NBER WORKING PAPERS SERIES

DO LOW-INCOME COUNTRIES HAVE A HIGH-WAGE OPTION?

Dani Rodrick

Working Paper No. 4451

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 1993

I am grateful to Paolo Manasse, Elhanan Helpman, and other participants at the conference on the New Trade Theories: A Look at the Empirical Evidence, May 27-29, 1993, Milan, for helpful comments, and to Giovanni Maggi and Bob Staiger for bringing Andres Rodriguez's work to my attention. This paper was prepared under a cooperative agreement between the Institute for Policy Reform (IPR) and the Agency for International Development (AID), Cooperative Agreement No. PDC-0095-A-00-1126-00. This paper is part of NBER's research programs in International Trade and Investment and International Finance and Macroeconomics. Any opinions expressed are those of the authors and not those of IPR, AID, or the National Bureau of Economic Research.

NBER Working Paper #4451
September 1993

DO LOW-INCOME COUNTRIES HAVE A HIGH-WAGE OPTION?

ABSTRACT

Poor countries must specialize in standardized, labor-intensive commodities. Middle-income countries may have a richer menu of options available to them if their labor force is reasonably well-educated and skilled. This paper is motivated by the possibility that there may exist multiple specialization patterns for countries of the second type. What creates the multiplicity of equilibria is a coordination problem inherent in high-tech activities. It is assumed that high-tech production requires a range of differentiated intermediate inputs that are non-tradable. For the high-tech sector to become viable, a sufficiently large number of intermediaries has to be produced domestically. But if none is currently being produced, there is little incentive for any single firm to do so on its own. The economy may get stuck in a low-wage, low-tech equilibrium--even though the high-tech sector is viable. As long as the high-tech sector is more capital-intensive than the low-tech sector, a high-wage policy would get the high-tech sector going and be welfare-enhancing.

Dani Rodrick
International Affairs Building
Room 1312
Columbia University
New York, NY 10027
and NBER

a new equilibrium with higher real income. When the new equilibrium entails complete specialization in the high-tech sector, the high-wage policy can be self-sustaining in the sense that it need not be incompatible with full employment of labor. But even when the new equilibrium requires a lower wage than prevailed in the initial, low-tech equilibrium, the shift to the superior equilibrium can be attained only by a policy that maintains wages temporarily high. That is, high wages are required to get the transition going.

The simplest way to analyze the model laid out in the previous section is by using unit-cost contours. Figure 1 shows a pair of these contours, one each for the low-tech and high-tech sectors. The unit-cost contour for the low-tech sector is the locus of w and r combinations that satisfy the condition $\theta(w,r)=1$. From cost-minimization, the slope of the contour at any point yields the desired capital-labor ratio at the associated factor-price combination.

The iso-cost contour for the high-tech sector is analogous, but reqires a bit more comment. This sector does not use labor directly. But since intermediate-goods require labor (and labor only), we can derive a unit-cost contour in (w,r) space for this sector also. Substituting for p from (3), equation (2) becomes:

$$\phi(r,\ w\lambda(h)c(z)n^{-\frac{1}{\sigma-1}}) = \pi \qquad (8)$$

We note that z is fixed by equation (4). This then defines a unit-cost contour for the high-tech sector, with the position of the contour depending on h and n. An increase in h or n shifts the contour out: in words, a more skilled work force or a larger number of intermediate varieties allows the high-tech sector to sustain (when it is active) larger factor payments to labor and capital.

basis of their labor-cost advantages rather than the skill level of their work force (Collins and Rodrik, 1991, pp. 57-61).

The case of Eastern Germany provides an appropriate contrast to the strategies of Poland, Hungary and (former) Czechoslovakia. Here, the monetary conversion to the DM at the 1:1 rate and the subsequent push by trade unions for wage equalization with the Western part of the country have resulted in a sharp increase in nominal wages. Since labor productivity currently stands at a fraction of Western Germany's, many observers have concluded that this increase in wage costs threatens continued mass unemployment. The German government has chosen to respond by heavily subsidizing investment in the East. In the words of Giersch (1992, p. 11):

> The capital-intensive development path, now de facto chosen for Germany's Eastern territories, will, if not corrected in a short period of time, lead to a pattern that has the characteristics of a dual economy.... There will be highly productive jobs in very modern plants, but too few of them for offering industrial employment opportunities for large numbers of people. Too many will remain unemployed or will have to migrate to the West.... Only some time in the next century can this development path lead to a viable economy--then with a high standard of technology.... In the meantime, Germany is likely to have her "mezzogiorno" in the East as Italy has it in the South.

Perhaps. What this account ignores is that the East German workforce is a well-educated and highly-skilled one (which makes the mezzogiorno comparison perhaps somewhat inappropriate). A priori, there is little reason to believe that this workforce cannot sustain labor productivity levels similar to that found in the West. And the high level of current wages may well have the desirable effect of drawing resources into high-tech industries that can utilize these skills, rather than into simple assembly operations.[1] The real

---

[1]This is seen clearly in the Treuhandanstalt's strategy for attracting foreign capital, which heavily relies on extolling the high quality of the labor force: "Western German businesses are not

question is whether about ten years down the line the Eastern part of the country will end up with an industrial structure that can sustain higher living standards than it would have had otherwise.

That there might be a trade-off between maintaining low wages and achieving industrial upgrading has long been a concern in East Asian countries. The Singaporean government, in particular, has sought to discourage labor-intensive industries and promote high-tech industries by raising minimum wages and discouraging immigration. In the words of the Financial Times, "[u]nable to compete on wages, land, or on the size of its domestic market, Singapore has quite deliberately priced itself out of the business of low-cost manufacturing" (March 29, 1993, p. II*)[2]. In Indonesia, policy makers have been debating for some time the virtues of a strategy that relies less on low wages and more on skills and human capital. The debate is well summarized by the headine of a Wall Street Journal article: "Indonesia is Divided Over How to Compete: Low Cost or High Tech" (March 25, 1993, p. A1). "We should be focusing on what we have: a low-cost labor force and raw materials," an Indonesian businessman is quoted as saying. The minister of research and technology (B.J. Habibie) retorts: "That theory is totally wrong.... How can you buy ships by selling fish?

---

the only ones to recognize eastern Germany's industrial strength. Other countries also acknowledge that the quality seal "Made in Germany" has taken on a broader significance, because of the great potential for innovation shown by eastern German companies, the strong motivation of their employees, and their extensive industrial know-how. As a result of close cooperation between the Treuhandanstalt and many dynamic entrepreneurs, modern business and industrial structures are emerging. With the well-trained and forward looking people of the new German federal states, investors can profit from increased trade...." (from an ad in the Financial Times, April 20, 1993). No mention of low labor costs here!

[2]Young (1992) and Lim, Fong, and Findlay (1993, pp. 115-116) argue that it may have gone too far in doing so.

How can you buy technology by making jeans? You cannot take that step-by-step approach. You have to leap ahead" (p. A9).

I argue in this paper that Mr. Habibie may well have a point. Countries that are poor yet reasonably well-endowed with human capital may indeed have a choice between two patterns of specialization: one that relies on labor-cost advantages, and one that relies on more sophisticated, high(er)-tech production. A strategy that raises wages (by lifting the minimum wage or subsidizing investment, for example) can not only push the economy in the direction of the more desirable equilibrium, but, in view of the higher living standards thereby resulting, be self-sustaining.

What creates the multiplicity of equilibria is a coordination problem inherent in high-tech activities. In the model considered below, high-tech production requires a range of differentiated intermediate inputs (as in Ethier, 1982; see also Markusen, 1989) that are non-tradable.[3] For the high-tech sector to become viable, a sufficiently large number of intermediates has to be produced domestically. But if none is currently being produced, there is little incentive for any single firm to do so on its own. In view of the interdependence of production decisions, then, the economy may get stuck in a low-wage, low-tech equilibrium--even though the high-tech sector is viable. As long as the high-tech sector is more capital-intensive than the low-tech sector, a high-wage policy would get the high-tech sector going and be welfare-enhancing.

This paper has some similarities to a number of well-known papers

[3]The joint significance of non-tradability and increasing returns was considered by Faini (1984) in the context of regional development issues. Porter (1990) provides a compendium of case studies which emphasize the importance of home demand.

with multiple equilibria in the presence of increasing returns (Azariadis and Drazen, 1990; Krugman, 1991; Matsuyama, 1991; Murphy, Shleifer, and Vishny, 1989). It differs from Azariadis and Drazen in its focus on inter-sectoral relations, Murphy et al. in its focus on an open economy, and from Krugman and Matsuyama in the role played by different factor-price configurations in selecting an equilibrium.

The approach taken here bears an especially close affinity to recent work by Rodriguez (1993).[4] As in the present paper, Rodriguez (1993) considers a model with two tradable final goods and a non-tradable sector that produces intermediate good varieties under increasing returns. Under the assumption that the two final goods differ in their intensity of use of intermediates, he demonstrates the possibility of multiple specialization patterns. When the economy specializes in the good that is intensive in intermediates, the return to capital and the wage rate may be higher than in the alternative equilibrium (which is also a feature of the present model). Rodriguez's focus is on identifying an "underdevelopment trap", and on explaining why rates of return to capital may be equalized among countries with very different levels of development.[5] He does not

---

[4]I became aware of Rodriguez's work after the first draft of this paper was completed and presented.

[5]See also Ciccone and Matsuyama (1993). This paper analyzes, in a growth setting, the interdependence of production decisions in a downstream consumer-goods industry with the size of the intermediate-goods sector. When a sufficiently large number of intermediate varieties is produced, downstream firms choose a more "roundabout" technology, making more intensive use of intermediates, and ultimately experience higher productivity. However, the decision to enter the intermediate-goods sector, which involves a set-up cost, is in turn dependent on anticipated market size downstream. Manasse (1992) also generates multiple equilibria, by focussing on the externality in each workers' decision to acquite skills. Calvo (1993) analyzes the possibility that an economy's growth rate may be indeterminate due to the interaction between pre-existing debt and the tax required to service it. Nelson (1956) is the grandfather of low-level equilibrium

discuss the issue of labor skills or the potential role of government wage policy in picking the more desirable equilibrium.

II. The Framework

We focus on a small-open economy that can produce two tradable final goods. Both of these goods are produced under constant returns to scale. The first of these is a labor-intensive, low-tech good, requiring labor and capital. Its unit cost function is given by $\theta(w, r)$, with w and r standing for the wage and rental rates prevailing in the economy. If the low-tech good is produced in equilibrium, its unit cost will equal the exogenous world price (which we fix to unity):

$$\theta(w,r) = 1 \tag{1}$$

The output of the low-tech sector is denoted by Y.

The high-tech sector uses capital and a range of intermediate goods (producer services and specialized inputs) that are imperfect substitutes for each other. We use the Dixit-Stiglitz-Ethier specification for these intermediates, so that the production function of the high-tech sector can be written as follows:

$$X = G(K_x, \ [\sum_{i=1}^{n} z_i^{\beta}]^{1/\beta})$$

where X is the output of the high-tech sector, K_x is the capital employed in this sector, z_i is the quantity of intermediate input i, and β is a parameter linked to the elasticity of substitution (σ) between any two input varieties (with $\beta = [\sigma-1]/\sigma > 0$). The function

---

trap models.

G(.) is assumed to be linearly homogeneous in capital and the aggregate of the intermediates taken together. That is, if we let $\Omega = (\Sigma z_i^{\beta})^{1/\beta}$, the high-tech sector exhibits constant returns to scale in K and Ω.

As usual, we will focus on a symmetric equilibrium where n intermediate varieties are produced at identical levels. In this case, it can be shown that the unit cost function that serves as the dual of G(.) can be written as $\phi(r, pn^{-1/(\sigma-1)})$, where p is the price of the representative intermediate. Let the world price of the high-tech sector be π. Then, if the high-tech sector is active in equilibrium, the following must hold:

$$\phi(r, pn^{-\frac{1}{\sigma-1}}) = \pi \tag{2}$$

Note that the productivity of the high-tech sector is linked to the number of input varieties available: as n increases, unit costs in the high-tech sector decline. (This assumes $\sigma>1$, which is a condition for an interior equilibrium in the intermediate-goods market--see below.)

The intermediates are non-tradable. They are produced using labor and under increasing returns to scale. Intermediate-good production is assumed to be skill-intensive, so that the quality of the work force is taken to be an important determinant of costs in this sector. The unit cost function of the representative intermediate is expressed as $w\lambda(h)c(z)$, where h is an index of the skill level of the work force (so that $\lambda'(h)<0$). Due to increasing returns, $c'(z)<0$.

The presence of scale economies implies that each intermediate will be produced by a single firm under monopolistically competitive conditions. Free entry eliminates excess profits, so that when this sector is active prices will just cover average costs:

$$w\lambda(h)c(z) = p \qquad (3)$$

In addition, the first-order condition of each producer requires that marginal costs equal marginal revenue, or that the reciprocal of the elasticity of demand be equal to the percentage premium of price over marginal cost ([p-MC]/p). If the number of intermediates is large, the (absolute value of the) demand elasticity faced by each producer will be approximated by the elasticity of substitution σ (see Helpman and Krugman, 1985, p. 119). In view of (3), p/MC = AC/MC. And since the cost function is assumed separable in w, h, and z, the ratio AC/MC depends only on z, and can be written as AC/MC = $\mu(z)$. The result is that the equality between marginal cost and marginal revenue can be written in a simple form:

$$\mu(z) = \frac{\sigma}{\sigma-1} \qquad (4)$$

This fixes the output level of each intermediate as a function of the elasticity of substitution alone. Hence, any change in the scale of the intermediate sector will have to come from a change in n. (Note also that eq. [4] rules out the possibility that $\sigma<1$.)

The partial derivatives of the unit cost functions with respect to factor prices yield unit factor demands. These can be used to express the factor-market clearing equations. The conditions for full employment of capital and labor, respectively, are given by:

$$\theta_r(w,r)\,Y + \phi_r(r,\; pn^{-\frac{1}{\sigma-1}})\,X = K \tag{5}$$

$$\theta_w(w,r)\,Y + \lambda(h)\,c(z)\,nz = L \tag{6}$$

The unit intermediate demand of the high-tech sector is similarly given by the derivative of the unit cost function with respect to the input price. Since the total intermediate supply is nz, the market-clearing equation for intermediates is given by:

$$\phi_p(r,\; pn^{-\frac{1}{\sigma-1}})\,X = nz \tag{7}$$

This completes the description of the model.[6] There are seven endogenous variables in this system: w, r, p, n, z, X, Y. How they are determined will depend on the pattern of specialization that obtains. There are three possibilities. In a diversified equilibrium, with both Y and X produced, equations (1)-(7) above jointly determine the values of the seven endogenous variables. In a low-tech equilibrium, when the high-tech and intermediate-goods sectors are inactive, equations (1), (5) and (6) will determine w, r, and Y (with X=n=z=0). In a high-tech equilibrium, on the other hand, Y=0, and equations (2)-(7) will determine the remaining six endogenous variables.

III. Analysis of the Model

[6] Rodriguez's (1993) model differs from this one in the following respects: (i) the two final goods are produced using Cobb-Douglas technology; (ii) both final goods use intermediate goods, but with different intensities; (iii) the intermediate sector has constant marginal wage costs but requires a fixed capital cost; (iv) there is no allowance for h.

A key feature of the model is that the competitiveness of the high-tech sector depends on both the skill level of the workforce (h) and on the range of domestically produced intermediate varieties (n). For a sufficiently low level of h, the high-tech sector will not be competitive even when the economy produces the maximum feasible number of intermediates (which is reached when the entire labor force is employed in the intermediate-goods sector). For a sufficiently high level of h, the high-tech sector will be competitive even when a very small number of intermediate goods is produced.

But when h is neither too high nor too small, the economy can have two equilibria: one in which the economy specializes in the low-tech sector and the high-tech sector remains uncompetitive, and another one in which the high-tech sector is competitive and becomes active. The possibility of multiple equilibria arises from a coordination problem. If the economy is initially specialized in the low-tech sector, it will not pay for any single firm to enter the high-tech (or the intermediate-goods sector) at the prevailing factor prices, even though a large-scale shift of resources in that direction can be both privately and socially profitable. The reason, in turn, is that there will be demand for intermediates only if a sufficiently large number of them is being produced. Hence the profitability of being in the intermediate-goods sector depends on the number of other firms already there.

Here the government's wage policy can play an important role. Since the high-tech sector is capital intensive, a government-set floor on wages is effectively a tax on the low-tech sector and a subsidy to the incipient high-tech sector. A sufficiently high minimum wage will prompt entry into the high-tech sector and result in a new equilibrium with higher real income. When the new equilibrium entails complete specialization in the high-tech sector, the high-wage policy can be self-sustaining in the sense that it need not be incompatible with full employment of labor. But even when the new equilibrium requires a lower wage than prevailed in the initial, low-tech equilibrium, the shift to the superior equilibrium can be attained only by a policy that maintains wages temporarily high. That is, high wages are required to get the transition going.

The simplest way to analyze the model laid out in the previous section is by using unit-cost contours. Figure 1 shows a pair of these contours, one each for the low-tech and high-tech sectors. The unit-cost contour for the low-tech sector is the locus of w and r combinations that satisfy the condition $\theta(w,r)=1$. From cost-minimization, the slope of the contour at any point yields the desired capital-labor ratio at the associated factor-price combination.

The iso-cost contour for the high-tech sector is analogous, but reqires a bit more comment. This sector does not use labor directly. But since intermediate-goods require labor (and labor only), we can derive a unit-cost contour in (w,r) space for this sector also. Substituting for p from (3), equation (2) becomes:

$$\phi(r,\ w\lambda(h)c(z)n^{-\frac{1}{\sigma-1}}) = \pi \tag{8}$$

We note that z is fixed by equation (4). This then defines a unit-cost contour for the high-tech sector, with the position of the contour depending on h and n. An increase in h or n shifts the contour out: in words, a more skilled work force or a larger number of intermediate varieties allows the high-tech sector to sustain (when it is active) larger factor payments to labor and capital.

The slope of the high-tech iso-cost contour shows the relative factor demands of the sector at any given factor price combination. To see this, note that the capital and (derived) labor demands of the sector are given by:

$$\phi_r(.)X = K_x \tag{9}$$

$$\lambda(h)c(z)nz = L_x \tag{10}$$

Along the iso-cost contour:

$$\phi_p(.)\left(\frac{dp}{dw}\right)dw + \phi_r(.)dr = 0 \tag{11}$$

And since dp/dw = λ(h)c(z) from (3), combining (9)-(11) yields:

$$\frac{K_x}{L_x} = \frac{\phi_r(.)}{\lambda(h)c(z)\phi_p(.)} = -\frac{dw}{dr} \tag{12}$$

As drawn this contour is steeper than the one for the low-tech sector, since the high-tech sector is capital-intensive relative to the low-tech sector.

Hence, with the proviso that the location of the high-tech iso-cost contour depends on n (an endogenous variable in this model), we can use standard geometric tools to analyze the properties of various kinds of equilibria. To locate an equilibrium, we follow the procedure below.

For any given n, the outer envelope formed by the two iso-contour curves determines the feasible factor-price frontier for the economy. Note the kink in this frontier where the two contours intersect. For full employment to result, the equilibrium must lie on a point of tangency between this frontier and a line whose slope (with a minus sign) is equal to the economy's aggregate capital-labor ratio, k (= K/L). This point tells us the division of the economy's resources between the two sectors. If the point lies along either iso-cost contour alone, then the economy fully specializes in one of the two activities. On the other hand, if the point happens to be on the kink in the frontier (where the two contours intersect), then the result is a diversified equilibrium. The latter occurs when the economy's capital-labor ratio lies between the two limiting factor-demand ratios defined by the intersection of the two contours (i.e., the highest and lowest slopes consistent with remaining on the kink). These two ratios define the economy's zone of diversification. In a diversified equilibrium, the closer is the slope of a sector's iso-cost contour (at the kink) to the economy's capital-labor ratio, the greater is the share of resources claimed by that sector.

For this to be an actual equilibrium, however, the level of n for which the high-tech sector iso-cost contour is drawn must be consistent with the division of the economy's resources implied by the point of tangency. We must alter n (and correspondingly shift the high-tech contour) until we can locate such a point.

Using this apparatus, we now turn to analyze different types of equilibria that can emerge.

(i) Specialization in low-tech is the only feasible equilibrium. Figure 1 shows a high-tech contour drawn for the maximum feasible level of n, n^* ($= L/\lambda(h)c(z)z$), at which the economy would be fully specialized in the high-tech sector. As drawn, the economy's capital-labor ratio entails a point of tangency (A) along the low-tech sector contour, to the southeast of the kink. This implies:

$$\phi(\overline{r},\ \overline{w}\lambda(h)c(z)n^{*^{-\frac{1}{\sigma-1}}}) > \pi \qquad (13)$$

We note that any $n < n^*$ would shift the kink in the factor-price frontier further away from this point of tangency, and hence could not possibly represent an equilibrium outcome. Therefore, the only feasible equilibrium is at point A.

In this equilibrium, the economy is fully specialized in the low-tech sector. High-tech production would not be competitive, even if the economy's entire labor force was diverted to the intermediate-goods sector. Such an equilibrium obtains: (i) when h is very low (which keeps the high-tech iso-cost contour close to the origin), and (ii) when the economy has little capital (which keeps the point of tangency on the bottom part of the low-tech contour).

(ii) Specialization in high-tech is the only feasible equilibrium. Now suppose that the economy's h is much higher, so that, unlike in the previous case, the tangency obtains on the high-tech segment of the factor-price frontier. Consider Figure 2, where the high-tech contour drawn for $n = n^*$ is tangent to the economy's capital-labor ratio at point B. This point represents an equilibrium at which the economy fully specializes in the high-tech sector. It is evident from the figure that this equilibrium maximizes the economy's factor income while ensuring full employment.

However, for this to be the only feasible equilibrium, it must be the case that the economy cannot get stuck in an equilibrium where the low-tech sector is active. Since there is a coordination problem in the high-sector (as discussed above), this is not a foreordained conclusion.

At this point, we must make some assumption about the way that intersectoral adjustments and factor flows take place in this economy. This requires specifying out-of-equilibrium behavior. Let $\underline{n}$ denote the maximum number of firms that can <u>coordinate</u> their actions and jointly establish themselves in the intermediate-goods sector. It is natural to assume that $\underline{n}$ is a very small number relative to n*; for concreteness, we may think of $\underline{n}$ as unity (which is the usual assumption), implying that each potential firm acts independently. Constituting only a small part of the economy, the potential entrant(s) to the high-tech sector will decide to become active if it pays to do so at the prevailing factor prices. An equivalent way of stating this is that firms have Nash conjectures, and take all others' behavior as given.

Figure 2 shows the high-tech contour drawn for $n = \underline{n}$. The point of tangency between the economy's capital-labor ratio and the low-tech contour obtains at C. This is a potential low-tech equilibrium. As drawn, however, the position of point C relative to the high-tech contour at $n = \underline{n}$ ensures that this point can never be an equilibrium. The reason is that at the factor-price combination represented by C, it would pay for $\underline{n}$ number of firms to jointly establish themselves and get the high-tech sector going. (Point C lies below the factor-price frontier defined by the high-tech contour, even when $n = \underline{n}$.) Once this happens (and assuming that no diversified equilibrium is stable for the same reason--see below), we will end up at the equilibrium represented by point B. Therefore, a high enough level of h ensures that the only possible equilibrium is one with full specialization in the high-tech sector.

(iii) Multiple equilibria. As the previous cases make clear, the existence of a low-tech equilibrium depends on where the factor price frontier's tangency point with the economy's capital-labor ratio is located. Figure 3 shows the factor price frontier with the high-tech contour drawn for $n = \underline{n}$. Here the point of tangency lies along the low-tech segment of the frontier (shown as D). At the factor price combination implied by point D (w_0, r_0), the high-tech sector is uncompetitive for the initial entrant(s):

$$\phi(r_0,\ w_0\lambda(h)\,c(z)\,n^{-\frac{1}{\sigma-1}}) > \pi \tag{14}$$

Consequently, it does not pay for anyone to start production of the intermediate good. The economy remains fully specialized in the low-tech sector.

Also shown in Figure 3 is another equilibrium where the economy is fully specialized in the high-tech sector (point E). Factor rewards (w^*, r^*) are higher at E than in the previous equilibrium. This equilibrium is stable also, since at (w^*, r^*) low-tech production is unprofitable:

$$\theta(w^*, r^*) > 1 \tag{15}$$

Point E is obviously the better equilibrium, but the economy can get stuck at D because it will not pay for any single firm to locate anywhere but in the low-tech sector at the factor prices prevailing at D.

Since the problem here is one of coordination, the government could in principle simply command factor owners to move to the high-tech sector. But in practice command-and-control measures are unlikely to work well. Figure 3 suggests an alternative policy, which acts directly on factor prices. Let the government decree a minimum wage of $\underline{w}$. The impact effect of the minimum-wage policy will be to reduce r to $\underline{r}$ along the low-tech iso-cost contour (and to generate some incipient unemployment). At ($\underline{w}$, $\underline{r}$), it now pays firms to enter the high-tech sector. Therefore, the high-tech sector will get going, and we will end up at the more desirable equilibrium (point E).[7] Note that the minimum-wage policy is in fact non-binding in the new equilibrium, and labor is once again fully employed at the end of the transition.

The reason that a high-wage policy works to move the economy away from the low-tech equilibrium is that this sector is labor-intensive (by assumption). An increase in wages hurts the low-tech sector comparatively more, and pushes resources into other, high-tech activities where labor costs are less important. The flip-side of the coin is that a low-wage policy deters the establishment of a viable high-tech sector by making the low-tech sector more attractive for resources to move in.

As Figure 3 makes clear, another way of looking at the problem is that the economy has too high a labor endowment (relative to the capital stock), and therefore has a low-wage equilibrium that competes with the high-wage one. This suggests alternative policies besides a minimum-wage one. Going outside the model somewhat, a temporary capital subsidy, for example, would have the same ultimate effect as the minimum wage when capital is internationally mobile. By increasing the economy's capital-labor ratio, inflows of foreign capital would raise the wage-rental ratio, move us in the nothwesterly direction from point D, and render the high-tech sector eventually viable. Similarly, in a dynamic model, an investment subsidy would produce the same effect over time.

---

[7]There is a finer issue, though. The first firm entering the intermediate-goods sector will do so only if it is assured that there will be downstream demand for its product. In turn, the first final-good producer will need to know that there will be an intermediate-good supplier. So there may continue to be a coordination problem, but one at a much smaller scale, even at the set of factor prices that makes the high-tech sector viable.

Figure 3 shows the most advantageous case for the high-wage policy, insofar as the minimum-wage policy is not binding in the new equilibrium. There is no guarantee that this will indeed be the case. A look at the diagram should convince the reader that the high-tech equilibrium could involve a market-clearing wage that is not only lower than $\underline{w}$--the minimum wage needed to get the high-tech sector going--but possibly also lower than w_0--the wage prevailing at the low-tech equilibrium. The reason is that there are two countervailing effects on wages as we go from the low-tech to the high-tech equilibrium: (i) when viable, the high-tech sector generates real income gains that can be shared between labor and capital; (ii) being more capital-intensive, the high-tech sector entails a lower wage-rental ratio. The larger the productivity gains from moving to the high-tech equilibrium, the more likely that the first effect will dominate the second.

However, even when the eventual wage is lower, the geometry of Figure 3 makes clear that the transition will require a high-wage policy initially to make entry into the high-tech sector profitable. This is a direct consequence of the assumption that the high-tech sector is capital-intensive relative to the low-tech policy. If maintained for more than a very short period of time, the high-wage policy will in this case be binding and it will entail some unemployment of labor. But the economy can still be better off, as the productivity gains of specialization in the high-tech sector will be reaped in perpetuity (see section IV).

(iv) Diversified equilibrium. For completeness, we look at a case where the economy is incompletely specialized and produces both low-tech and high-tech goods. This shown in Figure 4. Equilibrium obtains at point F, at the kink of the factor-price frontier where the two iso-cost contours intersect. Note that the relevant high-tech contour is drawn for a level of n, n', that is intermediate between $\underline{n}$ and n* ($\underline{n} \leq n' < n^*$). Also, as drawn, full specialization in high-tech (shown at point G) would not pay, since this would entail moving inside the factor price frontier for the diversified equilibrium. We note from the geometry of this equilibrium that diversification is more likely when the factor intensities of the two sectors are very dissimilar and when h is not too high.

As in the previous case, a diversified equilibrium can co-exist with an equilibrium with full specialization in low-tech. Once again, a (temporary) high-wage policy will be needed to move the economy in the direction of the superior equilibrium. However, the market-clearing wage in a diversified equilibrium is necessarily lower than in the low-tech-only equilibrium, since both points lie on the same low-tech contour (compare points H and F in Figure 4). Therefore, a high-wage policy cannot be self-sustaining if the eventual equilibrium is a diversified one.

(v) Welfare. Let us now turn to discuss briefly the welfare properties of alternative outcomes under multiple equilibria. Note that there exist no coordination problems or market imperfections that interfere with the movement of resources from the high-tech to the low-tech sector. Furthermore, the low-tech sector operates under constant returns to scale and perfectly competitively. These two features guarantee that the size of the low-tech sector in any market equilibrium can never be too small from the perspective of social welfare. If the social value of a given bundle of resources in the high-tech sector can be enhanced by a move into the low-tech sector, there is nothing in the present model that would prevent this move from taking place. In terms of our diagrams, the economy would never locate at a point that lies below the low-tech iso-cost contour.

Hence, while the economy can get stuck in a low-tech equilibrium when a welfare-enhancing high-tech equilibrium exists, it cannot get stuck in an inferior high-tech equilibrium. Consequently, when a high-tech equilibrium exists, it entails at least as high a level of welfare as any contending low-tech equilibrium.

(vi) A numerical example. To solidify intuition regarding the workings of the model, it may be useful to present the solutions of a numerical exercise. Table 1 lists the assumptions made regarding functional forms and parameter values: the production functions of both final goods (and hence the associated unit cost functions) are taken to be Cobb-Douglas, and the elasticity of substitution between intermediate varieties (σ) is fixed at 1.75. Under the parameter assumptions made here, the model yields a low-tech equilibrium with $w = r = 1$, and national income (G) of 200.

The possibility of a high-tech equilibrium can be analyzed with the help of the two figures in Figure 5. The top panel of Figure 5 shows the level of national income that would obtain under a hypothetical high-tech equilibrium, as a function of λ. This relationship is downward sloping since higher λ goes with lower levels of labor skill (h). It can be seen from the Figure that for $\lambda \leq 7.2$ the high-tech equilibrium produces higher levels of income than the low-tech equilibrium (the latter yielding a fixed income of 200 irrespective of λ). For reasons explained above, the low-tech equilibrium is the unique equilibrium for $\lambda > 7.2$.

Next we ask when are multiple equilibria possible. The bottom panel of Figure 5 shows the minimum wage that would destabilize a low-tech equilibrium and get high-tech production started (the dotted curve). This minimum wage is increasing in λ because a lower h implies lower productivity in the high-tech sector. When this floor wage lies below 1 (which is the prevailing wage in the low-tech equilibrium), the low-tech equilibrium can never be stable, and the high-tech equilibrium is the unique equilibrium. As the Figure shows, this is the situation for $\lambda \leq 0.6$. However, for $0.6 < \lambda \leq 7.2$, the low-tech equilibrium is stable, even though a high-tech sector equilibrium would produce higher real income.

The presence of this latter range creates the possibility of welfare-enhancing government policy. In particular, as discussed earlier a government-mandated increase in wages can lead the economy to the high-tech equilibrium. However, the simulation also shows the danger in such a policy: while a sufficiently large increase in mandated wages will necessarily shift the equilibrium, it will also result in unemployment when the wage in the high-tech equilibrium falls below the wage needed to destabilize the low tech equilibrium. (The former is increasing in λ and is shown as the solid curve in the lower panel of Figure 5.) Only for a relatively small range of λ in the neighborhood of 0.6 is the high-wage policy self-validating.

IV. A Dynamic Extension

As discussed above, the equilibrium wage with high-tech production will often be lower than the minimum wage needed to get the high-tech sector going. Temporary unemployment will then emerge as the cost of the high-wage policy. To see the implications, we now consider a dynamic extension of the model. We limit attention to the case where: (i) there exists a stable high-tech equilibrium; and (ii) moving there from the low-tech equilibrium requires a minimum wage, $\underline{w}$, which exceeds the labor-market-clearing wage in the high-tech equilibrium.

We asume that the minimum wage remains binding for a finite length of time, T. We can think of T as the shortest period of time for which minimum-wage legislation must remain binding. Alternatively, in the presence of exogenous technological change, T is the time that elapses until the productivity of labor becomes sufficiently high to render the prevailing minimum-wage non-binding. The dynamics will be somewhat different in the second case from the one to be presented here, but the general logic of the story is common.

We assume that the two final goods are the only two goods that are consumed. Under the assumption that individual preferences are identical and homothetic, we let aggregate consumption to be characterized by a time-separable utility function of the sort:

$$U = \int u(c_y(t),\ c_x(t))\, e^{-\delta t}\, dt \qquad \textbf{(16)}$$

where y and x denote the low-tech and high-tech goods, respectively. The supply side of the economy remains unchanged, and will behave in each period in the same manner as in the static version.

We start at time 0, when a minimum-wage of $\underline{w}$ shifts the equilibrium to the high-tech one. By assumption, $\underline{w}$ exceeds the market-clearing wage so there is unemployment for $0 \leq t < T$. With less than full employment of labor, the economy will produce a lower number of intermediates, and the output level of the high-tech good, X_1, will lie below its full-capacity level, X^*. We will have a constant level of X_1 for $0 \leq t < T$, followed by a contant level of X^* for $t \geq T$.

We assume that the economy can lend and borrow freely at an international discount rate δ (which equals the domestic discount rate). Then the economy's present discounted value of income can be expressed as follows:

$$A = \int_0^T \pi X_1 \, e^{-\delta t} dt \; + \; \int_T^{\infty} \pi X* \, e^{-\delta t} dt \tag{17}$$

$$= \frac{\pi}{\delta} \; [X_1 + (X* - X_1) \, e^{-\delta T}] \tag{18}$$

The intertemporal budget constraint in turn is given by:

$$\int_0^{\infty} [\pi c_x(t) \; + \; c_y(t)] \, e^{-\delta t} dt \leq A \tag{19}$$

Consumers maximize (16) subject to (19). In view of the constancy of output prices, the resulting consumption path is flat also. The economy will run a current account deficit during $t < T$, when income is low, and will make it up by running a surplus after T is reached. The current account deficit in the early period can be calculated using (18) and (19) as $\pi (X* - X_1) e^{-\delta T}$. The deficit is larger the higher is the income gain from returning to full employment and the shorter is T.

Comparing real income under the present scenario with what would have otherwise prevailed in the low-tech equilibrium is easy. This entails comparing $\frac{Y}{\delta}$ with $\frac{\pi}{\delta}$ $[X_1 + (X* - X_1)e^{-\delta T}]$. Hence, even if Y > πX_1, an initial period of unemployment may be worthwhile as long as (X^*-X_1) is sufficiently large or T is sufficiently small. Note, however, that when access to foreign borrowing is restricted, consumption smoothing cannot be undertaken. In the latter case, the comparison is less favorable to the minimum-wage induced high-tech equilibrium.

V. A Brief Look at West Germany, 1948-51

One historical episode to which these ideas may have some relevance is the experience of West Germany in the immediate aftermath of World War II. Because of the destruction of a sizable part of its capital stock during the war, as well as the influx of refugees from the east, the German economy found itself in circumstances not entirely dissimilar to those discussed in the present paper: poor in physical capital and rich in human skills and in labor. The economic situation seemed to require a sharp fall in real wages relative to the pre-war period for the maintenance of full employment. We focus here on the critical few years after the currency reform, from 1948 to 1951. The latter year marks the beginning of the Korean War boom and the take-off in German exports.

The currency reform of June 20, 1948 was successful in stabilizing the monetary situation (after a brief spurt in inflation). From our perspective, what is especially striking in the West German experience subsequent to the reform is the rapid rise in real wages, and an even more rapid increase in labor productivity (Figure 6). The productivity performance was in part the natural consequence of reconstruction and of catching up to pre-war levels. But a wholesale restructuring of the economy was also in progress:

> In low-productivity agriculture and forestry alone, 350,000 jobs were lost in the eighteen months after the reform, with half of this loss occuring in 1949. In turn, employment in construction and in high-productivity manufacturing--above all in investment goods--grew sharply. This rapid structural adjustment was bound to leave deep traces in any productivity statistics... (Giersch et al., 1993, p. 8)

The fact that real wages lagged behind labor productivity made for healthy profit margins, leading to a spurt in private investment and enabling what later came to be called the "German miracle".

The fall in unit labor costs, thanks to the rapid growth in productivity, was largely unanticipated. As Giersch et al. (1993) and Wolf (1993) stress, German unions were not exactly in a docile mood, and did not hesitate to strike. The large real wage gains they obtained look harmless only with hindsight and the benefit of the ex post productivity boom. In a way that parallels the story developed in the present paper, the prevailing level of wages was ultimately validated by reconstituting and building on Germany's comparative advantage in high quality, skill-intensive industries.

Moreover, the German economy did not take the low-wage path despite unfavorable developments in other areas that might have made wage caution a more natural response. Unemployment increased steadily from 1948 on, reaching a peak of 12 percent in March 1950 from about 4.5 percent during the second half of 1948 (Giersch et al., 1993, p. 7; see also Figure 7). The trade deficit grew as well (Figure 7), to the point where a balance-of payment crisis in early 1951 forced the government to re-impose the quantitative restrictions on imports that had been removed earlier and to stop issuing new import licenses. Ludwig Erhard's liberalism did not extend to the external sector: he rejected devaluation and a rapid implementation of trade liberalization.

Since the German economy had been one of the world's most sophisticated economies prior to the war, Germany's reconstruction was in many ways a much easier task than the one faced by either former socialist countries in transition or by developing countries searching for a more solid industrial base. For this reason, one should not read too much into the post-war German experience of rapidly rising real wages. The lesson would appear to be a much more limited one, namely that a fall or stagnation in real wages is not a precondition to industrial growth and restructuring.

VI. Concluding Remarks

Countries that are poor in both human and physical capital have no alternative but to specialize in labor-intensive commodities. Countries that are rich in both will have high labor costs and will therefore specialize in activities where skills and technology play the dominant role in shaping costs. I have argued in this paper that countries somewhere in between these two extremes may well have two scenarios available to them: a low-wage, low-tech one, and a high-wage, high-tech one. Government policy may help pick the superior scenario.

A theoretical demonstration does not on its own amount to policy advice. It is hard to know in practice how wide the range of indeterminacy in specialization identified in this paper really is, if it exists at all. The German experience after the war is open to diverse interpretations, and does not come close to clinching the case. The Singaporean high-wage strategy during the early 1980s, referred to briefly in the introduction, has resulted in mixed success at best. Hence, the empirical relevance of these ideas remains to be demonstrated. In the absence of such a demonstration, going for high wages must be judged a risky strategy.

REFERENCES

Azariadis, Costas, and Allan Drazen, "Threshold Externalities in Economic development," Quarterly Journal of Economics CV(2), May, 501-526.

Calvo, Guillermo, 1993, "Growth, Debt, and Economic Transformation: The Capital Flight Problem," International Monetary Fund, unpublished manuscript.

Ciccone, Antonio, and Kiminori Matsuyama, 1993, "Start-up Costs and Pecuniary Externalities as Barriers to Economic Development," NBER Working Paper No. 4363, May.

Collins, Susan M., and Dani Rodrik, 1991, Eastern Europe and the Soviet Union in the World Economy, Washington, DC, Institute for International Economics.

Ethier, Wilfred, 1982, "National and International Returns to Scale in the Modern Theory of International Trade," American Economic Review, 72, 389-405.

Faini, Riccardo, 1984, "Increasing Returns, Non-Traded Inputs, and Regional Development," Economic Journal 94, pp. 308-323.

Giersch, Herbert, 1992, "The German Economy 1945-1995: What Went Right, What Is Going Wrong?" Egon Sohmen Lecture, MIT, September.

Giersch, H., K.-H. Paqué, and H. Schmieding, 1993, "Openness, Wage Restraint and Macroeconomic Stability: West Germany's Road to Prosperity," in R. Dornbusch et al., eds, Postwar Economic Reconstruction and Lessons for the East Today, Cambridge, MA, The MIT Press.

Hamilton, Carl B., and L. Alan Winters, 1992, "Opening Up International Trade with Eastern Europe," Economic Policy, 14, 78-104.

Helpman, Elhanan and Paul Krugman, 1985, Market Structure and Foreign Trade, Cambridge, MA, MIT Press.

Lim, Linda, Pang Eng Fong, and Ronald Findlay, 1993, "Singapore," in R. Findlay and S. Wellisz, eds., The Political Economy of Poverty, Equity, and Growth: Five Small Open Economies, New York, Oxford University Press for the World Bank.

Krugman, Paul, 1991, "History versus Expectations," Quarterly Journal of Economics, CVI (May), 651-667.

Manasse, Paolo, 1992, "The Low Income Trap Revisited: The Simple Macroeconomics of Fluctuations, Inequality and Unemployment," unpublished manuscript, IGIER and University of Calabria.

Markusen, James R., 1989, "Trade in Producer Services and Other Specialized Intermediate Inputs," American Economic Review, 79 (March), 85-95.

Matsuyama, Kiminori, 1991, "Increasing Returns, Industrialization and Indeterminacy of Equilibrium," Quarterly Journal of Economics, CVI (May), 617-650.

Murphy, Kevin, Andrei Shleifer, and Robert Vishny, 1989, "Industrialization and the Big Push," Journal of Political Economy, XCVII, 1003-1026.

Nelson, Richard, 1956, "A Theory of the Low-Level Equilibrium Trap in Underdeveloped Economies, American Economic Review, XLVI, 894-408.

Porter, Michael, 1990, The Competitive Advantage of Nations, New York, The Free Press.

Rodriguez, Andres, 1993, "The Division of Labor and Economic Development," unpublished manuscript, Stanford University.

Wolf, Holger, 1993, "The Lucky Miracle: Germany 1945-1951," in R. Dornbusch et al., eds, Postwar Economic Reconstruction and Lessons for the East Today, Cambridge, MA, The MIT Press.

Young, Alwyn, 1992, "A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong and Singapore," in O.J. Blanchard and S. Fischer, eds., NBER Macroeconomics Annual 1992, Cambridge, MA, MIT Press.

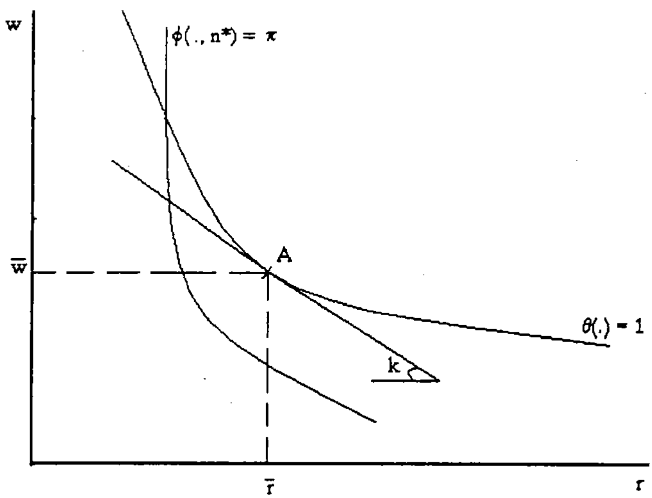


Figure 1

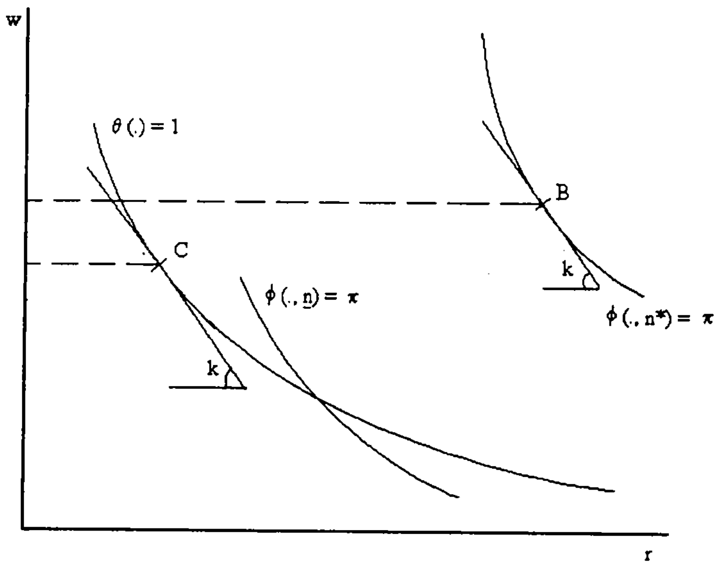


Figure 2

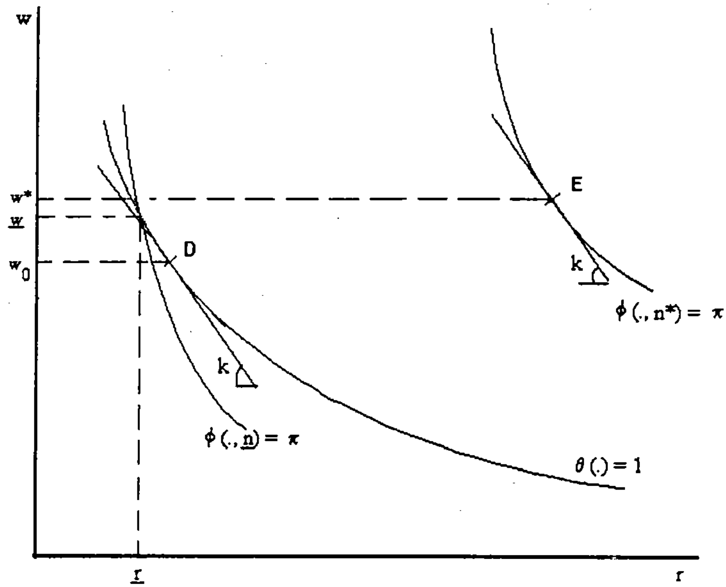


Figure 3

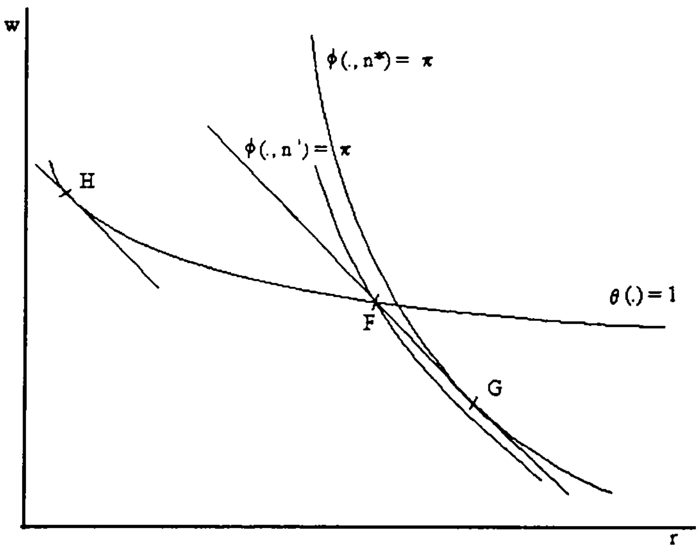


Figure 4

Table 1: Simulation Functional Forms and Parameters

Equations:

Unit cost functions

$\left(w^{\alpha}\cdot r^{1-\alpha}-1\right)\cdot Y=0$ low-tech sector (w/ compl. slackness)

$\left[r^{\beta}\cdot\left(p\cdot n^{-\frac{1}{\sigma-1}}\right)^{1-\beta}-\pi\right]\cdot X=0$ high-tech sector (w/ compl. slackness)

$p=w\cdot\lambda\cdot c$ representative intermediate

Factor-market equilibrium conditions

$Y\cdot\left[\frac{d}{dw}\left(w^{\alpha}\cdot r^{1-\alpha}\right)\right]+\lambda\cdot c\cdot n\cdot z=L$ labor

$Y\cdot\left(\frac{d}{dr}w^{\alpha}\cdot r^{1-\alpha}\right)+X\cdot\frac{d}{dr}\left[r^{\beta}\cdot\left(p\cdot n^{-\frac{1}{\sigma-1}}\right)^{1-\beta}\right]=K$ capital

$X\cdot\frac{d}{dp}\left[r^{\beta}\cdot\left(p\cdot n^{-\frac{1}{\sigma-1}}\right)^{1-\beta}\right]=n\cdot z$ intermediate inputs

National income

$G=Y+\pi\cdot X$

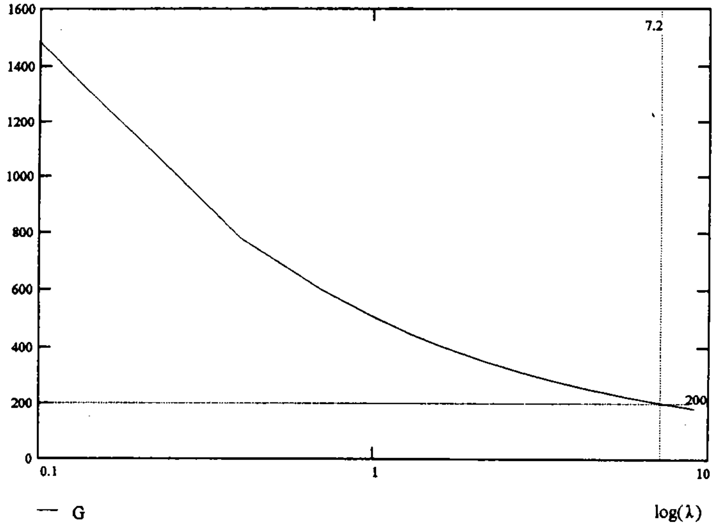
Parameters:

$\alpha:=0.5$ $\beta:=0.8$ $c:=1$ $z:=1$

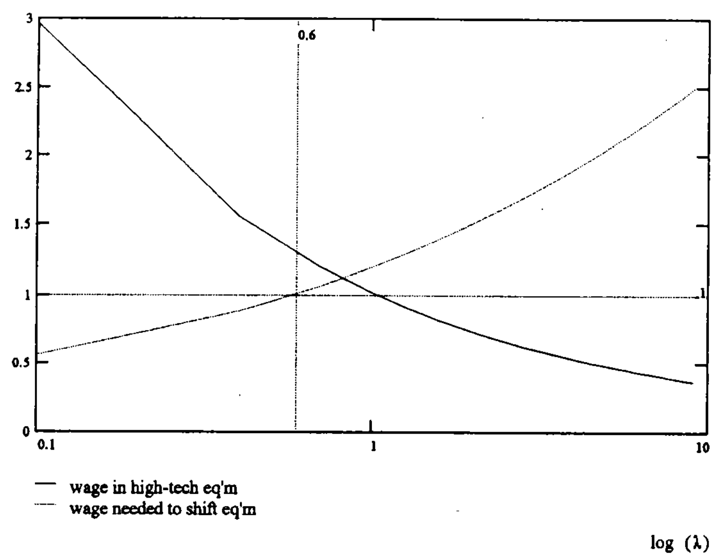
$L:=100$ $K:=100$ $\sigma:=1.75$ $\pi:=0.9$

Low-Tech Equilibrium:

$w:=1$ $r:=1$ $Y:=200$ $G:=200$ $X:=0$ $n:=0$



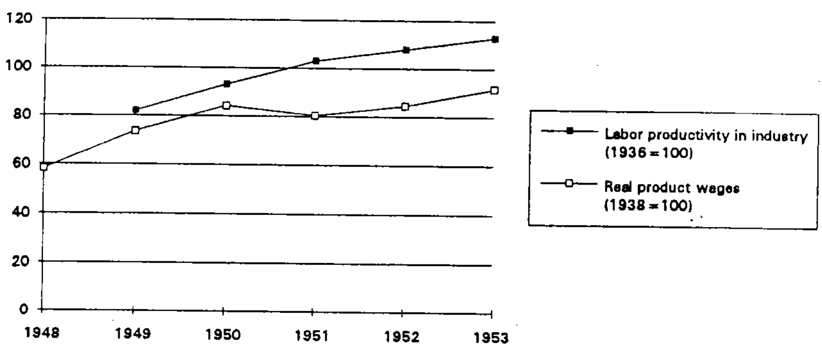
1600
1400
1200
1000
800
600
400
200
0
7.2
200
0.1
1
10
— G
log(λ)



3
2.5
2
1.5
1
0.5
0
0.6
1
0.1
1
10
wage in high-tech eq'm
wage needed to shift eq'm
log (λ)

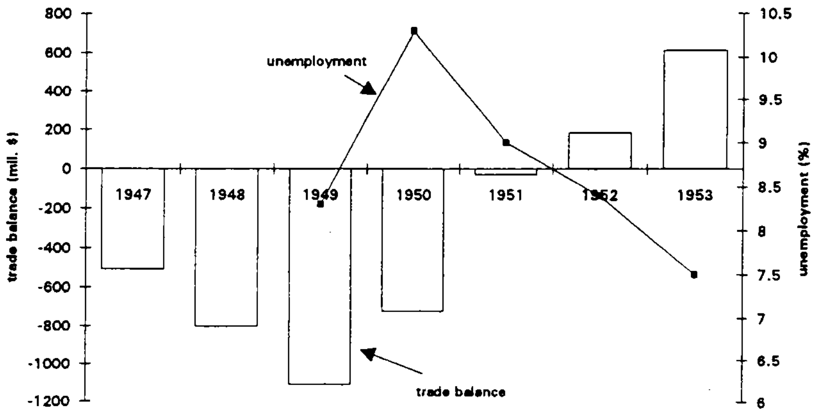
Figure 5

Real Wages and Productivity in Germany



Source: Calculated from U.S. Embassy in Germany, Handbook of Economic Statistics, January 1, 1955, Bonn.

Figure 6



Source: Same as Figure 5.

Figure 7