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Chapter Author: J. Peter Neary

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3 Intersectoral Capital Mobility, Wage Stickiness, and the Case for Adjustment Assistance

J. Peter Neary

This paper extends the two-sector Heckscher-Ohlin model of a small open economy in which capital is sector-specific in the short run to allow for labor-market disequilibrium caused by transitional wage stickiness. The implications for the stability and speed of convergence toward a new long-run equilibrium following an exogeneous change in the terms of trade are examined, and conditions are derived under which "immiserizing reallocation" can occur during the adjustment period. The framework presented is used to suggest appropriate measures of adjustment costs and to reconcile recent discussions of the welfare-theoretic case for adjustment assistance.

3.1 Introduction

There seems to be little doubt that many of the most vocal pleas for adjustment assistance are nothing more than old protectionism in new bottles: the prospect of increased low-cost imports from newly industrialized countries is frequently a convenient excuse for providing declining industries with assistance which has little justification from the viewpoint

J. Peter Neary is professor of political economy at University College Dublin. Since obtaining his D.Phil. from Oxford University in 1978, he has taught at Trinity College Dublin and Princeton, and has been a Visiting Scholar at MIT and at the Institute for International Economic Studies, University of Stockholm. He has published on international economics, macroeconomics, and consumer theory in *American Economic Review, Economica, Economic Journal, European Economic Review, Oxford Economic Papers,* and *Quarterly Journal of Economics.*

This paper was begun while the author was a Visiting Scholar at the Institute for International Economic Studies, University of Stockholm. Valuable discussions with Koichi Hamada and Ronald Jones, as well as helpful comments from participants at this conference, especially Avinash Dixit and Michael Mussa, and support from the Committee for Social Science Research in Ireland are gratefully acknowledged.

of comparative advantage. At the same time the liberal economist's instinctive suspicion of such intervention should not be allowed to rule out the possibility that it may on occasions be given some theoretical justification over and above its undoubted tactical value in sugaring the pill of tariff reductions.

The object of the present paper is to attempt to examine some of the issues raised by the adjustment-assistance debate in the light of the positive and normative theory of international trade. As we shall see, the normative prescriptions of this body of theory are, in principle, relatively straightforward, but their application in any individual case depends crucially on the assumptions made about the behavior and institutional environment of the private sector. Section 3.2 of the paper therefore begins by reviewing the implications of one set of assumptions regarding the medium-run adjustment of the standard two-sector Heckscher-Ohlin model of a small open economy. This approach, which assumes that capital is a fixed factor in the short run, but moves between sectors in the medium run in response to intersectoral differences in rentals, has been extensively examined in recent work by Mayer (1974), Mussa (1974, 1978), Jones (1975), Kemp, Kimura, and Okuguchi (1977), and the author (1978*a*, *b*) among others. Section 3.3 proceeds to extend this literature by relaxing the assumption made in earlier papers that full employment of labor is maintained throughout the adjustment period by instantaneous wage flexibility. When this assumption is dropped, the labor market as well as the capital market is out of equilibrium during the adjustment period, and the consequences of this for the path followed by the economy are examined.

The model of section 3.3 is then applied in section 3.4 to the question of the appropriate measure of adjustment costs, both private and social, and it is shown that national income can fall temporarily during the adjustment process, a phenomenon which is labeled "immiserizing reallocation." Finally section 3.5 takes up the normative issue of the appropriate form of public assistance to the adjustment process, an issue recently examined by Lapan (1976) and Mussa (1978). The principal conclusion, which is no doubt obvious but still deserves to be stressed, is that the case for adjustment assistance is essentially a second-best one. In an otherwise undistorted economy where the government is no better informed about the future course of the economy than the private sector, there is no case on grounds of allocative efficiency for public intervention to supplement or counteract private decisions. However, intervention may be justified in the presence of domestic distortions, even if the private sector has perfect foresight of future returns to capital. Of course, even when a theoretical case for adjustment assistance can be made, its practical implementation raises some difficult questions of political economy, which are briefly discussed in the concluding section.

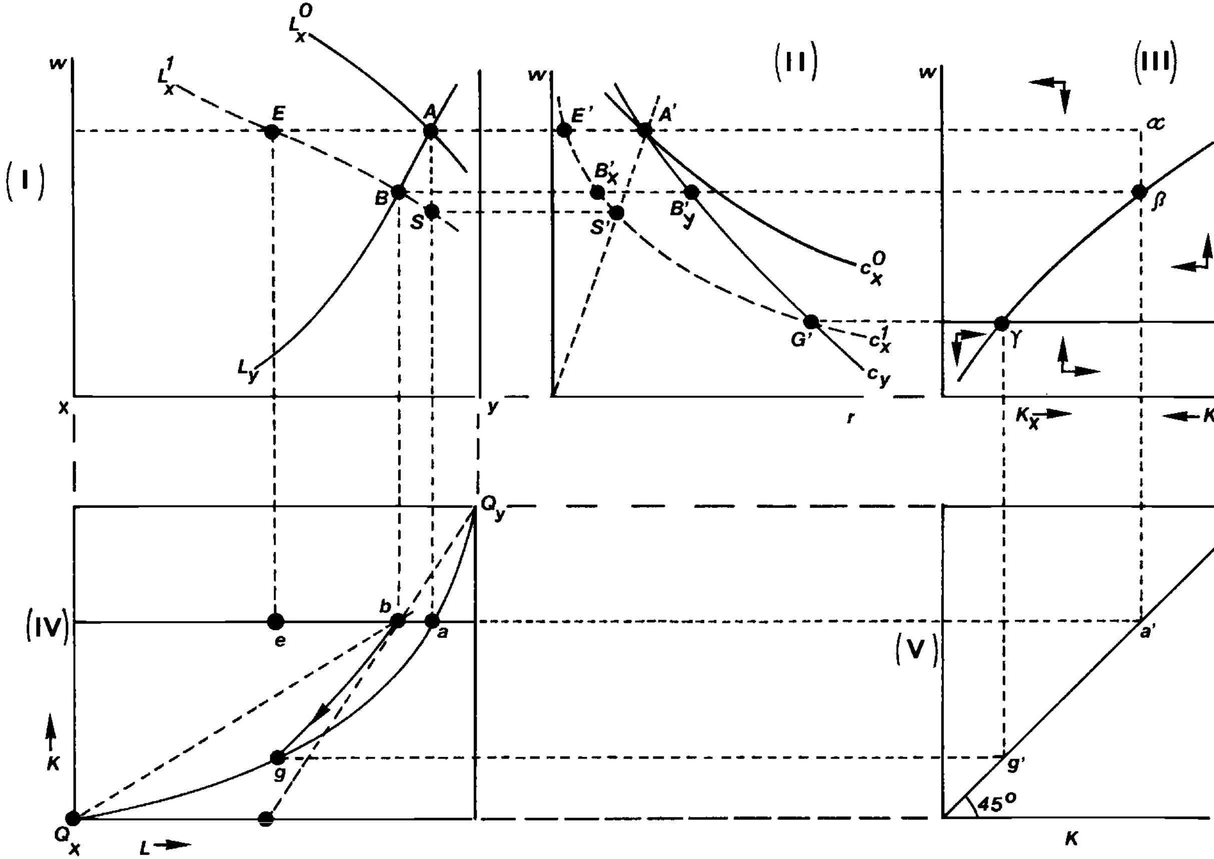
3.2 Short-Run Capital Specificity in the Heckscher-Ohlin Model

We begin by reviewing the short-run capital specificity adjustment process assuming continual full employment, using a diagrammatic technique presented in Neary (1978*a*) and reproduced in panels (i) and (iv) of figure 3.1. We assume an economy producing two goods, X and Y, under conditions of perfect competition and constant returns to scale, using two inelastically supplied primary factors of production, capital (K) and labor (L). Assuming for the present that product and factor markets are undistorted, initial equilibrium in the labor market is determined by the intersection of the labor-demand schedules for the two sectors at point A in panel (i). This equilibrium is contingent on a particular commodity price ratio, given exogenously to the economy, and on a particular allocation of the capital stock between the sectors. This allocation corresponds to the solid horizontal line in the Edgeworth-Bowley box, panel (iv), and since point a, which is vertically below point A, lies on the efficiency locus of the box, it follows that these two points represent a full, or long-run, equilibrium, at which each factor is allocated such that it receives the same return in both sectors.

This initial long-run equilibrium is also represented by point A' in panel (ii) of figure 3.1, at the intersection of the isocost curves c_x^0 and c_y. Each of these curves shows combinations of the wage rate w and the rental rate r which imply a unit cost of production for the sector in question equal to its world price.[1] Hence only the factor prices corresponding to A' ensure zero profits for both sectors. The slope of each isocost curve at a given point equals the capital-labor ratio in the sector in question, so at A' sector X is relatively labor-intensive; this is also indicated, of course, in panel (iv) by the fact that the efficiency locus lies below the diagonal of the Edgeworth-Bowley box.

Consider now the effects of an exogenous once-and-for-all fall in the world price of X. This shifts that sector's labor-demand schedule downward in panel (i) from L_x^0 to L_x^1, and shifts its isocost curve inward toward the origin in panel (ii) from c_x^0 to c_x^1. (These two shifts are by the same proportionate amount as the price fall, so that point S, which lies vertically below A in panel [i], corresponds to the same wage rate as point S', which lies on the ray from the origin to A' in panel [ii].) Assuming that capital is sector-specific in the short run and that the wage rate is perfectly flexible, the fall in the price of X determines a new short-run equilibrium at point B at which the wage rate is lower, and sector Y has expanded, availing itself of some of the now-cheaper labor released by the contracting sector X. Moreover, it is clear from panel (ii) that the return on capital has fallen in sector X and risen in sector Y (to levels represented by the points B_x' and B_y', respectively). Over time, this increased relative attractiveness of renting capital goods to sector Y rather than to sector X may

Fig. 3.1



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be expected to induce an intersectoral reallocation of the capital stock, and for the remainder of this section we assume that this reallocation takes place at a rate determined by the differential equation:

$$DK_x = \phi\{\frac{r_x}{r_y} - 1\} \qquad \phi' > 0, \phi(0) = 0, \tag{1}$$

where D represents the time derivative operator and the capital stock is assumed to be always fully employed:

$$K_x + K_y = \bar{K} . \tag{2}$$

The adjustment mechanism embodied in equation (1) is ad hoc in at least two respects. In the first place it considers only the return to reallocating capital, thus implicitly assuming constant costs in the "capital-reallocation" industry. Second, the return is measured by the difference between the current rentals on capital in the two sectors rather than by the difference between the present value of the stream of future rentals accruing to a unit of capital in each sector; this implicitly assumes that capital owners have static expectations of future rental rates. Both of these deficiencies are avoided in a recent paper by Mussa (1978) which specifies an explicit microeconomic model of the reallocation decision, and also allows for the general-equilibrium feedback onto wages arising from the direct use of labor by the capital-reallocation industry. However, the richness of Mussa's analysis of the capital market precludes his examining the consequences of sluggish adjustment in the labor market, with which the present paper (as well as much of the applied literature on adjustment assistance) is primarily concerned. Moreover, his own analysis is ad hoc in some respects: in particular, it assumes of necessity that the marginal cost of reallocating capital is a nondecreasing function of the rate of reallocation, since otherwise the optimal adjustment policy is of the "bang-bang" type, and the economy moves instantaneously to the new long-run equilibrium.[2] For these reasons it seems worthwhile to explore the implications of the simple adjustment mechanism (1).

As capital moves out of the labor-intensive sector X into sector Y, the resulting fall in the aggregate demand for labor puts downward pressure on the wage rate, thus inducing a substitution toward more labor-intensive techniques in both sectors. Hence in panel (iv) of figure 3.1 the capital reallocation drives the economy away from point b (which lies directly below B) along a path on which the capital-labor ratios in both sectors are continually falling. Such a path (which must lie in the triangle Q_xbh) is shown by the solid line bg. The new long-run equilibrium at g is also illustrated by point G' in panel (ii), where the equality of rental rates in the two sectors is restored.

Since our main objective is to investigate the consequences of sluggish wage adjustment, it is desirable to illustrate the adjustment process in yet another manner, which explicitly relates the wage rate to the intersectoral allocation of capital. This is done in panels (iii) and (v) of figure 3.1 (where panel [v] simply translates the vertical axis of panel [iv] into the horizontal axis of panel [iii]). Point α in panel (iii) represents the initial equilibrium, and the fall in the price of X causes an immediate fall in the wage rate, moving the equlibrium to point β. Over time the reallocation of capital causes a southwesterly movement of the equilibrium point in panel (iii), as the wage rate drifts downward and the proportion of the capital stock employed in sector X steadily falls. The economy therefore follows the path $\beta\gamma$, which corresponds exactly to the path bg in panel (iv), until eventually the new long-run equilibrium at γ is attained.

The different panels of figure 3.1 thus illustrate from a number of perspectives the short-run capital specificity adjustment hypothesis with continual full employment, whose properties are familiar from earlier writings: the initial fall in the price of X lowers the wage rate and brings about a rental differential in favor of sector Y. Over time this induces an intersectoral capital flow, and both factor prices and factor allocations move monotonically toward their new long-run equilibrium levels which, as predicted by the Stolper-Samuelson theorem, exhibit a fall in the wage rate and a rise in the rental rate (now equalized between the two sectors) relative to both commodity prices. We turn therefore in the next section to examine how this picture is affected when we abandon the assumption of rapid adjustment of wages.

3.3 Short-Run Capital Specificity with Sticky Wages

Strictly speaking, the model outlined in the previous section assumed not that the wage adjusts instantaneously, but merely that it moves sufficiently rapidly to restore labor-market equilibrium before capital begins to move between sectors. Previous writers have not made explicit the mechanism by which this equilibrium is brought about, but it seems natural to assume that it involves a positive relationship between wage changes and the level of excess demand for labor:

$$(3) \qquad Dw = \psi\left\{\frac{L^d}{\bar{L}} - 1\right\} \qquad \psi' > 0, \psi(0) = 0,$$

where L_d is the demand for labor by both sectors and $\bar{L}$ is the fixed aggregate labor supply. Note that, according to equation (3), excess demand for and excess supply of labor affect the wage rate in a symmetric fashion. Without specifying the microeconomic underpinnings of (3) in greater detail, this seems a reasonable simplification, especially since we are primarily interested in the qualitative general-equilibrium consequences of labor-market disequilibrium.

Suppose now that the speed of adjustment implied by the $\psi(\cdot)$ function in equation (3) is *not* instantaneous relative to that embodied in the $\phi(\cdot)$ function in equation (1). This means that both labor and capital markets may be simultaneously out of long-run equilibrium. Assuming that the wage rate is fixed in the short run in terms of good Y, the impact effect of the fall in the price of X is therefore that sector X lays off EA workers (in panel [i] of figure 3.1) which sector Y has no incentive to hire. The resulting unemployment of EA causes the wage rate to drift downward over time while at the same time capital begins to reallocate out of sector X in response to the induced rental differential (represented in panel [ii] by the gap between the rental in X at E' and that in Y at A'). Hence the economy moves away from point α in panel (iii) in a southwesterly direction. But now, by contrast with the full-employment case of the previous section, the time paths of factor prices and factor allocations need not be monotonic. The economy may overshoot the long-run equilibrium point γ, in which case, when the wage falls below its long-run equilibrium level, the rental differential moves in favor of sector X and so the direction of intersectoral capital movement is reversed. The path followed by the economy is thus a counterclockwise spiral in panel (iii), which must bring it into the region of excess demand for labor below the labor-market equilibrium locus $\gamma\beta$. Within this region firms are frustrated in their efforts to hire labor, and so their output levels are determined by their "effective" demand for labor $\bar{L}$ rather than their "notional" demand L^d. As we shall see below, this has a number of implications for the behavior of the economy when excess demand for labor prevails. However, it does not affect the qualitative nature of the adjustment path, and so the dynamic evolution of the economy is governed by the arrows in panel (iii).

Is there any guarantee that the economy will converge toward the new long-run equilibrium at γ? In order to investigate this we examine the local stability of the model, for which it is necessary to derive algebraic expressions for the two stationary loci in the neighborhood of γ. Consider first the capital-market equilibrium locus, the stationary locus of (1). An expression for this in differential form may be derived by manipulating the price-equal-to-unit-cost equations, which reflect the fact that under competition the proportional change in the price of each sector's output must be a weighted average of changes in the returns to the factors employed there, where the relevant weights (the θ_{ij}) are the shares of each factor in the value of the sector's output:

$$\hat{p} = \theta_{lx}\hat{w} + \theta_{kx}\hat{r}_x, \tag{4}$$

$$0 = \theta_{ly}\hat{w} + \theta_{ky}\hat{r}_y. \tag{5}$$

(A circumflex over a variable indicates a proportional rate of change: $\hat{w} = d \log w$.) Manipulating (4) and (5) yields

(6) $$\hat{r}_x - \hat{r}_y = -\frac{|\theta|}{\theta_{kx}\theta_{ky}} \hat{w} + \frac{1}{\theta_{kx}} \hat{p},$$

where $|\theta|$, which equals $\theta_{lx} - \theta_{ly}$, is the determinant of the matrix of value shares, and is positive if and only if sector X is relatively labor-intensive in value terms. Note that from equation (6) the intersectoral rental differential does not depend on K_x: with a fixed wage the capital market is not self-equilibrating. Hence with a fixed wage rate and fixed commodity prices the allocation of capital between sectors is either indeterminate (in the knife-edge case where the wage happens to equal its long-run equilibrium value) or else the economy is driven to specialize.[3]

In the present model, however, the wage is sticky rather than fixed and its dynamic evolution is governed by equation (3). To analyze this case, we note that the aggregate demand for labor equals the sum of the labor demands from each sector, each of which in turn equals the sector's unit labor requirement a_{lj} times its output level:

(7) $$L^d = a_{lx} X + a_{ly} Y.$$

The levels of output themselves equal the available stock of capital in each sector divided by the sector's unit capital requirement a_{kj}:

(8) $$X = K_x / a_{kx}, \; Y = K_y / a_{ky}.$$

Totally differentiating (7) and (8) yields

(9) $$\hat{L}^d = \lambda_{lx}(\hat{a}_{lx} - \hat{a}_{kx} + \hat{K}_x) + \lambda_{ly}(\hat{a}_{ly} - \hat{a}_{ky} + \hat{K}_y),$$

where λ_{lj} is the proportion of the demand for labor which emanates from sector j. Assuming that neither sector is rationed in the labor market, equation (9) may be expressed in terms of factor prices by invoking the definition of the elasticity of factor substitution:

(10) $$\hat{a}_{lj} - \hat{a}_{kj} = \hat{L}_j - \hat{K}_j = -\sigma_j(\hat{w} - \hat{r}_j) \qquad (j = x, y)$$

(11) $$= -\frac{\sigma_j}{\theta_{kj}} (\hat{w} - \hat{p}_j).$$

(The step from [10] to [11] makes use of equations [4] and [5].) Moreover the changes in sectoral capital stocks in (9) may be related by recalling that they must satisfy the full-employment constraint for capital, (2), which may be written in differential form as

(12) $$\lambda_{kx}\hat{K}_x + \lambda_{ky}\hat{K}_y = 0.$$

Substituting from (11) and (12) into (9) yields an expression in differential form for the aggregate demand for labor as a function of changes in state and exogenous variables only:

(13) $$\hat{L}^d = -\Delta\hat{w} + \frac{|\lambda|}{\lambda_{ky}} \hat{K}_x + \lambda_{lx}\frac{\sigma_x}{\theta_{kx}}\hat{p},$$

where Δ, the wage elasticity of the aggregate labor-demand schedule, is a weighted average of the corresponding elasticities in each sector:

(14) $$\Delta \equiv \lambda_{lx}\frac{\sigma_x}{\theta_{kx}} + \lambda_{ly}\frac{\sigma_y}{\theta_{ky}}$$

and where $|\lambda|$, which equals $\lambda_{lx}\lambda_{ky} - \lambda_{ly}\lambda_{kx}$, the determinant of the matrix of factor-to-sector allocations, is positive if and only if sector X is relatively labor-intensive in physical terms. Equation (13) shows that the aggregate demand for labor falls with a rise in the wage rate (so that the labor market is stable in isolation) and rises with a rise in the relative price of X (the good in terms of which the wage rate is *not* pegged) or with an increase in the proportion of the capital stock employed in the labor-intensive sector.

We are now in a position to examine the local stability of the model. Linearizing equations (1) and (3) around a long-run equilibrium point (K_x^*, w^*), and substituting from (6) and (13) with p fixed, yields the matrix differential equation

(15) $$\begin{bmatrix} DK_x \\ Dw \end{bmatrix} = \begin{bmatrix} 0 & -E_\phi\frac{|\theta|}{\theta_{kx}\theta_{ky}} \\ E_\psi\frac{|\lambda|}{\lambda_{ky}} & -E_\psi\Delta \end{bmatrix} \begin{bmatrix} (K_x - K_x^*)/K_x \\ (w - w^*)/w \end{bmatrix},$$

where E_ϕ and E_ψ are multiples of the slopes of the adjustment functions (1) and (3) (e.g., $E_\phi = \phi' r_x/r_y$) and so are measures of the speed of adjustment of the capital and labor markets, respectively. It is clear that the trace of the matrix is negative provided techniques are variable in at least one sector (so that Δ is nonzero). Therefore a necessary and sufficient condition for local stability of the system (15) is that the determinant of the coefficient matrix be positive. This is equivalent to the condition

(16) $$|\lambda|\ |\theta| > 0,$$

i.e., that the value and physical rankings of the relative factor intensities of the two sectors coincide at a point of long-run equilibrium.[4]

This condition, which is the same as that derived in Neary (1978*b*) under the assumption of continual full employment, is automatically fulfilled if there are no permanent factor-market distortions. Hence we may conclude that, at least for small displacements of the initial equilibrium, the model converges in a stable fashion toward the new long-run

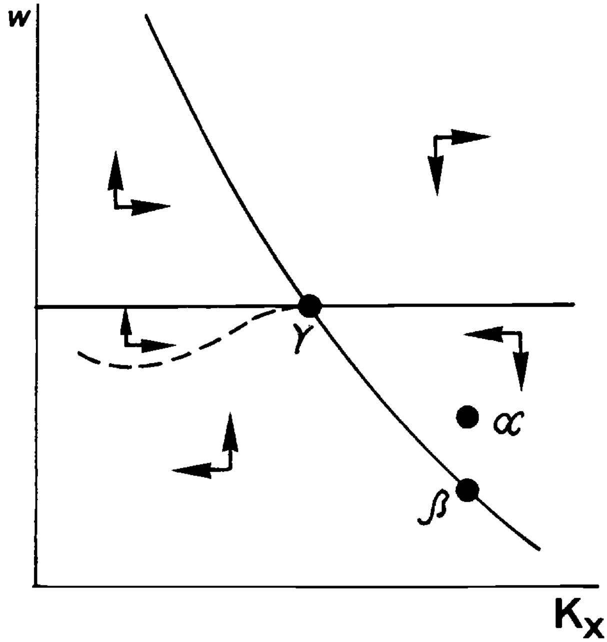

Fig. 3.2

equilibrium point γ in panel (iii) of figure 3.1. A similar phase diagram may be devised for the case where sector *X* is relatively capital-intensive, and it is illustrated in figure 3.2. The path followed by the economy is now a clockwise loop in (K_x, w) space, and since the price of the capital-intensive good has fallen, the wage rate must rise in the long run. (Compare points α and γ.) But in other respects the medium-run adjustment of the economy is qualitatively similar to that in figure 3.1. Only if there are permanent factor-market distortions can any problem of instability arise. Such a case is illustrated in figure 3.3, where sector *X* is relatively capital-intensive in the physical sense but has to pay relatively more for labor than for capital by comparison with sector *Y*, with the result that at the long-run equilibrium point γ sector *X* is relatively labor-intensive in the value sense. Hence that equilibrium is a saddle point: unless the economy lies initially on the dashed line through γ it is driven to specialize in one of the two goods. This finding reinforces the conclusions of Neary (1978*b*), where it was argued that stability considerations render implausible the many comparative-statics paradoxes associated with the nonfulfillment of condition (16).

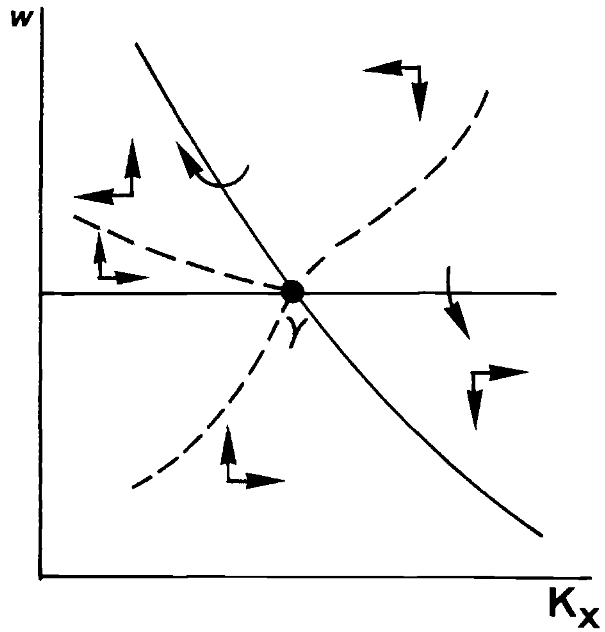

Fig. 3.3

Returning to the stable case, an explicit calculation of the characteristic roots of the coefficient matrix in (15) yields

$$\mu_1, \mu_2 = -E_\psi\Delta \pm \left(E_\psi^2\Delta^2 - 4E_\phi E_\psi \frac{|\lambda|\ |\theta|}{\lambda_{ky}\theta_{kx}\theta_{ky}}\right)^{1/2}. \tag{17}$$

It is clear that convergence is more rapid, and cycles are less likely, the greater the potential for factor substitution in either sector, and so the greater the aggregate elasticity of demand for labor. In the extreme case of fixed coefficients in both sectors, the demand for labor is independent of the wage rate. The characteristic roots (17) now have no real parts, and so if both adjustment mechanisms (1) and (3) continue to operate, the economy remains in a limit cycle, as shown in figure 3.4. By contrast, if Δ is relatively large, the value of the wage rate which equilibrates the labor market is sensitive to the allocation of the capital stock, and so convergence is likely to be rapid and monotonic, as figure 3.5 illustrates.

The preceding analysis is strictly applicable only when there is unemployment or when the economy is in the neighborhood of a long-run equilibrium point. When a finite degree of excess demand for labor

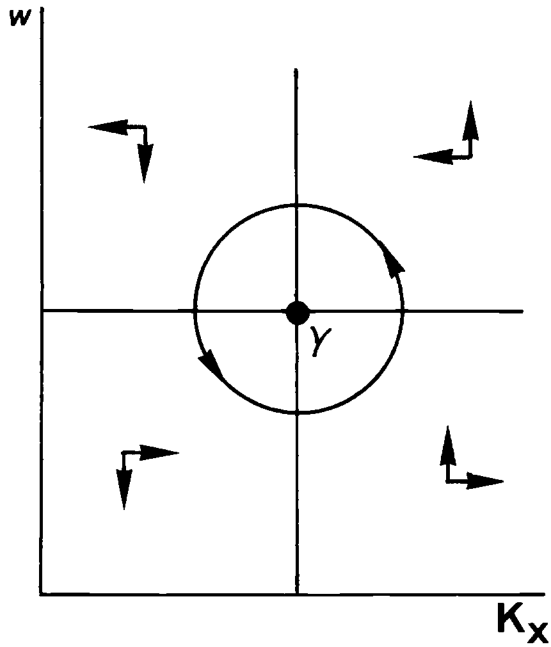

Fig. 3.4

prevails, equations (4), (5), and (10) do not necessarily hold, because if the aggregate demand for labor exceeds the supply, some firms must be rationed in the labor market, which leads them to produce at a point where the marginal product of labor is not equated to the real wage. Hence in the preceding derivations the "notional" factor demand schedules and equilibrium loci, which implicitly assume that no rationing takes place, must be replaced by their "effective" counterparts, in the manner which is becoming familiar from the literature on "disequilibrium" macroeconomics.[5] The details of this procedure are set out in appendix B, where it is shown that, when excess demand for labor prevails, the notional capital-market equilibrium locus (6) is displaced to an extent which depends on the rationing rule for allocating labor between the two sectors. The resulting effective loci are shown as dashed lines in figures 3.2, 3.3, 3.5, and 3.7, and it is clear that they do not affect the qualitative conclusions about the behavior of the economy drawn above.

Before concluding this section, we may note that it has been assumed throughout that it is the wage rate expressed in terms of good Y which is sticky in response to excess demand or supply in the labor market. This asymmetric assumption is not inappropriate when we are concerned with

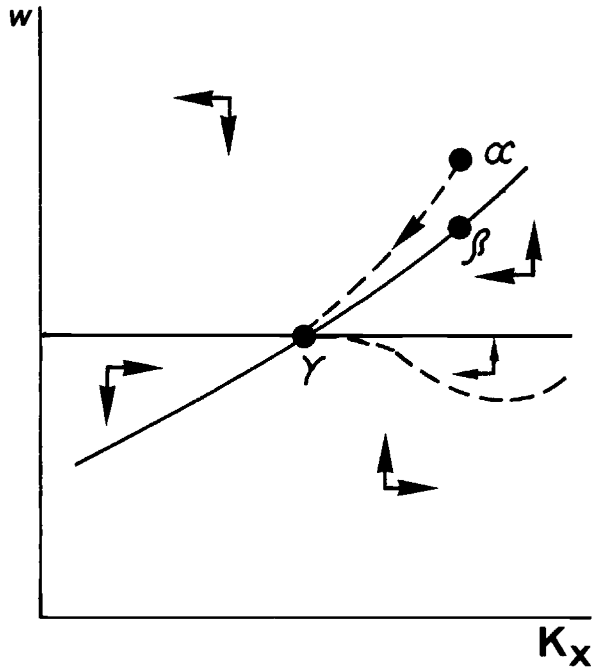

Fig. 3.5

the consequences of a fall in the price of X, and in any case the analysis is not substantially dependent on it. More generally, we may assume that it is the real wage in the sense of the utility level of wage earners which is fixed in the short run and which responds sluggishly to labor-market disequilibrium. Formally, this may be expressed by equating the nominal wage w to the nominal expenditure of the representative wage earner, which is a function of both commodity prices and the wage earner's utility level u:

(18) $$w = E(p_x, p_y, u).$$

Totally differentiating (18) yields

(19) $$\rho\hat{u} = \hat{w} - \xi\hat{p}_x - (1 - \xi)\hat{p}_y,$$

where ρ is the utility elasticity of expenditure and ξ is the budget share of good X. The analysis of this section now goes through almost unchanged provided u is substituted for w in equations (3) to (15); the only qualification is that if real wages are sticky in terms of good X (i.e., $\xi = 1$), a fall in the price of X does not give rise to unemployment in the short run.

3.4 Measuring the Costs of Adjustment

So far we have examined the consequences of sluggish wage adjustment from the perspective of the factor markets. However, in order to quantify the costs of adjustment under alternative assumptions about the medium-run evolution of the economy, it is desirable to recast the analysis in output space.

In figure 3.6 the initial equilibrium point A'' corresponds to the initial equilibrium in figure 3.1, with the additional assumption that X is the import good so that initial consumption is at C_a. Following the fall in the world price of X, the new long-run equilibrium production point is G'' with consumption at C_g, which lies on the income-consumption curve ICC corresponding to the new world price ratio. At the new long-run equilibrium, the level of national income measured in units of Y equals the distance ON, which therefore provides a benchmark with which national income at any intermediate production point may be compared. For example, if production were to remain at A'' in the short run,[6] the improvement in the terms of trade would still yield a consumption gain of HJ but national income would fall short of its long-run potential by the amount JN. Hence under the assumptions of given world prices and no long-run domestic distortions, a true welfare-theoretic measure of the "costs of adjustment" along a given adjustment path is the present value of the stream of all such shortfalls of output below its long-run level ON.[7]

Consider now the adjustment path under the short-run capital specificity hypothesis with continual full employment. As noted by Mayer (1974) the economy is initially constrained by a short-run transformation curve such as $T'T'$ which lies inside the long-run curve TT, and so production moves following the price change from A'' to B''. Over time the capital reallocation shifts the short-run transformation curve progressively to the left and the economy moves along the path indicated by the dashed line toward the new long-run equilibrium point G''. Since the only departure from a full optimum during the adjustment period is the intersectoral rental differential and since this falls steadily as capital reallocates (as shown in panel [ii] of figure 3.1), it is intuitively obvious that the shortfall of national income below its long-run level declines monotonically during the adjustment period. (An algebraic proof of this is provided in appendix A.)

The situation is very different when the wage rate is sticky, however. To begin with, the level of output of good Y remains unchanged in the short run and the output of X falls by more than it does when the wage is flexible. Hence the new short-run equilibrium point E'' lies on the same horizontal line as A'' and to the left of B''. Evaluated at the new world prices, the value of national output must fall, but the change in real national income is ambiguous. Figure 3.6 illustrates the borderline case

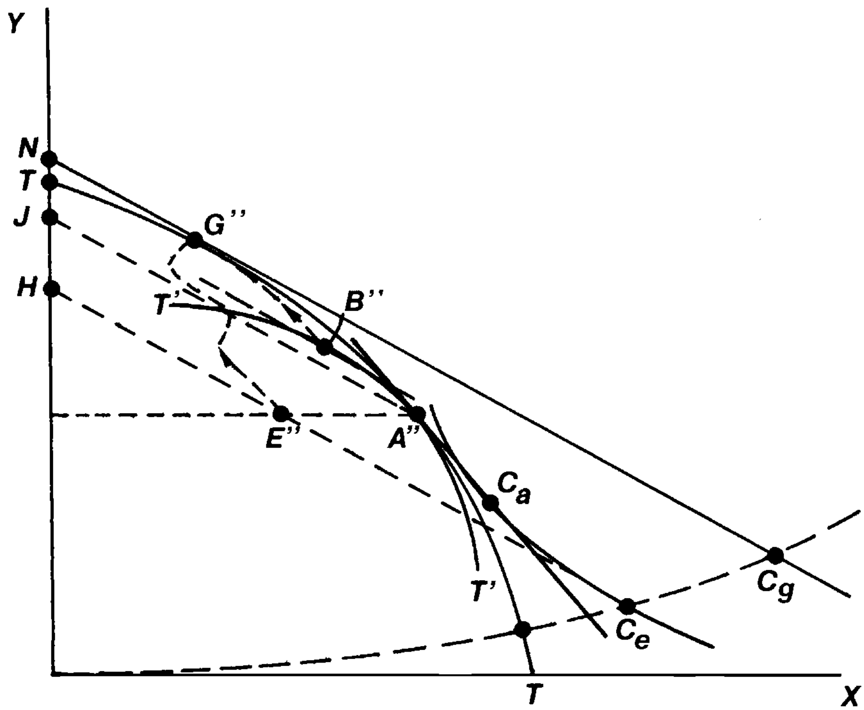

Fig. 3.6

where real national income is unchanged—with production at E'' consumers can just attain, at C_e, the same social indifference curve they enjoyed, at C_a, before the price change. Hence the level of real income remains at OH. But this is just a fortuitous occurrence, and, as noted by Haberler (1950), real income may either rise or fall due to the short-run wage rigidity.

Over time, movements of capital between sectors and adjustments of the wage rate lead the economy along the path $E''G''$, but, unlike the full-employment case, this path need not exhibit any regular properties. Since, as seen in the last section, factor allocations and factor prices may follow cyclical paths, the same is true of output levels. Moreover, there is no guarantee that real income will rise monotonically during the adjustment period, which introduces the possibility of "*immiserizing reallocation*," by analogy with the phenomenon of immiserizing growth, familiar from comparative-statics models.

To see how immiserizing reallocation may occur, consider figure 3.7, which repeats the essential features of figure 3.1, panel (iii). In regions 1

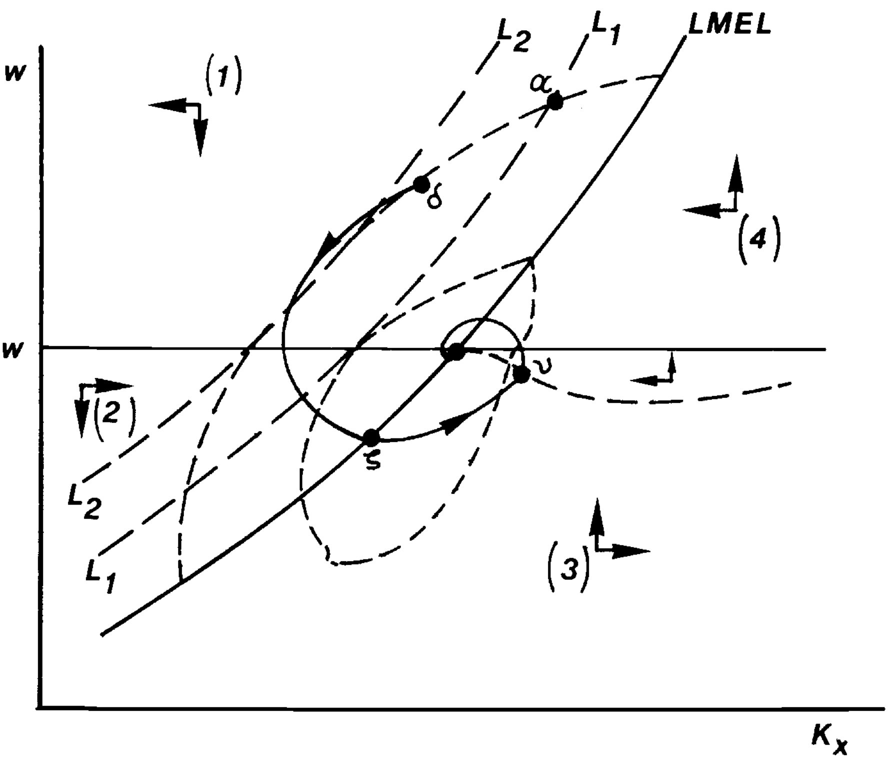

Fig. 3.7

and 2 of figure 3.7, where excess supply of labor prevails, the dashed lines L_1L_1 and L_2L_2 parallel to the labor-market equilibrium locus represent given levels of employment, while the dotted lines represent given levels of national income: these two sets of loci differ since, except at the long-run equilibrium wage w^*, the failure to equalize rentals between sectors lowers national income below the maximum attainable with a given level of employment. Hence along the solid line, which represents one possible path that the economy may follow starting at point α, the level of employment falls between α and δ, and to the left of δ the level of income also falls. Thus immiserizing reallocation takes place even though the direct consequences of each market's adjusting in isolation—the reallocation of capital toward the high-rental sector and the fall in the wage rate which tends to encourage a higher level of employment—tend to raise national income. These favorable effects are more than offset by the change in industry mix, whereby the declining labor-intensive sector (X) releases more labor than the expanding sector is willing to absorb.

Immiserizing reallocation cannot occur in region 2, since here the labor-intensive sector is expanding, which reduces the level of unemployment, and so all three effects tend to raise national income. However, it can occur in region 3, where national income is below its potential not because of unemployment but because marginal products of labor are not necessarily equalized between sectors due to the fact that one or both sectors are unable to realize their notional labor demands. Note that as a result it is not possible to determine the value of national income corresponding to a point in regions 3 and 4 from a knowledge of that point's (K_x, w) coordinates alone, for in addition it is necessary to specify what rationing rule is being used to allocate the scarce labor supply between the two sectors. One plausible assumption is that labor is allocated on a "first come, first served" basis, which implies that along the path segment $\zeta\upsilon$ only sector X is constrained, since at point ζ sector Y is unconstrained and its notional demand for labor falls steadily as its capital stock falls and the wage rate rises. In region 4, however, it is not possible to be so definite, since at some point the return flow of capital into sector Y must lead it to seek to expand its employment level. Hence along the segment of the path above υ in region 4 either or both sectors may face ration constraints on their labor demands. Moreover, as noted in section 3.3, the location of the boundary between regions 3 and 4 and so of the point υ itself also depends on the rationing rule assumed. Fortunately these considerations do not prevent us from reaching definite conclusions about the qualitative behavior of national income along the portions of the adjustment path in regions 3 and 4. In both regions when only one sector is constrained a reallocation of capital toward the high-rental sector and a *rise* in the wage rate tend to raise national income, the latter because it induces the unconstrained sector to shed labor which can be absorbed by the rationed sector where its marginal product is higher. In region 3, however, the inflow of capital into the labor-intensive sector increases the aggregate excess demand for labor, and so increases the gap between the marginal product of labor and the wage rate thus tending to lower national income. It is quite possible for this effect to dominate (as illustrated in figure 3.7 by the fact that the path $\zeta\upsilon$ crosses the dotted iso-income locus), so leading once again to immiserizing reallocation. This cannot happen in region 4, since capital is now moving into the capital-intensive sector and so national income unambiguously rises. However, immiserizing reallocation can still take place in region 4, if substantial excess demand for labor exists and if the labor-rationing rule is such that both sectors are constrained. (These results are proved algebraically in appendix A.)

In conclusion, therefore, the combination of sticky wages and sluggish intersectoral reallocation of capital can lead to phases of immiserizing reallocation, where, because of the combination of two sources of allocative inefficiency, private decisions actually lower real national income. This is most likely to occur in regions 1 and 3, that is, when the wage rate and the proportion of the capital stock in use in the labor-intensive sector move in the same direction; however, it can also happen in region 4 if both sectors are rationed in their demands for labor. Notice finally that this has taken place in an environment with no permanent distortions in factor or commodity markets. Adding such distortions to the model would provide an additional, albeit well-known, source of immiserizing reallocation.

3.5 Policies toward the Adjustment Process

Having examined the positive consequences of our assumptions about dynamic adjustment, we are now in a position to consider their implications for public intervention in the adjustment process.

Within the framework of the present model, adjustment assistance could take many forms, which can be divided into two broad categories, static and dynamic subsidies. By static subsidies we mean subsidies which persist indefinitely at a constant rate, such as a permanent subsidy to capital in sector X. Such a policy can clearly never be first-best provided the social discount rate is less than infinite, since it distorts the long-run equilibrium and thus ensures that maximum national income is never attained (although it is conceivable that if this were the only form of intervention available, the short-term gains which it could make possible might outweigh its long-term costs).

In any case, it is probably more appropriate to reserve the term "adjustment assistance" for dynamic subsidies only. An explicit calculation of the optimal time paths of such subsidies in the model presented in earlier sections would require the solution of an optimal control problem with two state variables (K_x and w) and at least one control variable (the level of tax or subsidy), and such an analysis is unlikely to be very illuminating.[8] However, a number of observations about the optimal form of dynamic intervention can be made on the basis of direct inspection of the competitive time path given in (15). First, given the formal structure of the model, if the government has sufficient instruments at its disposal to simultaneously control the speeds of adjustment in both markets (i.e., E_ϕ and E_ψ) and if there are no constraints on its ability to finance these subsidies in a nondistorting way, then in principle it can bring the economy arbitrarily close to the first-best equilibrium instantaneously and so can reduce adjustment costs arbitrarily close to zero.

The optimal policy to support this first-best plan would imply a subsidy to capital movement in order to raise E_ϕ and thus would speed up the process of capital reallocation. However, if E_ψ, the speed of adjustment of wages, cannot be affected by government policy, then the optimal second-best policy will in many cases imply a *reduction* in E_ϕ, in other words, a slowing down of the capital reallocation process. For, from (17), if the competitive path implies a cyclical movement in factor prices and allocations, then some reduction in E_ϕ will be sufficient to eliminate the cycles and so to lower the present value of the transitional costs of adjustment. The second-best optimal dynamic subsidy is more likely to take this form the slower the speed of adjustment of wages (i.e., the smaller is E_ψ) and the smaller the potential for factor substitution in either sector (i.e., the smaller is Δ).

These considerations illustrate the importance of simultaneously considering the adjustment process in both labor and capital markets in devising the appropriate form of adjustment assistance. At the same time the present model does not provide any microfoundations for the adjustment functions $\phi(\cdot)$ or $\psi(\cdot)$, and so implicitly assumes that these functions represent dynamic distortions rather than true social costs of adjustment. It is of interest therefore to compare our conclusions with those of two recent papers, by Lapan (1976) and Mussa (1978), which provide more complete analyses of the sources of sluggish adjustment in the labor and capital markets, respectively.[9]

Mussa's model, which assumes continual full employment but provides an explicit microeconomic analysis of the capital reallocation decision, has already been summarized in section 3.2. One of his major conclusions is that if capital owners' expectations of the future course of factor prices are rational, then private decisions will coincide with the socially optimal plan and intervention will be unnecessary. However, this conclusion was derived from a model with no other distortions, static or dynamic, and so, from the general theory of the second best, it need not survive their introduction. In particular, if future wage rates, though perfectly foreseen, do not reflect the social opportunity cost of labor, then some interference with the competitive path of capital reallocation is likely to be justified. (That rational expectations need not emasculate discretionary macroeconomic policy if wages and prices are sticky has been argued by Neary and Stiglitz 1982.)

Where Mussa assumes continual full employment and concentrates on the capital reallocation decision, Lapan ignores the latter by assuming that capital is permanently sector-specific and focuses instead on the labor market. Unlike the present paper, he assumes that the labor markets in the two sectors are segmented, with migration between the two markets taking place in response to differences in sectoral unemployment rates. Lapan shows that the optimal policy requires a wage subsidy to the declining sector at a rate which may or may not decline over time. As comments by Cassing and Ochs (1978) and Ray (1979) with replies by Lapan (1978, 1979) have made clear, intervention in this model is justified by two different features: first, the assumption that due to "institutional" factors labor, though immobile, must be paid the same wage in both sectors; and second, the assumption that the responsiveness of the rate of labor migration into the expanding sector to the unemployment rate in the declining sector decreases with the rate of unemployment, reflecting (if unemployment is voluntary) the fact that congestion occurs in the search for new jobs.

It is clear that all of these results are fully consistent with the theory of distortions and welfare, whose implications for static policy intervention in open economies have been surveyed by Bhagwati (1971) and Corden (1974). In a first-best world, with no distortions and with rational expectations of future factor prices, the market is the best judge of the rate of intersectoral resource transfers. But once one of these assumptions is abandoned, a case for adjustment assistance on purely efficiency grounds can be constructed.

3.6 Summary and Conclusion

This paper has examined the consequences of appending transitional wage stickiness to the two-sector Heckscher-Ohlin model of international trade theory, concentrating on the adjustment path of the economy following an exogenous fall in the price of the labor-intensive import-competing sector. It was shown that in the absence of substantial permanent factor-market distortions the economy moves in a stable fashion toward the new long-run equilibrium predicted by static Heckscher-Ohlin analysis. However, the combination of wage stickiness and sluggish intersectoral capital movements implies an adjustment path with properties very different from those exhibited by the full-employment short-run capital specificity adjustment path. In particular, factor prices, factor allocations, and output levels may exhibit cyclical paths as the economy alternates between phases of unemployment and excess demand for labor. Moveover, these cycles in output levels may be reflected in cycles in the value of national income, giving rise to phases of "immiserizing reallocation" during which the presence of two separate dynamic distortions induces production and employment decisions which actually reduce the level of national income. This phenomenon does not arise from any perversity in the assumed adjustment processes: capital always moves toward the high-rental sector, and wages always rise or fall in response to excess demand for or supply of labor. Both of these processes tend of themselves to raise national income (the rise in wages under excess demand for labor does so because it induces the sector which is not rationed on the labor market to release labor to the other sector, where its marginal product is higher.) Rather, immiserizing reallocation occurs because the accompanying change in industry mix may lead to either an increase in unemployment (when the labor-intensive sector contracts) or an intensification of the aggregate excess demand for labor (when the labor-intensive sector expands), and each of these tends to lower national income.

The implications for government policy of these assumptions about the dynamic adjustment of the economy were then examined. It was noted that as far as the formal structure of the present model is concerned the government could in principle ensure instantaneous adjustment if it had access to two dynamic policy instruments and if revenue could be raised costlessly to finance the disbursement of subsidies. Of course, such a high degree of controllability of the economy is clearly farfetched. If either of these conditions are not met, then transitional adjustment costs are unavoidable, but some intervention may still be justified and will in many circumstances take the form of subsidies designed to slow down rather than speed up the rate of intersectoral capital reallocation. However, these conclusions are based on a model where the microeconomic underpinnings of sluggish wage adjustment and intersectoral capital reallocation were not specified. When this is done, as it is, for example, in the recent work of Lapan (1976) and Mussa (1978), the key question becomes whether there is a divergence between social and private costs of adjustment. Such a divergence can arise from any one of a number of sources, including imperfect foresight on the part of capital owners of the future course of factor prices, government- or trade-union-induced restrictions on wage flexibility or labor mobility, and congestion in the process of search for new jobs.

While the likelihood that one if not all of these sources of market imperfection will be present in any particular situation suggests a presumption in favor of adjustment assistance, some strategic and political considerations should be kept in mind before recommending assistance in practice.[10] Principal among these are the related questions of the autonomy of the policy agency concerned with administration of the assistance program, and the likelihood that the nature of the dynamic distortions present may not be independent of the existence or expected duration of such a program. Moreover, since the terms on which assistance is granted are likely to vary from case to case, there is a grave danger that the establishment of an assistance program may lead to a diversion of resources toward lobbying activities, or, in the terminology of Hirschman (1970), to an increased used of "voice" as a means of postponing "exit." (This is especially likely when declining industries are geographically concentrated and government policies restrict interregional labor mobility.)

Finally, it should be recalled that we have concentrated in this paper on defenses of adjustment assistance which rely on its raising allocative efficiency in an environment where the revenue to finance subsidies can be raised costlessly. This neglects the well-known fact that, when nondistorting revenue sources are unavailable, the optimal levels of any subsidy must be modified to reflect the by-product distortion costs of revenue raising. In addition it ignores what is probably the strongest economic and certainly the most potent political argument for adjustment assistance—its use as a redistributional tool in compensating factors tied to declining industries, and thus in ensuring that the gains from trade liberalization do not accrue only to consumers and to factors employed in export industries.

Appendix A *The Time Path of National Income during the Adjustment Process*

Changes in real national income Z at the prices prevailing after the initial change in the terms of trade are a weighted average of the changes in sectoral output levels, the weights being the share of each sector in national income:

$$\text{(A1)} \qquad \hat{Z} = \theta_x \hat{X} + \theta_y \hat{Y}.$$

To evaluate this change, it is necessary to distinguish between cases where all firms are on their "notional" labor-demand schedules and those where they are not. Considering first the former cases, the change in output in each sector is a weighted average of the changes in input levels, the weights being the shares of each factor in the value of output:

$$\text{(A2)} \qquad \begin{aligned} \hat{X} &= \theta_{lx}\hat{L}_x + \theta_{kx}\hat{K}_x, \\ \hat{Y} &= \theta_{ly}\hat{L}_y + \theta_{ky}\hat{K}_y. \end{aligned}$$

Substituting from (A2) into (A1), and using equation (12) to eliminate $\hat{K}_y$, yields

$$\text{(A3)} \qquad \hat{Z} = \theta_x\theta_{lx}\hat{L}_x + \theta_y\theta_{ly}\hat{L}_y + \left[\theta_x\theta_{kx} - \theta_y\theta_{ky}\frac{\lambda_{kx}}{\lambda_{ky}} \right] \hat{K}_x.$$

This may be simplified by invoking the identities

$$\text{(A4)} \qquad \theta_i\theta_{li} = \theta_l\lambda_{li} \qquad (i = x, y),$$

where θ_l is the share of wages in national income, and

$$\text{(A5)} \qquad \theta_x\theta_{kx}\frac{r_y}{r_x} = \theta_y\theta_{ky}\frac{\lambda_{kx}}{\lambda_{ky}}.$$

Equation (A3) thus becomes

$$\text{(A6)} \qquad \hat{Z} = \theta_l(\lambda_{lx}\hat{L}_x + \lambda_{ly}\hat{L}_y) + \theta_x\theta_{kx}\left[1 - \frac{r_y}{r_x}\right] \hat{K}_x.$$

Since employment is demand-determined, the first bracketed term in (A6) is simply the change in the aggregate demand for labor, L^d:

(A7) $$\hat{Z} = \theta_l \hat{L}^d + \theta_x \theta_{kx} \left[1 - \frac{r_y}{r_x}\right] \hat{K}_x.$$

When full employment is maintained by wage flexibility, L^d is constant, and so

(A8) $$\hat{Z} = \theta_x \theta_{kx} \left[1 - \frac{r_y}{r_x}\right] \hat{K}_x.$$

Since capital is assumed to be reallocated at all times toward the high-rental sector, (A8) confirms the assertion in section 3.4 that immiserizing reallocation cannot take place under the full-employment short-run capital specificity adjustment mechanism.

When unemployment prevails, we may substitute from equation (13) into (A7) to obtain

(A9) $$\hat{Z} = \left[\frac{\theta_l}{\lambda_{ky}} |\lambda| + \theta_x \theta_{kx} \{1 - \frac{r_y}{r_x}\}\right] \hat{K}_x - \theta_l \Delta \hat{w}.$$

Hence, under excess supply of labor, national income is raised by a reallocation of capital toward the high-rental sector or by a rise in employment; and the latter in turn may be brought about by either a fall in wages or a reallocation of capital toward the labor-intensive sector. Immiserizing reallocation can therefore occur when the expanding high-rental sector is relatively capital-intensive (as in region 1 of figure 3.7) but not when it is labor-intensive (as in region 2 of figure 3.7).

Comparing equations (A9) and (13), it may be noted that when excess supply of labor prevails, iso-national-income and iso-employment loci are tangential in figure 3.7 when the capital market is in equilibrium. When the capital market is out of equilibrium, the iso-national-income locus at a given point in (w, K_x) space is more steeply sloped than the iso-employment locus at the same point if and only if sector X is the high-rental sector.

We turn next to cases where excess demand for labor prevails, so that at least one sector is off its notional labor-demand schedule. If this is true of sector X, then the levels of both labor and capital inputs are predetermined in the short run, and the first equation in (A2) must be replaced by

(A10) $$\hat{X} = \bar{\theta}_{lx} \hat{L}_x + \bar{\theta}_{kx} \hat{K}_x.$$

The input elasticities of supply may now be interpreted as sectoral value shares evaluated not at market factor prices but at "virtual" factor prices, $\bar{w}_x$ and $\bar{r}_x$, where the latter are the factor prices which would induce unconstrained firms to behave in the same way as employment-constrained ones. Thus

(A11) $$\bar{\theta}_{lx} = \frac{\delta X}{\delta L_x} \frac{L_x}{X} = \frac{\bar{w}_x}{p} \frac{L_x}{X} = \frac{\bar{w}_x}{w} \theta_{lx}.$$

We must now distinguish between three cases.

a) Both sectors constrained: In this case neither sector is willing to relinquish any labor, so that sectoral employment levels are constant and hence the level of national income is independent of the wage rate. Substituting from (A10) and the corresponding equation for sector Y, and using (12) to eliminate $\hat{K}_y$, (A1) becomes

$$\hat{Z} = \left[\theta_x \bar{\theta}_{kx} - \theta_y \bar{\theta}_{ky} \frac{\lambda_{kx}}{\lambda_{ky}} \right] \hat{K}_x. \tag{A12}$$

Invoking an equation similar to (A5), but in terms of virtual rather than actual rentals, this becomes

$$\hat{Z} = \theta_x \bar{\theta}_{kx} \left[1 - \frac{\bar{r}_y}{\bar{r}_x} \right] \hat{K}_x. \tag{A13}$$

Since there is no necessary relationship between the rankings of the two sectors by market rentals (which determine the direction of capital movement) and virtual rentals (which reflect the extent to which the sectors are forced off their notional labor-demand schedules), it is possible for immiserizing reallocation to take place in this case.

b) Only sector X constrained: In this case the amount of labor available to sector X is determined through the full-employment constraint,

$$\lambda_{lx} \hat{L}_x + \lambda_{ly} \hat{L}_y = 0, \tag{A14}$$

by sector Y's notional labor-demand function (11). Substituting into (A10) and making use of (12) yields

$$\hat{X} = \left[\bar{\theta}_{kx} + \bar{\theta}_{lx} \frac{\lambda_{ly}}{\lambda_{lx}} \frac{\lambda_{kx}}{\lambda_{ky}} \right] \hat{K}_x + \bar{\theta}_{lx} \frac{\lambda_{ly}}{\lambda_{lx}} \frac{\sigma_y}{\theta_{ky}} \hat{w}. \tag{A15}$$

Note that an increase in the wage rate *raises* the output of X, since it induces sector Y to release labor, so relaxing the labor-demand constraint on sector X. Substituting from (A2) and (A15) into (A1) yields an expression which may be simplified by invoking equations (A4) (for sector Y), (A5), and (A16):

$$\theta_x \bar{\theta}_{lx} w = \theta_l \lambda_{lx} \bar{w}_x. \tag{A16}$$

Manipulation yields

$$\hat{Z} = \left[- \frac{\theta_l}{\lambda_{ky}} |\lambda| \left\{ \frac{\bar{w}_x}{w} - 1 \right\} + \theta_x \theta_{kx} \left\{ 1 - \frac{r_y}{r_x} \right\} \right] \hat{K}_x + \theta_l \lambda_{ly} \frac{\sigma_y}{\theta_{ky}} \left[\frac{\bar{w}_x}{w} - 1 \right] \hat{w}. \tag{A17}$$

Since $\bar{w}_x$ exceeds w, (A17) shows that immiserizing reallocation is possible in this case when the high-rental sector is relatively labor-intensive (e.g., in region 3 of figure 3.7). This is because, by contrast with (A9), national income is increased by a *fall* in the aggregate effective demand for labor when excess demand for labor prevails, and such a fall is encouraged by either a rise in wages or a reallocation of labor toward the relatively capital-intensive sector.

c) Only sector Y constrained. A similar series of derivations yields in this case

(A18)
$$\hat{Z} = \left[-\frac{\theta_l}{\lambda_{ky}} |\lambda| \{\frac{\bar{w}_y}{w} - 1\} + \theta_x \theta_{kx} \{1 - \frac{r_y}{r_x}\} \right] \hat{K}_x + \theta_l \lambda_{lx} \frac{\sigma_x}{\theta_{kx}} \left[\frac{\bar{w}_y}{w} - 1 \right] \hat{w}.$$

Appendix B *The Capital-Market Equilibrium Locus under Excess Demand for Labor*

When excess demand for labor prevails, the capital-market equilibrium locus is not given by equation (6), since the assumption made in deriving that equation, namely, that the rental in each sector equals the marginal product of capital there, does not hold in a sector which is rationed in its demand for labor. Instead, the rental is simply the residual income per unit of capital accruing to the sector after wage payments are made. Thus, for sector X

(A19)
$$r_x = \frac{pX - wL_x}{K_x} .$$

Totally differentiating, holding p constant, and substituting from (A10) and (A11) yields

(A20)
$$\theta_{kx} \hat{r}_x = -\theta_{lx} \hat{w} + \theta_{lx} \{\frac{\bar{w}_x}{w} - 1\}(\hat{L}_x - \hat{K}_x).$$

When firms in sector X are on their notional labor-demand curves, this reduces to equation (4) in the text. However, when sector X is rationed in the labor market, $\bar{w}_x$ exceeds w, implying that at a given market wage a fall in the sector's capital-labor ratio (which represents a relaxation of the labor-demand constraint) raises the return to capital.

In order to derive an expression for the capital-market equilibrium locus, it is again necessary to distinguish between three cases.

a) *Both sectors constrained.* Combining (A20) with the corresponding equation for sector Y, recalling that L_x and L_y are constant, and using (12) to eliminate $\hat{K}_y$ yields

$$\text{(A21)} \qquad \hat{r}_x - \hat{r}_y = -\frac{|\theta|}{\theta_{kx}\theta_{ky}}\hat{w} - \left[\frac{\theta_{lx}}{\theta_{kx}}\{\frac{\bar{w}_x}{w} - 1\} + \frac{\lambda_{lx}}{\lambda_{ly}}\,\frac{\theta_{ly}}{\theta_{ky}}\{\frac{\bar{w}_y}{w} - 1\}\right]\hat{K}_x.$$

The coefficient of $\hat{K}_x$ is zero in the neighborhood of the long-run equilibrium point, and is otherwise negative, implying that when both sectors are rationed, the capital-market equilibrium locus is downward-sloping if and only if sector X is relatively labor-intensive.

b) *Only sector X constrained.* In this case

$$\text{(A22)} \qquad \hat{r}_x - \hat{r}_y = -\frac{|\theta|}{\theta_{kx}\theta_{ky}}\hat{w} + \frac{\theta_{lx}}{\theta_{kx}}\left[\frac{\bar{w}_x}{w} - 1\right](\hat{L}_x - \hat{K}_x).$$

Using (A12), (11), and (12) to eliminate $\hat{L}_x$, this becomes

$$\text{(A23)} \qquad \hat{r}_x - \hat{r}_y = -\frac{1}{\theta_{kx}\theta_{ky}}\left[\,|\theta| - \theta_{lx}\frac{\lambda_{ly}}{\lambda_{lx}}\sigma_y\{\frac{\bar{w}_x}{w} - 1\}\right]\hat{w} - \frac{\theta_{lx}}{\theta_{kx}}\,\frac{|\lambda|}{\lambda_{lx}\lambda_{ky}}\left[\frac{\bar{w}_x}{w} - 1\right]\hat{K}_x.$$

A reallocation of capital toward sector X has the direct effect of tightening the labor-market constraint which the sector faces and thereby lowering the return to capital there; in addition, by inducing sector Y to release some labor, it indirectly tends to relax the constraint on sector X. A necessary and sufficient condition for the direct effect to dominate is that sector X be relatively labor-intensive. As for an increase in the wage rate, it has the usual effect of lowering the relative rental in the labor-intensive sector. In addition, by encouraging sector Y to release some labor, it raises output and the return to capital in sector X.

By inspecting (A23) it may be established that this locus is horizontal in the neighborhood of long-run equilibrium and downward-sloping when the extent of excess demand for labor is small. If the labor market is extremely tight (so that $\bar{w}_x$ greatly exceeds w), the locus is downward-sloping if and only if sector X is relatively capital-intensive.

c) *Only sector Y constrained.* A similar series of derivations yields

(A24)
$$\hat{r}_x - \hat{r}_y = -\frac{1}{\theta_{kx}\theta_{ky}}\left[|\theta| + \theta_{ly}\frac{\lambda_{lx}}{\lambda_{ly}}\sigma_x\left\{\frac{\bar{w}_y}{w} - 1\right\} \right]\hat{w}$$
$$+ \frac{\theta_{ly}}{\theta_{ky}}\frac{|\lambda|}{\lambda_{ly}\lambda_{ky}}\left[\frac{\bar{w}_y}{w} - 1\right]\hat{K}_x.$$

Notes

1. Mussa (1979) illustrates the usefulness of these isocost curves in international trade theory.
2. This criticism of adjustment costs as a rationale for noninstantaneous movement from one long-run equilibrium to another was first made by Rothschild (1971) in the context of investment theory.
3. These facts are reflected in the shape of the transformation curve in the minimum-wage model of Brecher (1974). Note, however, that if the wage is pegged at a level which implies excess demand for labor, then (as shown in appendix B) the capital-market equilibrium locus does depend on the intersectoral allocation of capital, and so a determinate unspecialized equilibrium is possible.
4. As shown by Jones and Neary (1979) this does not rule out a temporary reversal of the sign of $|\theta|$ in the course of the adjustment process.
5. See Dixit (1978), for example. I am indebted to Avinash Dixit for pointing out the need to "Clowerize" the capital-market equilibrium locus under excess demand for labor in the present model.
6. Production would remain at A'' if both capital and labor were sector-specific in the short-run but their returns in each sector were perfectly flexible, ensuring continual full employment of both factors. The consequences of these assumptions have been examined by Kemp, Kimura, and Okuguchi (1977) and Neary (1978*b*).
7. Since real income is evaluated at post- rather than prechange prices, the measure of adjustment costs proposed here is of the compensating rather than the equivalent variation kind. The construction of a true measure of adjustment costs is, of course, greatly facilitated by the assumption that commodity prices are exogenous. The difficulties of constructing measures of static efficiency losses in a closed economy are illustrated by Desai and Martin (1979).
8. The optimal policy under the minimum-time objective for the special case where techniques are fixed in both sectors (so that the competitive solution is as illustrated in figure 3.4) has been derived by Koichi Hamada in a paper published in Japanese.
9. Optimal policy choice in models with adjustment costs has also been examined by Bhagwati and Srinivasan (1976) and Mayer (1977). However, they were not concerned with adjustment assistance.
10. Wolf (1979) presents a valuable survey of actual experience with adjustment assistance and discusses some of the issues touched on here.

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Comment Carlos Alfredo Rodríguez

In Neary's two-sector, two-factor, small-country, open-economy model, the wage level adjusts slowly in response to the rate of unemployment while physical capital moves slowly between sectors in response to differences in its marginal value product in each sector. Neary shows that in the resulting dynamic adjustment path, national income evaluated at world prices may actually fall for some time in spite of the quite reasonable adjustment mechanism postulated for the factor markets and the absence of distortions in the goods markets. This possibility is baptized "immiserizing reallocation" (IR) by the author and is, in my view, the main contribution of the paper. However, I feel that the paper does not provide a clear, intuitive explanation for the phenomenon of IR, and doing so is the purpose of this comment.

Explaining Immiserizing Reallocation

There are two state variables in the model: the wage rate, w, and the capital used in sector X, K_x, (K_y equals the fixed total stock minus K_x). According to Neary, IR may happen when w falls (so there must be unemployment) and K_x also falls (so that the marginal product of K in Y exceeds that in the X sector). Clearly, the fall in wages can only contribute to a higher level of employment and therefore will raise national

Carlos Alfredo Rodríguez is professor of economics with C.E.M.A. in Buenos Aires, Argentina, and was professor of economics at Columbia University. He has published extensively on international trade and monetary theory.

income (remember, there are no distortions in goods markets so that here cannot be any "adverse" Rybczynski effect); therefore the fall in wages cannot be the direct cause of IR, which then must be the result of the shift of capital between sectors in the face of short-run wage rigidity.

The question is how can shifting capital from a low- to a high-marginal-value product activity reduce national income in the absence of distortions in the goods markets? The answer is that in a fixed wage economy, the marginal product of capital does not equal its social marginal product (i.e., the increase in national income due to a unit increase in the capital stock). In Neary's world, because of the fixed wage assumption, the social opportunity cost of labor is zero since any increase in employment in one sector comes exclusively from the pool of unemployment and not from reduced employment (and output) in the other sector. The social marginal product of labor being zero implies that the social marginal product of capital in each sector is equal to its average private product in the sector (this will be formally proved below). The criterion for IR therefore becomes that capital moves from a high average product activity to a low average product activity. Notice that it is perfectly possible for the sector with the higher average product of capital to have the lower marginal product of capital. Since capital moves in response to differences between private rates of return (marginal products), the possibility of IR is therefore explained as a result of the difference between the private and social rates of return to capital in each sector. To the extent that unemployment persists, the possibility of IR is eliminated when capitalists perceive the average product of capital as its opportunity cost and this can be obtained through a subsidy to the use of capital in each sector equal to the difference between its average and marginal product. This second-best subsidy will eliminate the possibility of IR but will not, of course, eliminate the social loss of unemployment due to the wage rigidity, the solution to which would require subsidizing labor by the full amount of its marginal product.

I will now derive algebraically the above results.

(1) $\bar{w} = F_L(L_x, K_x)$

(2) $\bar{w} = G_L(L_y, K_y)$

demands for labor.

(3) $X = F(L_x, K_x)$

(4) $Y = G(L_y, K_y)$

production functions.

The functions $F(\cdot)$ and $G(\cdot)$ are assumed to be homogeneous in the first degree so that

(5) $F_{LL} = -(K_x/L_x)F_{KL},$

(6) $G_{LL} = -(K_y/L_y)G_{KL}.$

The capital constraint requires that

$$(7)\qquad K_x + K_y = \bar{K},$$

while there is no labor constraint since there is unemployment.

National income, assuming world prices equal unity, is

$$(8)\qquad I = X + Y = F(L_x, K_x) + G(L_y, K_y).$$

The phenomenon of IR can arise when capital is shifted away from the X sector into the Y sector. The net effect on national income of this capital reallocation is obtained by computing the derivative dI/dK_y in (8) subject to the conditions (1), (2), and (7). Differentiating (1), (2), and (8) and using (7), we obtain

$$(8')\qquad dI/dK_y = (dL_x/dK_y)\bar{w} + (dL_y/dK_y)\\ \bar{w} + (G_K - F_k),$$

$$(1')\qquad dL_x/dK_y = F_{KL}/F_{LL} = -(L_x/K_x) \qquad \text{(using [5])},$$

$$(2')\qquad dL_y/dK_y = G_{KL}/G_{LL} = -(L_y/K_y) \qquad \text{(using [6])}.$$

The first two terms on the RHS of (8′) represent the effect on national income of the reallocation of labor induced by the movement of capital; the last term in (8′) captures the direct effect of the reallocation of capital (which is positive since by assumption G_K exceeds F_K). The possibility of IR requires therefore that the sum of the first two terms on the RHS of (8′) be sufficiently negative to offset the positive contribution of the last term $(G_K - F_K)$. We can go one step further to see whether a more definite expression can be obtained. Replacing (1′) and (2′) into (8′) using (1) and (2), we obtain

$$(9)\qquad dI/dK_y = -(F_L L_x/K_x) + (G_L L_y/K_y) + G_K - F_K = \\ = \frac{G_L L_Y + G_K K_y}{K_y} - \frac{F_L L_x + F_K K_x}{K_x},$$

which, given the linear technology, becomes

$$(10)\qquad dI/dK_y = (Y/K_y) - (X/K_x).$$

According to (10), shifting capital away from the X sector into the Y sector will increase national income if and only if the average product of capital in the Y sector exceeds the average product of capital in the X sector. This result is totally independent of the relationship between the marginal products of capital in both sectors and, as explained before, is due to the fixed wage assumption.

Comment Avinash Dixit

This is a typically competent Neary paper on the specific factor model. The added feature is wage stickiness, which is shown to produce interesting new problems such as cyclical adjustment paths involving "immiserizing" phases where the value of output may be falling. Like all fix-price models, this one could be criticized for its lack of explicit attention to the process of price formation. The ad hoc nature of the capital allocation process could also be discussed. Neary is aware of both problems, and would offer the standard replies. Instead of indulging in this ritual, therefore, I shall point out how some of the technical aspects of the paper could be developed more neatly. Thus the discussion is an alternative version of Neary's appendix A.

Instead of Neary's λ-θ approach following Jones (1965), I shall use the revenue or national product function following Chipman (1972) and Dixit and Norman (1980). In the flexible-wage case, the matter is very simple. The value of output is given by

$$Z = R(p_x, p_y, K_x, K_y, L), \tag{1}$$

where the function on the RHS gives the maximum of $p_x X + p_y Y$ subject to production feasibility given factor supplies K_x, K_y, and L. The important property of this function for our purposes is that its partial derivatives with respect to K_x and K_y are the value marginal products of these factor quantities, i.e., the rental rates r_x and r_y in the respective sectors. Differentiating with respect to time, therefore, we have

$$\dot{Z} = (\partial R/\partial K_x)\dot{K}_x + (\partial R/\partial K_y)\dot{K}_y = (r_x - r_y)\dot{K}_x \tag{2}$$

using $\dot{K}_y = -\dot{K}_x$. Since $\dot{K}_x$ has the same sign as $(r_x - r_y)$, national product increases monotonically along the adjustment path.

When the sticky wage is below its full-employment level, labor must be rationed between the two sectors. Neary considers alternative cases and finds ambiguous answers. The nature of this ambiguity is brought out most sharply by considering a case where labor is allocated efficiently, i.e., so as to maximize the value of output. Now we once again have (1), but the partial derivatives of R with respect to K_x and K_y are the shadow rentals $\bar{r}_x$ and $\bar{r}_y$. Differentiating,

$$\dot{Z} = (\bar{r}_x - \bar{r}_y)\dot{K}_x. \tag{3}$$

The sign of $\dot{K}_x$ is that of the difference between the market rental rates $(r_x - r_y)$. There is no logical connection between this and the difference

Avinash Dixit is professor of economics and international affairs at Princeton University. He is coauthor (with Victor Norman) of *The Theory of International Trade*, and of other books and articles on international trade, industrial organization, public finance, and growth and development theory.

between the shadow rental rates; therefore the immiserizing decrease in Z along the adjustment path is a possibility.

When the sticky wage is too high, there is unemployment. In this case it is better to replace the revenue function by the closely related profit function $\pi(p_x,p_y,K_x,K_y,w)$, this being the maximum of $(p_xX + p_yY - wL)$ subject to feasibility given (K_x,K_y) and the prices. Its partial derivatives with respect to K_x and K_y are the rentals r_x and r_y, while the labor demand function is minus the partial derivative with respect to w:

$$(4) \qquad L^d(p_x,p_y,K_x,K_y,w) = -\pi_w(p_x,p_y,K_x,K_y,w).$$

National product is then profit plus the wage bill:

$$(5) \qquad Z = \pi(p_x,p_y,K_x,K_y,w) + wL^d(p_x,p_y,K_x,K_y,w).$$

In the specific factor model, labor demand is found by equating the marginal product of labor in each sector to the product wage there:

$$(6) \qquad w/p_x = f_x'(L_x/K_x) \text{ or } L_x = K_x g_x(w/p_x),$$

where f_x is the production function in intensive form and g_x is the function inverse to f_x'. Similarly for the other sector. Therefore

$$(7) \qquad L^d(p_x,p_y,K_x,K_y,w) = K_x g_x(w/p_x) + K_y g_y(w/p_y).$$

Using all this and differentiating (5), we have

$$(8) \qquad \dot{Z} = (r_x - r_y)\dot{K}_x + wL_w^d\,\dot{w} + w[g_x(w/p_x) - g_y(w/p_y)]\dot{K}_x.$$

The first term is positive as before. The second term is also positive, since L_w^d is negative, and in the region of unemployment so is $\dot{w}$. The only possible ambiguity arises from the third term. The term in brackets is the difference between the labor-capital ratios in the two sectors, which is positive by Neary's assumption that sector X is more labor-intensive. Therefore the third term will be positive when $\dot{K}_x$ is positive, i.e., in Neary's region (2). In that region, therefore, national product is increasing along the adjustment path. In region (1), however, $\dot{K}_x$ is negative and so is the third term, and it is possible for it to outweigh the first two and thus produce an immiserizing decrease of national product during the adjustment process.

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