skills are formed according to the following function[15]:

$$s = s(a,t) = k \cdot e^{af(t)}, \qquad \qquad (10)$$

with *s* representing the level of skills, measured in terms of efficiency units. The variable *a* denotes ability, while *k* and *t* pertain to the productivity and years of education, respectively. The function *f(t)* is such that the following conditions on partial derivatives hold: $s_t > 0, \quad s_{tt} < 0$. The number of years spent in lower education equals *t̲*. Therefore an individual with ability *a* yields skills *s(a,t̲)* after lower education. When this individual also follows a higher education, he or she will have a level of skills *s(a,t̄ )* upon completion.

Skilled workers receive a wage $w_H$ per man-hour and unskilled workers receive $w_L$, where both depend on the amount of skills a worker possesses. For that reason employers consider labour in terms of efficiency units. They pay for one efficiency unit of skilled and unskilled labour the wage

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[14] A first attempt along this line was made by Davis and Reeve (1997), but they were not able to explain wage divergence in a satisfactory way as we elaborated in the introduction.

$$\tilde{w}_H = w_H / s(a,\bar{t}) \qquad \text{and} \qquad \tilde{w}_L = w_L / s(a,\underline{t}) \qquad , \tag{11}$$

respectively, where $s(a,\bar{t})$ and $s(a,\underline{t})$ represent the efficiency of skilled and unskilled workers, respectively, with ability $a$.

Since the wages $\tilde{w}_H$ and $\tilde{w}_L$ are given for workers, they will accumulate skills such that the present discounted value of the alternate career paths are equal. This implies that should hold:[16]

$$\int_{\bar{t}}^{T} \tilde{w}_H \cdot s(\tilde{a},\bar{t}) \cdot e^{-rt} dt = \int_{\underline{t}}^{T} \tilde{w}_L \cdot s(\tilde{a},\underline{t}) \cdot e^{-rt} dt , \tag{12}$$

where $\tilde{a}$ is the marginal ability between unskilled and skilled labour. Defining the relative wage in terms of efficiency units by $\tilde{w} = \tilde{w}_H / \tilde{w}_L$, the above may be reformulated as:[17]

$$e^{\tilde{a}.[f(\bar{t})-f(\underline{t})]} = \frac{\Delta_{\underline{t},\bar{t}}}{\tilde{w}} . \tag{13}$$

Equation (13) then shows how the marginal ability $\tilde{a}$ is decreasing in the relative wage $\tilde{w}$.

From this analysis it follows that unskilled workers have an ability level below $\tilde{a}$ and end up with quality $s < s(\tilde{a},\underline{t})$, while for the skilled $s \geq s(\tilde{a},\bar{t})$ should hold. Skilled and unskilled labour measured in efficiency units, $H$ and $L$ respectively, are defined analogous to equation (9) above, by

$$L \equiv \int_{\underline{a}}^{\tilde{a}} s(a,\underline{t})da \qquad \text{and} \qquad H \equiv \int_{\tilde{a}}^{A} s(a,\bar{t})da . \tag{14}$$

### 3.3 Equilibrium on the labour market

Since marginal ability $\tilde{a}$ is decreasing in $\tilde{w}$ - cf. equation (13) - one sees from equation (14) that supply of unskilled labour $L$ is decreasing in relative wages too, whereas supply of skilled labour $H$ is increasing. As a consequence, relative supply of labour $h^S \equiv H/L$ is increasing in $\tilde{w}$. This upward-sloping relative supply curve $h^S$ is shown in the first quadrant of Figure 2 below. It is the endogenous

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[15] This function, together with the notion of an ability distribution, is introduced in Muysken and Ter Weel (2000).

[16] For simplicity we ignore the costs of higher education.

[17] We find $\dfrac{s(\tilde{a},\bar{t})}{s(\tilde{a},\underline{t})} = e^{\tilde{a}.[f(\bar{t})-f(\underline{t})]} = \dfrac{\tilde{w}_L \cdot \Delta_{T,\underline{t}}}{\tilde{w}_H \cdot \Delta_{T,\bar{t}}}$ with $\Delta_{b,c} \equiv \int_{c}^{b} e^{-rt} dt$ and $\Delta_{\underline{t},\bar{t}} = \dfrac{\Delta_{T,\underline{t}}}{\Delta_{T,\bar{t}}}$

labour supply counterpart of exogenous labour supply in Figure 1. Since demand for skilled relative to unskilled labour is expressed in efficiency units, the analysis of the previous section still holds. Therefore the downward sloping demand curve $h^D$ from Figure 1 is presented in the first quadrant of Figure 2 as well.

Equilibrium will result at the intersection of demand and supply, as is depicted by point E in Figure 2. The equilibrium relative wage and price are $\tilde{w}^F$ and $P^F$, respectively, while labour supply follows from $h^F$.

# 4 Unemployment and the wage gap

We now introduce a binding minimum wage into the analysis which leads to unemployment. Unemployment amongst unskilled workers then is shown to lead to a higher proportion of skilled workers. While this is relevant for Europe, we argue that lower education in America is less productive than in Europe. Thus the quality of unskilled workers in America is lower. The corresponding lower wage then also leads to a higher proportion of skilled workers. As a consequence

*Figure 2        Equilibrium prices, skill formation and unemployment*
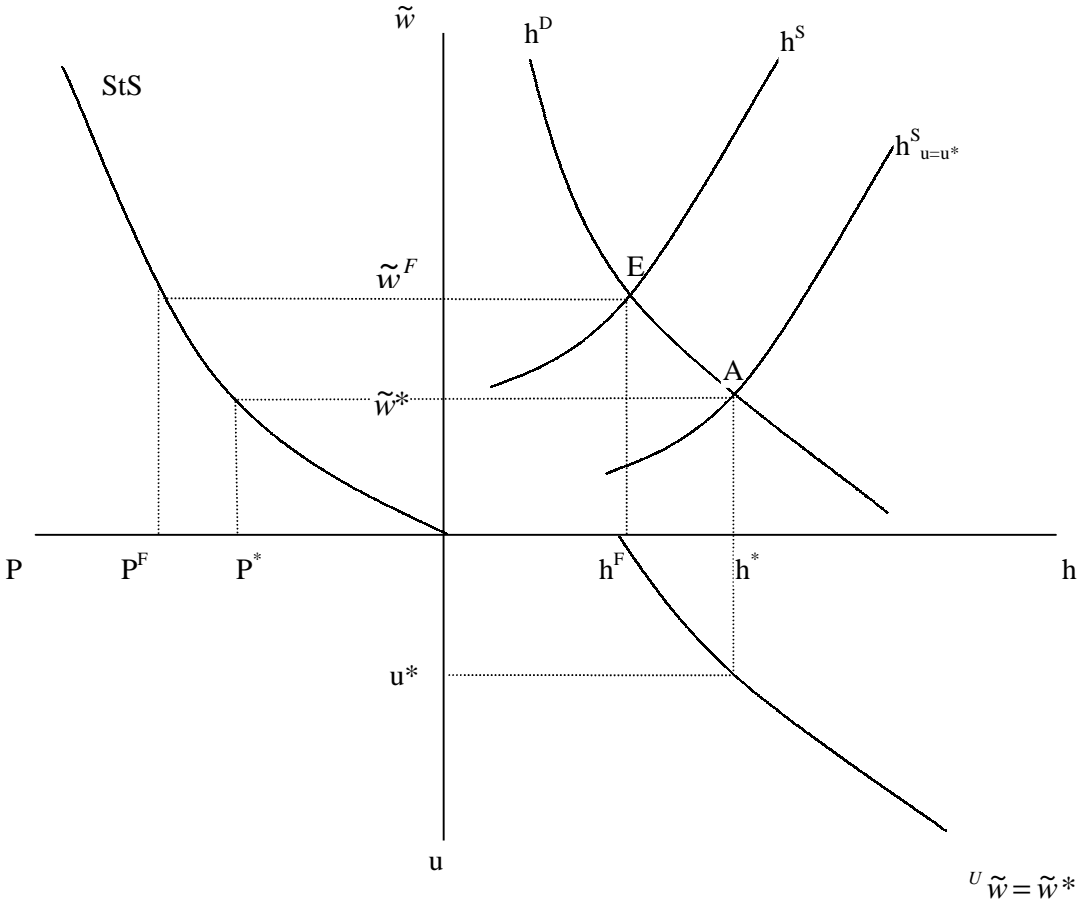
this proportion remains the same for America and Europe. Therefore the wage differences between Europe and America follow from a lower hourly wage in America for unskilled workers.

## 4.1 The impact of a minimum wage

Let the minimum wage in Europe be set at $w_L^*$ such that the least skilled worker earns a sufficient income. Then we find in terms of efficiency units $\tilde{w}_L^* = w_L^*/s(\underline{a},\underline{t})$. We assume that this minimum wage is binding, i.e. $\tilde{w}_L^* > \tilde{w}_L^{\,F}$, hence unemployment will occur. As noted before, unemployment is concentrated at low skill levels. We denote the rate of unemployment for unskilled workers by $u$. Through the analysis underlying the Stolper-Samuelson curve in Figure 1, the skilled wage is fixed too, say at $\tilde{w}_H^*$, and the relative wage is fixed at $\tilde{w}^* < \tilde{w}^F$.

Let unemployment benefits be a fraction $b$ of the minimum wage, i.e. the replacement rate is $b$. Then the expected unskilled wage is $[1-(1-b)u]\,\tilde{w}_L^*$. This can be substituted into the arbitrage equation (12) to determine the marginal ability $\tilde{a}^*$ from:

$$\int_{\underline{t}}^{T} \tilde{w}_H^* \cdot s(\tilde{a}^*,\bar{t}) \cdot e^{-rt}dt = \int_{\underline{t}}^{T} [1-(1-b)u]\tilde{w}_L^* \cdot s(\tilde{a}^*,\underline{t}) \cdot e^{-rt}dt$$

$$\Leftrightarrow \qquad e^{\tilde{a}^*\cdot[f(\bar{t})-f(\underline{t})]} = [1-(1-b)u]\frac{\Delta_{\bar{t},\underline{t}}}{\tilde{w}^*}. \qquad (15)$$

Thus $\tilde{a}^*$ is a decreasing function of unemployment $u$, because the relative wage is fixed at $\tilde{w}^*$. Moreover, since $h$ is decreasing in $\tilde{a}^*$, there exists a positive relation between $h$ and $u$. This relation is positive because, at a given relative (minimum) wage, a higher rate of unemployment means that unskilled labour becomes relatively less attractive - hence more persons will choose higher education. It is represented as the $u_{\tilde{w}=\tilde{w}^*}$ curve in the fourth quadrant of Figure 2. This curve essentially replaces the definition of unemployment in the third quadrant of Figure 1.

The position of the $h^s$-curve in Figure 2 is conditional on $u$ - the curve shifts rightward with increasing unemployment. The curve $h^s_{u=u^*}$ is conditional on $u^*$ and equals demand at wage $\tilde{w}^*$, as can be seen from the first quadrant in Figure 2.[18] The resulting relative employment $h^*$ is of course consistent with a rate of unemployment $u^*$ as can be seen from the third quadrant in the figure.

The relative price level is also fixed by the minimum wage. For the goods market this implies that relative demand for goods is given, implying a relative employment level $h^*$.

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[18] This function is found by substituting $\tilde{a}^*$ in equation (14) in stead of $\tilde{a}$.

## 4.2     Skills and the wage gap between Europe and America

In the same way as above we compare America and Europe, where both have the minimum wage, but only Europe has unemployment. First we turn to a comparison between skill formation in America and in Europe. The number of years spent in education for the unskilled is the same in both countries, and for the skilled it is the same too. Furthermore, the ability distribution over the entire population *NT* is assumed to be the same in America and Europe. Thus the only way in which skills of workers can differ is through the productivity of education. Since education is assumed to be equally productive for the skilled, the same skills are obtained in both Europe and America. The skilled workers are equally productive and hence earn the same wage in both countries. The unskilled have spent the same number of years $\underline{t}$ in compulsory schooling. However, skill formation is assumed to be less productive for the unskilled in America than it is in Europe. Since this is an important element in our analysis, we elaborate this briefly.

Phelps (1998) notes that low-wage individuals in America are not able to make a decent living and he states that this situation is bound to have a negative effect on their motivation (pp. 3 ,4, 17).[19] He also links productivity (and thus wages) to the ability of adopting and working with new technologies.[20] This amounts to pleading for broad education, since this "equips individuals to acquire and grasp new or unfamiliar information …" (p. 68). Therefore "… the best way to remedy the plight of the low-paid is through improved and extended education. The key is to help them increase their productivity by offering them the education and vocational training needed to understand and utilise the constantly more sophisticated new technologies."(p. 150)

However, according to Ashenfelter (1994), under investment in education has been considerable in the United States. A theoretical explanation for this phenomenon is provided by Turrini (1998) who shows that endogenous public investments in human capital can enhance the skilled/unskilled income differentials that arise from technology or trade shocks. He shows that sub-optimal responses to changes in returns to skills are not due to individuals' behaviour, but rather are

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[19] "Education is one channel through which attitudes can penalise. People who in their formative years do not believe that their work opportunities will be of much value to them are likely to invest less time and money in their education on this account. Thus they will be less able in their adult years to pick up the skills needed to earn good wages. The low pay and the poor prospects for future pay raises are likely in turn to affect their morale, with the result that their participation in the labour force is not sustained and their capacity to perform well in entry-level jobs is impaired." (p. 52)

[20] This is reminiscent of an idea forwarded by Acemoglu and Zilibotti (1999): "Many technologies used by the LDCs are developed in the OECD economies, and as such are designed to make optimal use of the skills of these richer countries' workforces. Due to differences in the supply of skills, some of the tasks performed by skilled workers in the OECD economies will be carried out by unskilled workers in the LDCs. Since the technologies in these tasks are designed to be used by skilled workers, productivity in the LDCs will be low." They show that upon endogenising skill acquisition decisions, improving the relative supply of skills in the LDCs leads to productivity convergence. Cf. also Acemoglu (1998).

attributable to government policy based on median voter behaviour. Turrini shows that the less equal the means of education are spread over the population, the less the median voter will be inclined to invest in education. Moreover, assuming the medium voter is relatively unskilled, he or she attaches lower value to additional skills if these are to be employed in low paid sectors. In both cases the government does not respond with additional education to the increasing earnings gap. Given the relatively large differences in earnings in America – cf. Table 3 below - this might explain why schooling productivity is lower in America.[21]

The lower productivity of schooling also appears from Tables 1 and 2 below.

Table 1        Mean literacy scores in 1994-5[22]

|  | US | UK | NL | Ger |
|---|---|---|---|---|
| less than upper secondary | 199,9 | 247,4 | 262,6 | 276,1 |
| upper secondary | 266,1 | 285,5 | 302,3 | 295,4 |
| tertiary | 302,5 | 311,8 | 311,2 | 314,5 |
| all levels | 267,9 | 267,5 | 286,9 | 285,1 |

Table 2        Mathematics achievements, 1995[23]

|  | US | UK | NL | Ger |
|---|---|---|---|---|
| fourth grade | 407 | 376 | 438 | - |
| eighth grade | 500 | 506 | 541 | 509 |

Since the number of years of schooling in the United States is not lower, it seems reasonable to infer that schooling of unskilled workers in America is less productive. As a consequence we assume that with respect to skill formation for unskilled persons in America the following relation holds:[24]

$$s = \underline{s}(a,\underline{t}) = \xi.k \cdot e^{af(t)} \qquad \qquad \xi < 1, \quad a < \tilde{a}* \qquad \qquad (16)$$

where the fact that $\xi < 1$ indicates that schooling in America is less productive. Therefore unskilled workers in America are less efficient, when compared to Europe. However, for skilled persons skill formation is similar to that in Europe, cf. equation (10).

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[21] Ideally we should incorporate Turrini's analysis in our model of human capital formation. However, this would complicate the analysis too much.

[22] For persons aged 16-65, on a scale with a range of 500 points. Source: OECD, 1998a.

[23] Source: OECD, 1998b.

[24] Since $\tilde{a}*$ is endogenous, cf. equation (15), the assumption $a < \tilde{a}*$ typically is made for analytical convenience. The proper way would be to assume that equation (16) holds for $a < a^{max}$ and later on show $a^{max} < \tilde{a}*$. However, this would complicate the analysis considerably, without altering its qualitative results.

### 4.3 Hours worked and the wage gap between Europe and America

It was assumed above that there is an institutional minimum hourly wage equal to $w_L^* = s(\underline{a}, \underline{t}) \cdot \tilde{w}_L^*$ for the unskilled in Europe. It seems reasonable to assume that this nominal minimum wage is set at a level such that the expected wage for the unskilled in Europe is just at 'subsistence level'. If the unskilled are assumed to work a normal amount of hours $hrs_{Eur}$, then their annual expected wage would be equal to

$$Y^{\min} = \{1 - (1 - b) \cdot u\} \cdot s(\underline{a}, \underline{t}) . \tilde{w}_L^* \cdot hrs_{Eur} . \tag{17}$$

This is the minimum income required to make a normal living, both in Europe and in America[25].

Factor price equalisation assures that the European unskilled efficiency wage per hour is inherited by America, i.e. $\tilde{w}_L^*(Am) = \tilde{w}_L^*(Eur) = \tilde{w}_L^*$. But since the unskilled are less efficient in America because $\xi < 1$, the hourly wage for unskilled workers is lower than in Europe, i.e. $w_L^*(Am) = \xi . w_L^*(Eur)$. This can also be observed from the data.

The data in Table 3 illustrate the relatively low unskilled wage in the United States. As Gottschalk and Smeeding (1997, p. 636) note, almost all industrial economies experienced some increase in wage inequality among prime aged males during the 1980s (Germany and Italy are the exceptions). But large differences in trends also exist across countries, with earnings inequality increasing most in the US and the UK and least in Nordic countries.

Table 3          Earnings dispersion in 1994 (*=1993)[26]

|       | US   | UK   | F    | Ger   | NL   |
|-------|------|------|------|-------|------|
| D9/D5 | 2,07 | 1,86 | 1,99 | 1,61* | 1,66 |
| D5/D1 | 2,10 | 1,78 | 1,65 | 1,44* | 1,56 |

From the table one sees that the US has the largest inequality. Gottschalk and Smeeding (1997, p. 643-6) note that for males this largely reflects considerably lower earnings at the bottom of the distribution. The earnings of persons at the tenth percentile are lower relative to the median in the US than in any other country. Moreover, persons at the bottom of the earnings distribution in the US fare poorly not only relative to the median in the US but also relative to persons at the P10 in other

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[25] This hinges on the assumption of free trade and zero transport costs such that goods prices are equalised.

[26] *Source*: OECD, 1996, table 3.1, pp. 61-2.

countries. As a possible explanation they mention the erosion of the real minimum wage. During the 1980s the real minimum wage fell by 44%.

Pursuing the above analysis, since wages are flexible, there is no unskilled unemployment in America.[27] Given the minimum income required, $Y^{min}$, the expected annual wage for the American unskilled should be equal to $Y^{min} = \xi \cdot \widetilde{w}_L^* \cdot hrs_{Am}$ when they work $hrs_{Am}$ hours. We then find the following equality

$$[1 - (1-b) \cdot u] \cdot \widetilde{w}_L^* \cdot hrs_{Eur} = \xi \cdot \widetilde{w}_L^* \cdot hrs_{Am}. \tag{18}$$

This implies that in order to earn a minimum living, unskilled workers in America are forced to work more hours than their European counterparts:

$$hrs_{Am} = hrs_{Eur} \cdot \left[ \frac{1 - (1-b) \cdot u}{\xi} \right] \tag{19}$$

It seems highly plausible that the efficiency gap between America and Europe is insufficient to counteract the unemployment effect.[28] Then the ratio on the right-hand side of equation (19) is larger than unity, hence hours worked in America will exceed those in Europe. This observation is perfectly consistent with Gottschalk and Smeeding (1997, p. 646) who note that if demand functions are not totally inelastic, employment will increase as the real minimum wage declines. This increase in hours will offset part of the decline in the wage, leading to a smaller increase in the dispersion of earnings than wages. Or as OECD (1990, p.90) states:" in the US, low-paid workers work longer hours than in most other countries, which pushes up their earnings when measured on an annual basis".

Finally it is interesting to observe in this context that in the US the number of hours worked has increased, while in other countries it has decreased, sometimes quite substantially – cf. Table 4.

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[27] Actually, this is not supported by facts: Although the general unemployment rate in the US is considerable lower than in Europe, the unemployment rate by educational attainment in 1996 for less than upper secondary and upper secondary skilled workers was 10,9 and 5,1 per cent, respectively, in the US, whereas it was 12,7 and 8,5 in the EU. OECD (1999) ,table D, pp. 238-9.

[28] Assuming a replacement ratio of 0,7 and an unemployment rate of 0,15, we find $1 - (1-b) \cdot u = 0,955$.

Hence as soon as the difference in quality exceeds 4,5 per cent this is already the case. Using the data in Table 2, a comparison for illiteracy between the US on the one hand and the UK and Germany on the other shows that the quality difference is 33% for less than upper secondary workers and 9% for upper secondary skilled ones.

Table 4        Average annual hours actually worked per person in employment[29]

|      | US    | UK    | F     | Ger   | NL    |
|------|-------|-------|-------|-------|-------|
| 1990 | 1.936 | 1.704 | 1.539 | 1.557 | 1.433 |
| 1997 | 1.966 | 1.701 | 1.519 | 1.498 | 1.365 |

## 4.4     America and Europe compared

Since relative wages are equal in terms of efficiency units and equation (18) holds, it follows from the arbitrage equations (12) and (15) that the marginal ability in America will be equal to that in Europe, i.e. equal to $\tilde{a}^*$. It then follows from equations (9) and (14) that $E$ and $H$, respectively, are equal in Europe and America too. However, since $\xi.hrs_{Am} = hrs_{Eur}[1-(1-b)u]$, one sees from equation (14), that $L$ is lower in America, when compared to Europe. That is,

$$L^{Am} \equiv \int_{\underline{a}}^{\tilde{a}^*} hrs_{Am}.\xi.s(a,\underline{t})\,da < L_{Eur} \equiv \int_{\underline{a}}^{\tilde{a}^*} hrs_{Eur}.s(a,\underline{t})\,da \qquad (20)$$

Hence, although the number of unskilled persons is equal in both countries, the number in efficiency units in America is lower. As a consequence we also find the above mentioned result that due to the less productive education the efficiency of the unskilled in America is lower when compared to those in Europe.

Since unskilled labour in terms of efficiency units in America at full employment is below that in Europe with unemployment, the supply curve of labour for America will lie between $h^s$ and $h^s_{u=u*}$ in Figure 2. It is presented as $h^s_{Am}$ in Figure 3 and equilibrium will be at full employment in point B, with employment $h^*_{Am}$.

Analogous to the analysis in Figure 1 we then will find again an excess demand for skilled workers which essentially is realised in Europe, through the import of skill-intensive goods by America. This shifts the demand curve for labour towards $h^D_{Eur}$ in Figure 3. The unemployment line in Figure 3 will not change, since the wage remains fixed at $\tilde{w}^*$. Unemployment in Europe then will be $u^{**}$ which exceeds the level $u^*$ in absence of trade. However, since labour supply in America is higher than at full employment in Europe, i.e. $h^*_{Am} > h^F$, unemployment in Europe will no longer double – as it did in Figure 1.

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[29] Source: OECD, 1999.

Figure 3       *America and Europe*
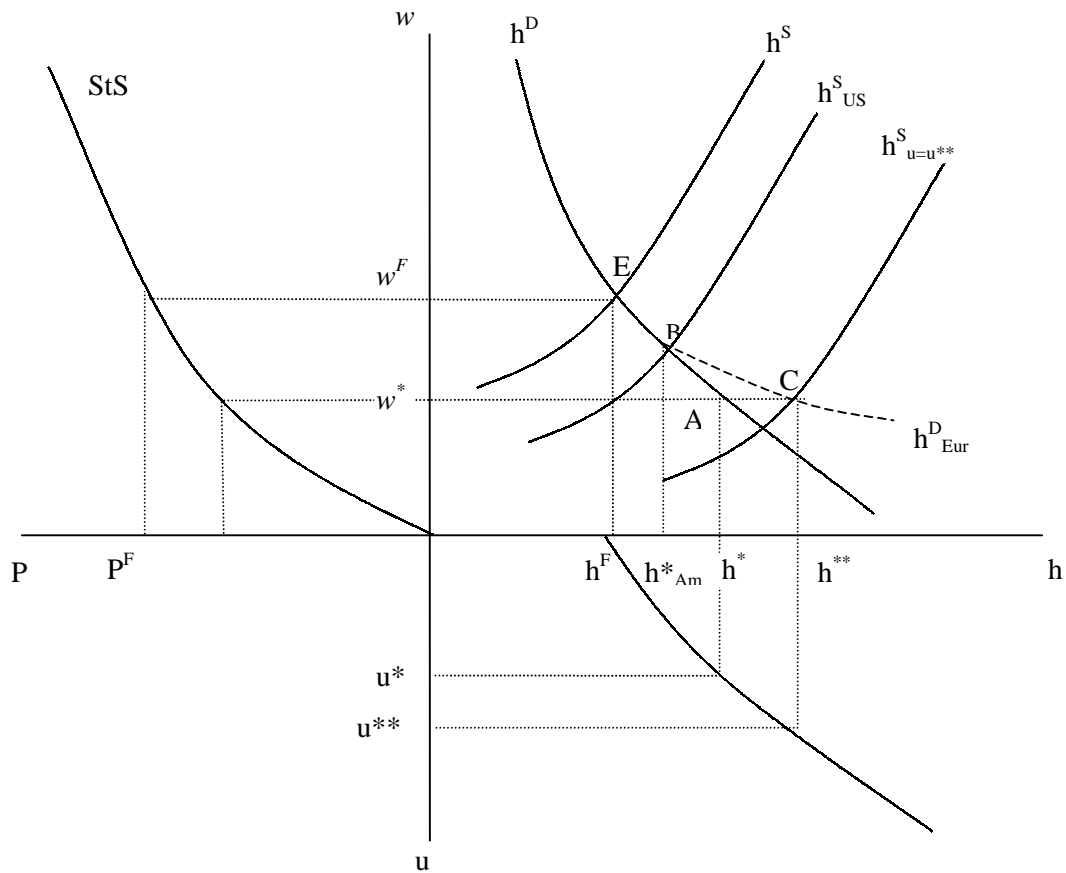


## 5       Concluding remarks

In this paper we have examined the role of human capital accumulation in explaining both diverging unemployment and wage experiences in America and Europe. Our analysis emphasises the quality differences between unskilled workers, resulting from the relatively poor educational system in America for unskilled workers. The resulting differences between America and Europe are summarised in Table 5 below.

From the table one sees that our analysis explains the phenomenon of "Moneyless America, Jobless Europe" very well. Although the efficiency-corrected wages are equal, the wages per hour worked are lower for unskilled workers in America because of the lower efficiency of unskilled workers. This explains the higher wage inequality in America, when compared to Europe. Moreover, unemployment in Europe will occur through the imposed minimum wage. Although this minimum wage spills-over to America through international trade and factor price equalisation, because of the free labour market in America unemployment will not occur there. On the other hand, the lower efficiency of unskilled labour will force the unskilled workers to work more hours per year compared

*Table 5*        *America and Europe compared*

| | Relative wage per efficiency unit | Relative wage per hour worked | Unemployment | Hours worked per year |
|---|---|---|---|---|
| America | $\tilde{w}^*(Am) = \tilde{w}^*$ | $\dfrac{w_H^*}{w_L^*(Am)} > \dfrac{w_H^*}{w_L^*(Eur)}$ | $0$ | $hrs_{Am} > hrs_{Eur}$ |
| Europe | $\tilde{w}^*(Eur) = \tilde{w}^*$ | $\dfrac{w_H^*}{w_L^*(Eur)}$ | $u^{**}$ | $hrs_{Eur}$ |

to their European colleagues, in order to earn a subsistence income. Thus the additional phenomenon of longer working hours in America is explained too.

It seems reasonable to conclude that our model is able to explain all stylised facts mentioned in the introduction in a satisfactory way. However, on the one hand one should realise that not all stylised facts are as clear cut as they might seem – this holds in particular for the absence of low skilled unemployment in America.[30] On the other hand, one implication of our analysis seems highly implausible.[31] As it stands now, our analysis would predict that America is exporting skill-extensive goods to Europe, while importing skill-intensive goods from Europe. However, this is inconsistent with both casual observation and the literature. For instance, Maskus cs. (1994, p. 63) conclude that their "..characterisation of the skill basis of US trade with Europe would suggest that the US has the relative advantage in services of professional and managerial occupations and the relative disadvantage of skilled manual trades. The other categories, including semi-skilled manual and unskilled workers, occupy an intermediate position."

The implication therefore is that technological differences can not be ignored in the full analysis. Introducing monopolistic competition along the lines of Dinopoulos and Segerstrom (1999) seems a promising way to do this. Nonetheless, our analysis has proven to be a fruitful way to explain the stylised facts which we mentioned in the introduction and these have been explained neither by Davis and Reeve (1997) nor by Dinopoulos and Segerstrom (1999).

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[30] Cf. n26 above.
[31] This implication is ignored by Davis (1998a,b).

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## ANNEX:    A simple formal representation

In his analysis, Davis distinguishes between skilled labour $H$ and unskilled labour $L$ as factors of production, with prices $w_H$ and $w_L$, respectively. The relative price is $w = w_H/w_L$. Total supply is $H^F$ and $L^F$, respectively, and relative supply is given by $h^F = H^F/L^F$. Moreover, two goods are produced: the skill-intensive good is $X$ and the skill-extensive good is $Y$, where $P$ is the relative price of $X$ to $Y$.

Let consumers have the following utility function:

$$U = \left[X^\rho + Y^\rho\right]^{1/\rho} \qquad 0 < \rho < 1, \tag{1}$$

where $1/(1+\rho)$ is the elasticity of substitution between $X$ and $Y$. Maximisation of utility subject to the budget constraint $I = P_X X + P_Y Y$, with a given income $I$ yields:

$$\frac{X}{Y} = \left[\frac{P_X}{P_Y}\right]^{-\frac{1}{1-\rho}}, \tag{2}$$

which shows that the relative consumption of skilled to unskilled goods is inversely related to the relative price.

The production of goods is represented by a Cobb-Douglas production function:

$$X = H_X{}^\alpha L_X{}^{1-\alpha} \qquad\qquad 0 \le \beta < \alpha \le 1$$

$$Y = H_Y{}^\beta L_Y{}^{1-\beta}, \tag{3}$$

where $\beta < \alpha$ indicates that $X$ is the skill-intensive and $Y$ the skill-extensive good.

Profit maximization subject to equations (3) yields:

$$w_H = \alpha P_X \left[\frac{H_X}{L_X}\right]^{\alpha-1} = \beta P_Y \left[\frac{H_Y}{L_Y}\right]^{\beta-1} \tag{4a}$$

$$w_L = (1-\alpha)P_X \left[\frac{H_X}{L_X}\right]^{\alpha} = (1-\beta)P_Y \left[\frac{H_Y}{L_Y}\right]^{\beta} \tag{4b}$$

Eliminating $H_X/L_X$ and $H_Y/L_Y$ respectively yields:[32]

$$\frac{w_H}{w_L} = k_1 \left[\frac{P_x}{P_y}\right]^{\frac{1}{\alpha-\beta}} \tag{5}$$

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[32] Here $k_1{}^{\alpha-\beta} = \alpha^\alpha (1-\alpha)^{1-\alpha} / \beta^\beta (1-\beta)^{1-\beta}$

This implies that the supply price of skill-intensive goods will be higher, the higher the skilled wage is. Davis calls the implied positive relation between $w$ and $P$ the 'Stolper-Samuelson'-curve. An interpretation of this relationship is that when the relative price $P$ increases, it is easier to make profit on $X$. Therefore skills will be lured away from $Y$ to $X$ and $w$ will increase.

Actually Davis depicts the StS-curve as a negative relation between the relative price and the minimum wage. This also follows from equations (4), since one can also derive:[33]

$$\frac{P_X}{P_Y} = k_2 \left[ \frac{P_Y}{w_L} \right]^{\frac{\alpha}{\beta}-1} \tag{6}$$

When we look at demand for labour more explicitly, we define for aggregate demand:

$$H = H_X + H_Y$$
$$L = L_X + L_Y \tag{7}$$

Let us define for simplicity: $h = H/L$, $h_X = H_X/L_X$ and $h_Y = H_Y/L_Y$. Then we can derive from equation (7):

$$\frac{L_X}{L_Y} = \frac{h_Y - h}{h - h_X} \tag{8}$$

Actually equations (4) yield $h_X$ and $h_Y$ as a function of relative prices:[34]

$$h_X = k_X \left[ \frac{P_X}{P_Y} \right]^{-\frac{1}{\alpha-\beta}} and \sim\sim h_Y = k_Y \left[ \frac{P_X}{P_Y} \right]^{-\frac{1}{\alpha-\beta}} \tag{9}$$

Moreover, combining equations (2) and (3) also yields $L_X/L_Y$ as a function of relative prices:

$$\frac{L_x}{L_Y} = \frac{h_Y{}^{\beta}}{h_X{}^{\alpha}} \left[ \frac{P_X}{P_Y} \right]^{-\frac{1}{1-\rho}} \tag{10}$$

Substitution of equations (9) and (10) in (8) then results in a relation between $h$ and $P$ which represents the demand curve for labour:

$$h = P^{-\frac{1}{\alpha-\beta}} \frac{k_X k_Y{}^{\beta} P^{-\frac{\rho}{1-\rho}} + k_Y k_X{}^{\alpha}}{k_Y{}^{\beta} P^{-\frac{\rho}{1-\rho}} + k_X{}^{\alpha}} \tag{11}$$

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[33] Here $k_2 = \beta^{\alpha} (1-\beta)^{\alpha/\beta-\alpha} / \alpha^{\alpha} (1-\alpha)^{1-\alpha}$

[34] Here $k_X{}^{\alpha-\beta} = \beta^{\beta} (1-\beta)^{1-\beta} / \alpha^{\beta} (1-\alpha)^{1-\beta}$ $and \sim\sim k_Y{}^{\alpha-\beta} = \beta^{\alpha} (1-\beta)^{1-\alpha} / \alpha^{\alpha} (1-\alpha)^{1-\alpha}$

The demand curve for labour we use is found by substituting equation (5) in equation (11).

However, substitution of equation (6) in equation (11) shows that relative labour demand can also be seen as a function of the unskilled wage relative to the price of the skill extensive good, i.e. $w_L/P_y$. As a consequence, when $w_L/P_y$ is set at $(w_L/P_y)^*$, then demand for labour is determined uniquely at $h^*$ and hence the relative wage at $w^*$ and the relative price at $P^*$.