International Finance Discussion Papers

Number 384

July 1990

Three-Factor General Equilibrium Models: A Dual, Geometric Approach

Douglas A. Irwin

Abstract

This paper develops dual, geometric techniques for two popular three-factor general equilibrium models: the specific-factor model and the Krueger model of economic development. Several comparative static exercises from international trade theory illustrate how these models easily lend themselves to geometric exposition.

Three-Factor General Equilibrium Models: A Dual, Geometric Approach

Douglas A. Irwin[1]

1. Introduction

The dual of the production function highlights the relationship between factor prices and output prices. Because many propositions in international trade theory focus on relationships between these prices, restating a model in terms of the dual provides an important contrast to the traditional geometric representation of factor and output quantities. In this context, Mussa (1979) has demonstrated the usefulness of expressing geometrically the two-sector Heckscher-Ohlin model in terms of its dual.

This paper develops the geometry of the dual for two popular three-factor general equilibrium models. The first is the specific-factor model, also known as the Ricardo-Viner model, developed by Jones (1971) and Samuelson (1971). This three-factor, two-good model features one perfectly mobile factor (labor) that is allocated between two sectors, each of which has a factor (capital) specific to its production. The specific-factor model is appealing for several reasons. Unlike the Heckscher-Ohlin model, it is able to explain why factors devoted to producing a particular good also seek trade policies designed to increase

---

1. The author is a staff economist in the Division of International Finance. The views expressed in this paper are solely the responsibility of the author and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or other members of its staff. I wish to thank Alan Deardorff and Kar-yiu Wong for helpful comments.

the relative price of that good (see Magee 1980). In addition, empirical studies (such as Grossman and Levinsohn 1989) suggest that a significant degree of capital-specificity exists in several manufacturing industries.

The second model is the three-factor, n-good model initially conceived by Krueger (1977). This model features intersectorally mobile labor combined with a specific-factor land in a single-good agricultural sector and with a specific-factor capital in a multi-good manufacturing sector. This model, elaborated by Deardorff (1984), is attractive for its description of the stages of economic development. Empirical tests presented in Leamer (1987) lend some support to the propositions of the model.

Despite the importance of these three-factor models, they are given relatively scant attention in many applications of duality to international trade theory (e.g. Woodland 1982). It will be shown here that such models easily lend themselves to a geometric approach using the dual. This approach helps clarify the factor and output price properties of these models which are sometimes unclear from conventional expositions. As noted below, however, the dual approach has drawbacks as well and should be considered as a complement to traditional geometric expositions in output and factor quantity space.

This paper proceeds as follows. Section 2 describes the basic geometric construction as applied to the specific factor model. Section 3 uses this apparatus to demonstrate the standard comparative static propositions used in international trade theory, such as the Rybcynski effect, the Stolper-Samuelson relationship, and sectoral technical progress. Section 4 extends the model to a simple version of the n-good

Krueger model. Section 5 subjects this model to the same comparative static exercises. Section 6 concludes the paper.

2. The Specific Factor Model in the Dual

The specific factor model consists of two final goods, both of which are produced using labor and capital. It is assumed throughout that both goods are produced. While labor is homogeneous and perfectly mobile between the two sectors, capital is immobile and specific to a particular sector's activity. Both goods are produced with a linearly homogeneous production technology, but due to the fixed nature of the capital stock in each sector the relevant consideration is that labor has a diminishing (but always positive) marginal product in each activity. Labor is allocated between the two sectors on a basis such that the marginal value products of labor are equalized.

This model can be expressed in terms of prices as the dual of the production functions. Figure 1 depicts the isoprice contours for the two goods in factor price space. For example, the isoprice contour for good 1, $P_1(w, r_1)$, shows the combination of various factor prices which imply zero profits for a given product price. The quadrants for both goods share the wage axis because the two sectors compete for labor, while the respective rental axes are independent.

Like the two-sector model examined by Mussa (1979), an increase in the price of a good is represented by a proportionate movement of its isoprice contour away from the origin. The absolute value of the slope of the isoprice contour indicates the capital-labor ratio used in production. The contour is convex to the origin, reflecting the fact that the capital-labor ratio is an increasing function of the wage-rental ratio. The elasticity of substitution between the two factors is represented by the curvature of the contour. Because capital is sector-specific and assumed to be fixed in inelastic supply, substitutions reflected in the capital-labor ratio in each sector are made solely through adjustments in the amount of labor employed.

If we examine the case of a small country, we can take the prices of the two goods as exogenous. Labor mobility ensures that the wage rate is equalized between the two sectors. While there may appear to be many equilibria with a single wage prevailing, in general a given factor endowment (supply of labor and stocks of capital) will determine a unique capital-labor ratio in each sector consistent with a unified wage. On first glance, the dual formulation, unlike the output and factor space geometry of the traditional two sector model, appears unable to show the determination of the equilibrium wage and rentals. Yet it is possible to derive a schedule in the first quadrant depicting the wage as a function of the first sector's rental and the other sector's price.

More formally, the capital-labor ratio in sector 2 can be written as a function of that in the second, i.e., $k_2 = \phi(k_1)$, with $\phi' < 0$. Wage equalization across sectors implies that $w = p_1 f_1(k_1) = p_2 f_2(\phi(k_1))$, where f_i is the marginal product of labor in sector i, i = {1,2}. This can be rearranged to form the implicit relationship $k_1 = \varphi(p_1, p_2)$. Using $p_1 = c_1(w, r_1)$, we can write $w = p_1 f_1(k_1) = c_1(w, r_1) f_1(\varphi(c_1(w, r_1), p_2)) = \gamma(r_1, p_2)$. It can be demonstrated that $1 > \partial\gamma/\partial r_1 > 0$, i.e., the function is increasing with a slope less than one in

(w, r_1).[2] The "magnification effect" of output prices on factor prices in general equilibrium accounts for this link. In this model, for example, a given change in output prices results in a greater change in payments to specific factors than to the mobile factor. Consequently, an increase in p_1 will increase both w and r_1, but will increase r_1 by a greater proportion.

It can also be shown that $\partial\gamma/\partial p_2 > 0$, i.e., the function shifts upward with an increase in p_2. In addition, $\partial w/\partial L < 0$ and $\partial w/\partial K_i > 0$, $i = \{1,2\}$, which determine the direction the function shifts with changes in the exogenous variables. The γ schedule shifts down with an increase in the endowment of labor as wages fall, given any r_1; the schedule shifts up with an increase in the endowment of capital specific to either sector as wages rise, given any r_1. These results are important for the comparative static exercises performed below.

An initial equilibrium is depicted on figure 1 at point a, where the γ schedule intersects the isoprice contour of the first sector. Given the product prices P_1 and P_2, the γ schedule indicates that the wage rate is equalized at w^0 while the rentals to capital (r_1^0 and r_2^0) may differ.[3] The slopes of the isoprice contours at this equilibrium, represented by the tangents k_1 and k_2, indicate the capital-labor ratios

2. Using Jones (1971) notation, the slope of the γ schedule can be seen from: $\hat{w} = \left[\dfrac{1}{1 + \dfrac{1}{\theta_{K2}} \dfrac{\lambda_{L2}\,\sigma_2}{\lambda_{L1}\,\sigma_1}} \right] \cdot \hat{r}_1$, for a given p_2 and variable p_1. The expression in brackets is positive but less than one.

3. If the immobile capital is homogeneous, so that rentals are comparable, an application of the Edgeworth box diagram to the immobile capital case, as in Neary (1978), can determine the relative values of the rentals.

in the two sectors. In this figure, k_1 is steeper than k_2, indicating that the capital-labor ratio is higher in good 1.

3. Comparative Statics

This section uses this apparatus to demonstrate four comparative static properties of the specific factor model.

3.1 Rybczynski Effect

Given the small country assumption, an increase in the quantity of any factor does not change the product prices of the two commodities. Consequently the isoprice contours remain in place. First consider an increase in the supply of labor available to the economy. Such an increase shifts the γ schedule down to γ' (given r_1, wages are uniformly lower with the additional labor) and equilibrium moves from points a and a′ to b and b′. The capital-labor ratios in both sectors decline because the sector-specific capital stocks are fixed. This can be seen by the (undrawn) lines tangent to the isoprice contours at b and b′, which are less steeply sloped than k_1 and k_2. The curvature of the isoprice contours determine the proportion of new labor allocated to each sector and thus the relative change in k_1 and k_2, r_1 and r_2. Thus with additional labor the equilibrium wage falls from w^0 to w^1 and the two rental rates rise from $r_i^{\,0}$ to $r_i^{\,1}$, $i = \{1,2\}$. Output of both goods increases, although this must be infered from the changes in factor supplies and is not directly observed.

Now consider an increase in the stock of capital associated with the production of good 1. This increases the marginal product of labor in that sector, which attracts labor by bidding up the prevailing wage as the γ schedule shifts upward from b to a in figure 1. The capital-labor ratio therefore must rise, indicating that less labor is added to the new capital than is needed to preserve the old capital-labor ratio. This can be seen in figure 1 by the increasing slope along P_1 from b to a. The capital-labor ratio also rises in the second sector as it loses labor. Hence, the wage rate rises and the rental rates decline in employs sectors. Output falls in the second sector, because it uses less labor with the same amount of capital, while output rises in the first sector.

Thus, in contrast with the standard two-sector model, changes in factor endowments alter factor prices in the specific-factors framework. These factor prices movements translate into real changes because goods prices are constant. Furthermore, depending on which factor increases in supply, either output of both goods increase or the traditional Rybczynski result holds with its differential impact on commodity outputs.

3.2 Stolper-Samuelson Relation

Consider an increase in the relative price of good 1 without any change in the country's factor endowment. An increase in the relative price of good 1 leads to an outward shift of that sector's isoprofit contour, as from P_1 to P_1' in figure 2. Expanded production in that sector can be accomplished only by attracting more labor because the capital endowments of each sector are fixed and immobile. The capital-labor ratio in sector 1 falls as the isoprice contour shifts out along the γ schedule, the slope of which is less than unity due to the magnification effect. But the fall is not enough to reduce wages. The capital-labor ratio rises in the other sector as it releases labor. Consequently the slope of the new capital-labor ratio line, k_1' tangent to the P_1' contour, must be less than k_1 tangent to P_1, while the (undrawn) tangent to P_2 at b′ is steeper than before. The rental r_1 unambiguously increases, both because the increase in price shifts the contour outward and because more labor is added to a given stock of capital.[4] The rental r_2 unambiguously declines because the withdrawal of labor, seen as the movement from a′ to b′, reduces the marginal product of capital along the fixed isoprice contour.

Consequently, real r_1 rises in terms of both goods because r_1 increases more than in proportion to the price of both goods, while real r_2 falls in terms of both goods. The new equilibrium wage rate is nominally higher, but the change in the real wage is ambiguous because it has fallen in terms of good 1 but has risen in terms of good 2.

3.3 Technical Progress

An increase in the productivity of one sector is analytically equivalent to a movement of that sector's isoprice contour away from the origin. The interpretation is different because the shift does not reflect a change in the price of output, but rather a change in the different possible prices of labor and capital consistent with zero-profit production after technical progress. For a given product price after technical progress, the sector can maintain zero profits while paying higher rewards to both factors.

Consider Hicks-neutral technical progress in the production of good 1 at constant product prices. With reference to figure 2, it is easily seen that such a change, by shifting P_1 to P_1', would increase r_1 and the wage and decrease r_2. In contrast to Stolper-Samuelson,

4. This can be seen by drawing a line perpendicular to the tangent at the initial equilibrium a on P_1. Production after the change in price does not take place where the ray intersects the new isoprice contour, P_1', where the capital-labor ratios would be identical, but at a more labor-intensive production technology.

technical progress increases the real wage of labor because the prices of goods do not change. In contrast to the standard two-sector result that technical progress moves factor prices in opposite directions, technical progress in either sector in this model increases the wage and the rental of the specific factor involved in its production and decreases the rental of the other specific factor. Like the two-sector case, this extends to non-Hicks neutral technical change where the outward shift of the contour is not homogeneous.

3.4 Factor Market Distortions

The geometric dual framework is also useful for analyzing distortions and interventions in factor markets. Consider a subsidy to labor used in the production of good 1. In the standard two-sector model, such a policy would create a gap between the effective wages as perceived by producers in each sector and move realized factor prices in opposite directions. In the specific-factor model, considered on figure 1 at the initial equilibria of b and b′, a labor subsidy to good 1 would allow that sector to employ more labor by pushing the subsidy-inclusive wage below w^1. This decreases the capital-labor ratio in sector 1 by shifting the equilibrium from b to c, thereby increasing the rental r_1. The labor diverted from sector 2 shifts the equilibrium there from b′ to a′, reducing r_2. Hence, wages exclusive of subsidy are increased and equal in both sectors at w^0, with the difference between that prevailing wage exclusive of subsidy and the effective wage for producers of good 1, w^2, representing the extent of the wage subsidy.

Thus, a labor subsidy to (tax on) either sector increases (decreases) wages and the returns to the specific factor in that sector while decreasing (increasing) the reward to the other specific factor.

By contrast, because the income of either specific factor is a pure rent, subsidies to or taxes on these factors do not change their employment. Consequently, the marginal product of labor is the same and neither labor allocation nor factor prices change.

4. Three Factor-n Goods: Krueger's Development Model

Anne Krueger's 1976 Frank Graham lecture outlined a way of integrating the multi-commodity Heckscher-Ohlin model with the specific factors model. This model sheds light on comparative advantage in the various stages of economic development and was subsequently examined by Deardorff (1984) and Leamer (1987).

The model consists of an agricultural sector where a single output is produced with a combination of labor and sector-specific land. A manufacturing sector consists of n-goods produced with labor and capital. Capital is specific to the manufacturing sector but mobile within it, i.e. between manufactured goods. Labor is homogeneous and can be freely substituted among the manufactured goods and with the agricultural good.

Such an arrangement is shown geometrically in figure 3. The right-hand quadrant depicts the manufacturing sector, consisting here of two goods. The analysis could be extended to three or more goods, but we will concentrate on the simpler two-good case to isolate the general properties of the model. This quadrant displays the isoprice contours of the two manufactured goods, $P_1(w,r_1)$ and $P_2(w,r_2)$, where r_i, $i = \{1,2\}$ is the return to capital in sector i. Good 1 is assumed to be more labor-intensive than good 2 for all factor prices. Mussa's (1979) exposition explored this quadrant in detail and should be refered to for details.

Because another sector with a specific factor is grafted onto the two-sector model, the Krueger model does not retain all of the comparative static properties of the two-sector model.

The left quadrant shows the isoprice contour for the agricultural sector, $P_A(w,r_A)$, which produces output from labor and the immobile factor land, earning the rental r_A. The equilibrium wage rate, with the price of all goods determined exogenously, is set by the intersection of the isoprice contours in the manufacturing sector. Labor is allocated between the two sectors, as in the pure specific factor model considered previously, on the basis of marginal product. The slope of the tangent k_A indicates the land-labor ratio in the agricultural sector. The overall capital-labor ratio in the manufacturing sector is a weighted average of that ratio in goods 1 and 2, represented by k_1 and k_2. Good 1 is the labor-intensive good because k_1 is less than k_2 where the two isoprice contours intersect. A line k_M, representing the overall capital-labor ratio in the manufacturing sector, could be drawn through the intersection of P_1 and P_2 with slope between that of k_1 and k_2.

5. Comparative Statics

As before, we now use this apparatus to demonstrate the comparative static properties of the Krueger model.

5.1 Rybczynski Effect

Consider first an increase in the economy-wide supply of labor. Like the two-sector model, but unlike the specific factor model, such an increase may have no effect on factor prices. The isoprice contours remain in place, and the Heckscher-Ohlin structure in the manufacturing sector ties down factor prices despite the specific-factor structure in agriculture. This can be seen with reference to figure 4 which shows the marginal value product of labor curves for both the agricultural and manufacturing sector, w_A and w_M, respectively.[5] If w_A intersects w_M within either the range OL_1 or L_2O', then the economy is not diversified and only one of the manufactured goods is produced because the capital-labor ratio in manufacturing is skewed outside of the diversification cone. But if, as is depicted in figure 4, the curves intersect in the segment L_1L_2 both before and after the increase in the labor supply, then factor prices will not change. In this case, the additional labor will be absorbed entirely by the manufacturing sector. No additional labor is added to agricultural production, ensuring that k_A is constant. The only change will be that the undrawn k_M decreases, indicating a decline in the capital-labor ratio in manufacturing. (However, the capital-labor ratio in each good in manufacturing, k_1 and k_2, will not change.) This results in a Rybczynski change in the composition of manufacturing output, with production of the labor-intensive good increasings and that of the capital-intensive good decreasing. Note that if the increase in the pool of labor is large enough to put the intersection of the two curves in OL_1, production of the capital-intensive good will be eliminated and factor prices will be altered.

An increase in the supply of capital will cause the w_M curve in figure 4 to shift proportionally to the left. If the intersection of the curves is again on the flat portion of the w_M curve, then the economy remains diversified and the increased capital has no impact on factor

---

5. $P_AF_L{}^A$ is the marginal value product of labor curve in agriculture and $V_L{}^M$ is the unit value marginal product curve for manufacturing as a whole. See Deardorff (1984) for details.

prices. The capital-labor endowment in manufacturing will increase (the k_M line will increase) and the composition of manufactured output will change according to the traditional Rybczynski theorem. Again there will be no intersectoral labor reallocation, leaving L_A and k_A the same. Note that if the intersection of the two marginal product curves was formerly OL_1 and an increase in capital is enough to push the intersection of w_M and w_A into L_1L_2, production of the previously unproduced capital-intensive manufactured good commences.

An increase in the supply of the specific-factor land also changed nothing in figure 3, except to increase the overall capital-labor ratio in manufacturing. Because product prices remain fixed, additional land allows the agricultural sector to withdraw enough labor from the manufacturing sector (by shifting the w_A line to the right in figure 4) to maintain the same land-labor ratio that existed before the increase in land. Agricultural output increases, while manufacturing loses labor with the Rybczynski effect on output again. Factor prices do not change if the economy remains diversified. If this is not the case, one interesting implication of Krueger's model is that a country with a small endowment of capital may nevertheless produce only capital-intensive manufactured goods if it is well-endowed with land. This will hold if land is so abundant as to force labor allocation into the region L_2O' in figure 4.

Thus, when considering changes in factor endowments in a diversified economy, the two-sector model's property of unchanged factor prices remains unaltered despite the addition of a specific factor. Deardorff (1984) has a description of the model with three goods and shows how goods of varying factor intensity will either begin or cease production with changes in factor endowments that affect diversification.

5.2 Stolper-Samuelson Relation

An increase in the relative price of labor-intensive good 1 is depicted in figure 5. The isoprice contour P_1 shifts outward to P_1' leading to a new factor price equilibrium with higher wages and lower returns to land and capital. These are real changes in factor prices. Wages rise by more than the increase in P_1 because, in addition to the outward shift of P_1 that boosts wages, there is a substitution toward more capital-intensive production techniques (the rays indicate constant capital-labor ratios). Rentals fall in nominal and real terms. The agricultural sector sheds labor and adopts a more land-intensive production method. The manufacturing sector absorbs the additional labor, and the slope of k_M (undrawn) is reduced. This seems to create a paradox where the overall capital-labor ratio is reduced in manfacturing but more capital-intensive production methods are used. An increase in the price of the labor-intensive good, which increases the capital-labor ratio used to produce each good, also has a Rybczynski effect on outputs because the sector's labor endowment has increased. Similarly, an increase in the price of the capital-intensive manufactured good decreases the real wage and increases the real return to capital. The effect on the real return to land is ambiguous although it increases in nominal terms.

If the price of the agricultural goods increases, its isoprice contour shifts from P_A to P_A' as in figure 5. The return to land, r_2, increases, but if the economy remains diversified neither the wage nor the return to capital changes. Hence the real wage and return to capital fall in terms of the agricultural good while the return to land increases in a proportion greater than the increase in P_A.[6] Like the above examples, however, there is a reallocation of labor in the economy. Agricultural production switches to more labor-intensive methods. The capital-labor ratio in manufacturing rises, leading to a Rybczynski effect on manufacturing output with no change in the prices of those outputs.

Hence, an asymmetric effect arises from price changes in the manufacturing and agricultural sector. A change in the price of a manufactured good affects all factor prices, while a change in the price of the agricultural good only alters the return to land if the manufacturing sector remains diversified.

5.3 Technical Progress

As seen in section 3.3, Hicks-neutral technical progress in the context of the dual is analytically equivalent to an outward movement of that sector's isoprice contour. Thus Hicks-neutral technical progress in the production of good 1, the labor-intensive manufactured good, increases the wage rate and decreases the two rentals. Technical progress in the capital-intensive manufactured good has the opposite effect. Technical progress in the production of the agricultural good, like an increase in its price, increases r_2 alone, with no change in either the wage or r_1 if all goods are produced.

5.4 Factor Market Distortions

Factor market interventions retain some of the two-sector results evaluated in Mussa (1979) because the Heckscher-Ohlin structure

6. Deardorff (1984) was in error with regard to the change in the real return to land.

ties down the specific-factor sector. A subsidy to labor in the production of good 1, the labor-intensive manufactured good, without a change in output leads to an equilibrium such as a and b on figure 3. The wage paid to labor exclusive of subsidy for production of good 1 is below that paid for production of good 2, while the rental paid to capital is the same. Somewhat paradoxically, Mussa notes, production becomes more capital-intensive. The added feature here is that labor is withdrawn from the agricultural sector providing a Rybczynski effect on the manufacturing sector's outputs. Rentals in both sectors decline.

It can also be seen with reference to figure 3 that a subsidy to capital in the production of good 2 leads to a equilibrium such as c and d with more labor-intensive production methods employed. Wages fall and labor is absorbed by the agricultural sector. A subsidy to labor in agriculture does not change the wage rate paid in manufacturing, and only leads to a withdrawal of labor from manufacturing and the concomitant Rybczynski effect on output there. All workers continue to receive w_0 but the subsidy lowers this cost to the agricultural producers and k_A is reduced. A labor subsidy in this case does not change the wage received by labor, and only reallocates labor between sectors. But is does indirectly enrich landlords by increasing the rent on the specific-factor land. As in Section 3.4, a tax on or subsidy to the specific-factor land changes nothing except its rental income.

6. Conclusion

This paper has extended the geometric dual formulation of international trade theory to models involving three factors and two or more goods. The specific-factor model changes many of the standard results derived from the traditional two-sector model. The melding of a Heckscher-Ohlin structure with a specific factor sector leads to a hybrid of comparative static findings. A disadvantage of the geometric dual approach is its inability to capture changes in output and factor allocations between sectors. An advantage of the dual approach is that it sets out the relationships among factor and output prices. As such, it complements the traditional reliance on the geometry of factor and output quantities.

References

Deardorff, Alan V. (1984), "An Exposition and Exploration of Krueger's Trade Model," Canadian Journal of Economics, 17, 731-746.

Grossman, Gene M. and James A. Levinsohn (1989), "Import Competition and the Stock Market Return to Capital," American Economic Review, 79, 1065-1087.

Jones, Ronald W. (1971), "A Three-Factor Model in Theory, Trade, and History," in Jagdish N. Bhagwati et. al. (eds.) Trade, Balance of Payments, and Growth, Amsterdam: North-Holland, 3-21.

Krueger, Anne O. (1977), "Growth, Distortions, and Patterns of Trade Among Many Countries," Princeton Studies in International Finance, No. 40, International Finance Section, Department of Economics, Princeton University.

Leamer, Edward E. (1987), "Paths of Development in the Three-Factor, n-Good General Equilibrium Model," Journal of Political Economy, 95, 961-999.

Magee, Stephen P. (1980), "Three Simple Tests of the Stolper-Samuelson Theorem," in P. Oppenheimer (ed.) Issues in International Trade, Stockfield: Oriel Press, 138-153.

Mussa, Michael L. (1979), "The Two-Sector Model in Terms of Its Dual: A Geometric Exposition," Journal of International Economics, 9, 513-526.

Neary, J. Peter (1978), "Short-Run Capital Specificity and the Pure Theory of International Trade," Economic Journal, 88, 488-510.

Samuelson, Paul A. (1971), "Ohlin Was Right," Swedish Journal of Economics, 73, 365-384.

Woodland, A. D. (1982), International Trade and Resource Allocation, New York: North-Holland.

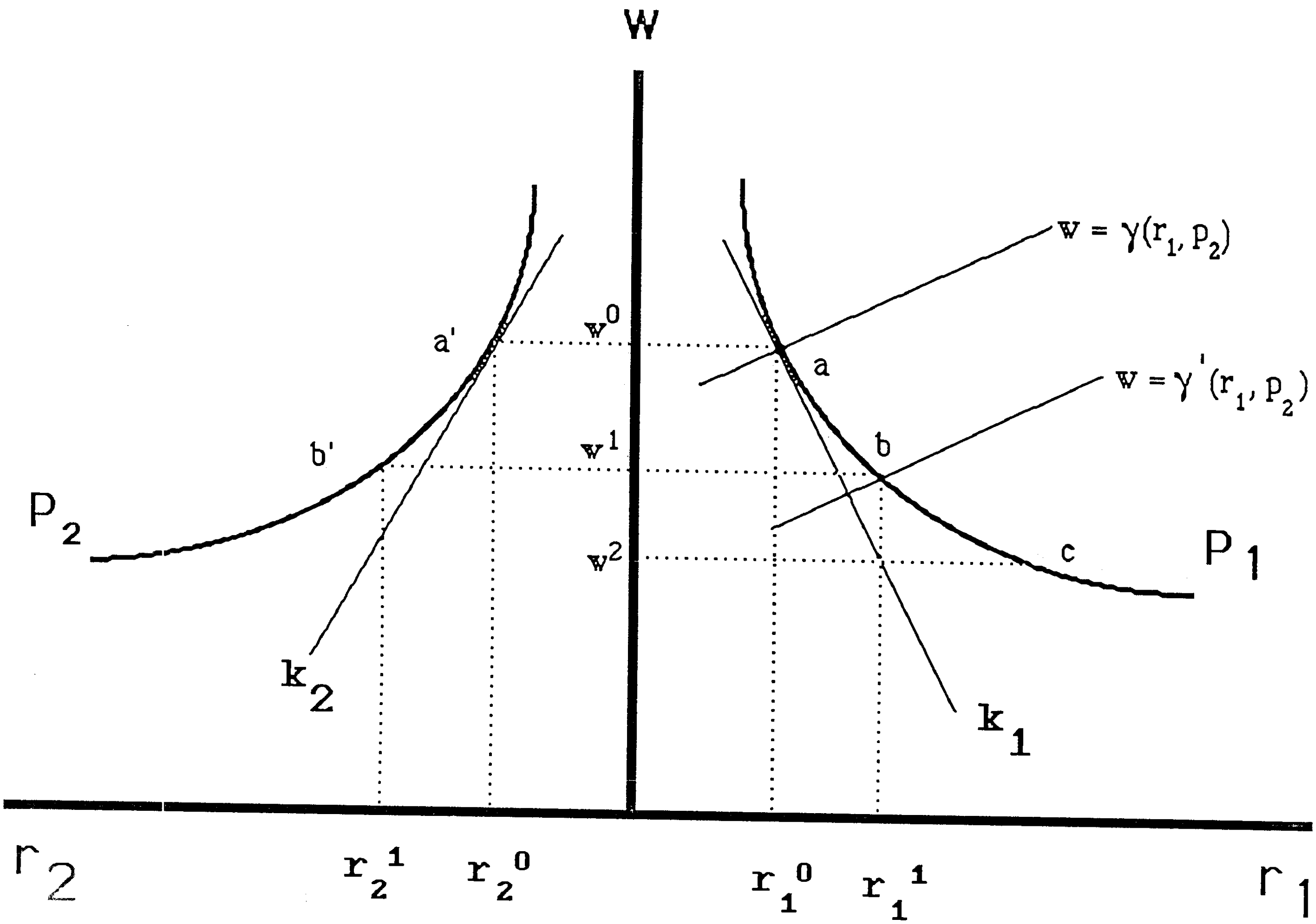
W
$w = \gamma(r_1, p_2)$
$w = \gamma'(r_1, p_2)$
w^0
w^1
w^2
a'
b'
a
b
c
P_2
P_1
k_2
k_1
r_2
r_2^1
r_2^0
r_1^0
r_1^1
r_1

Figure 1

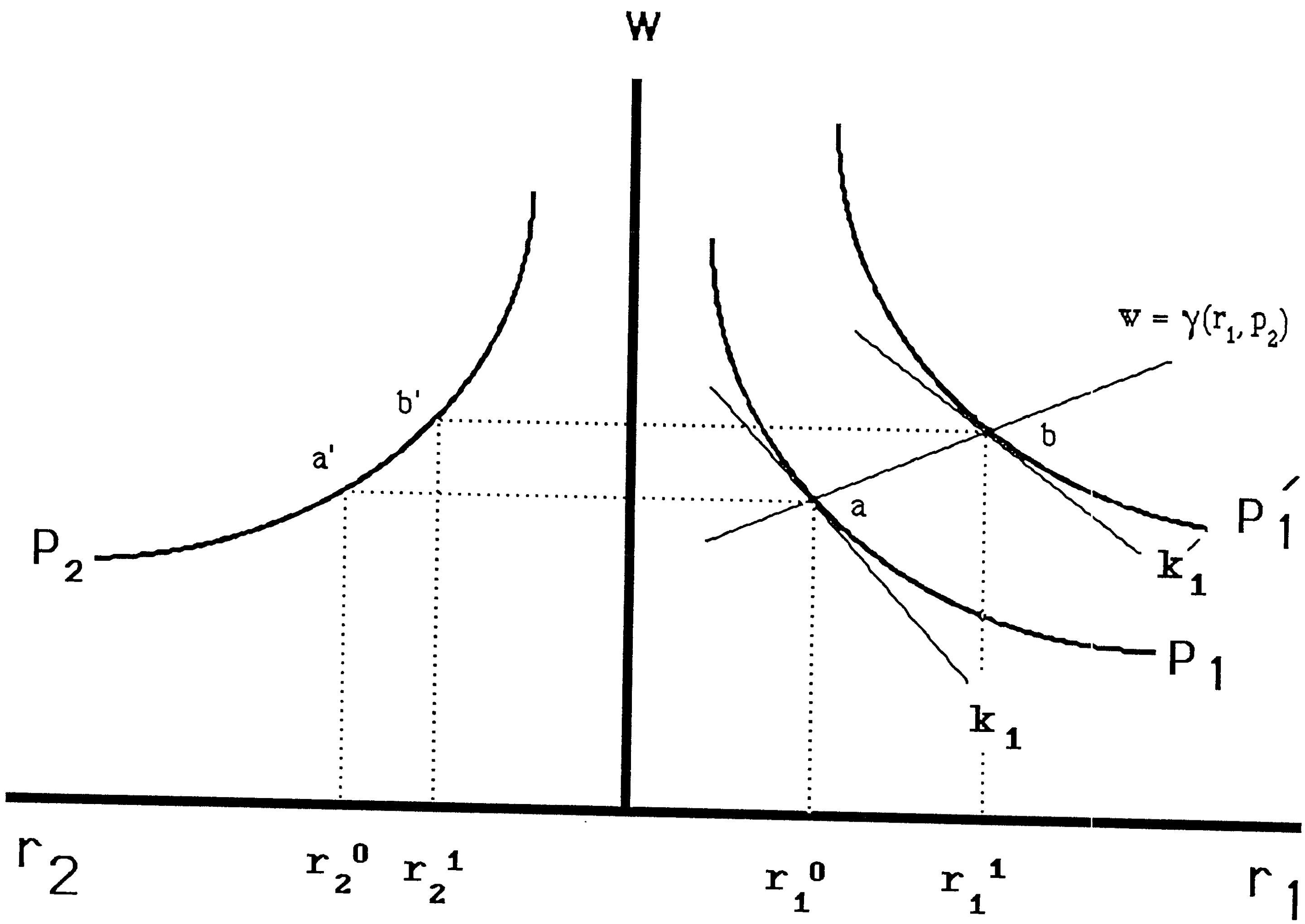

Figure 2

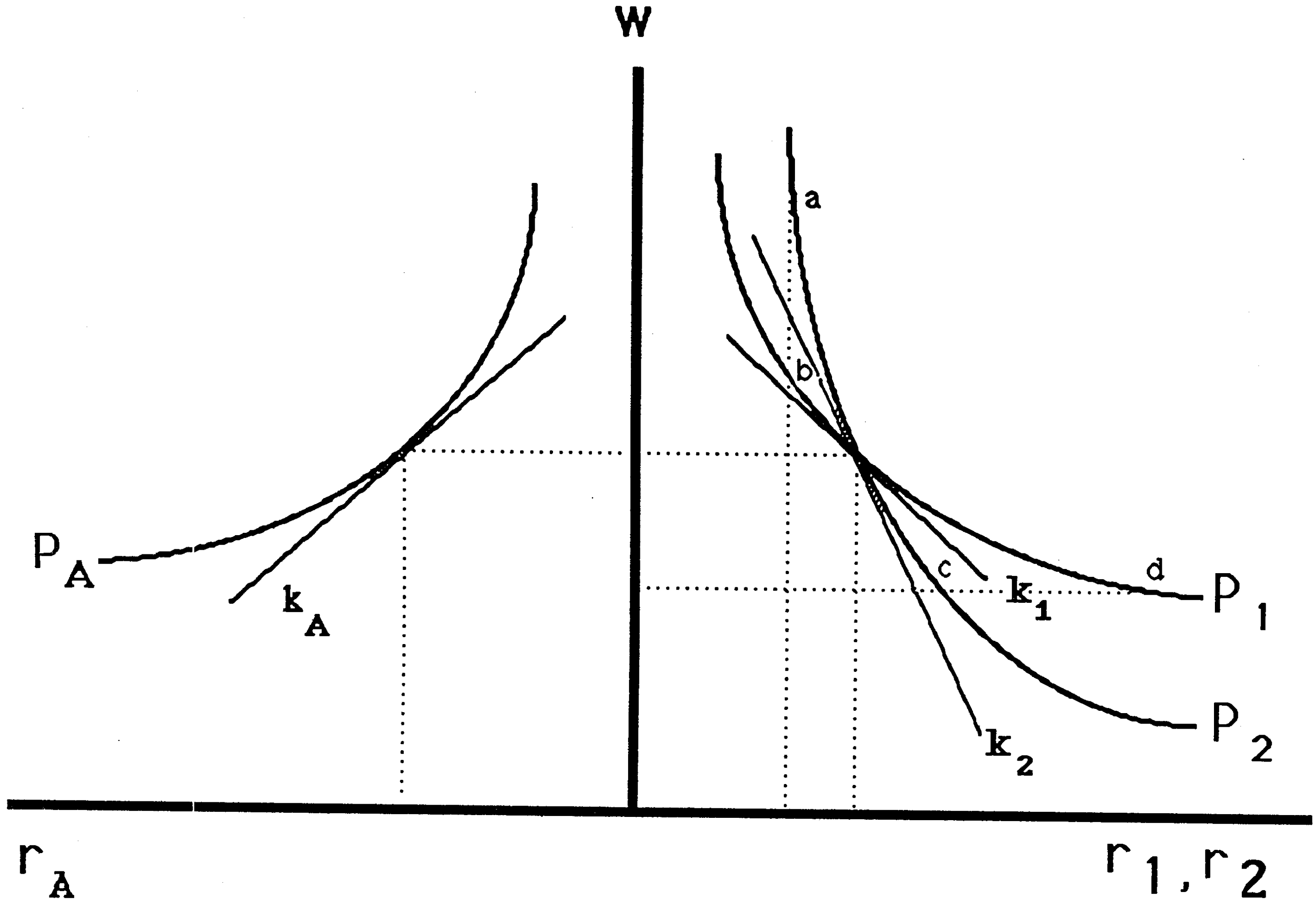

Figure 3

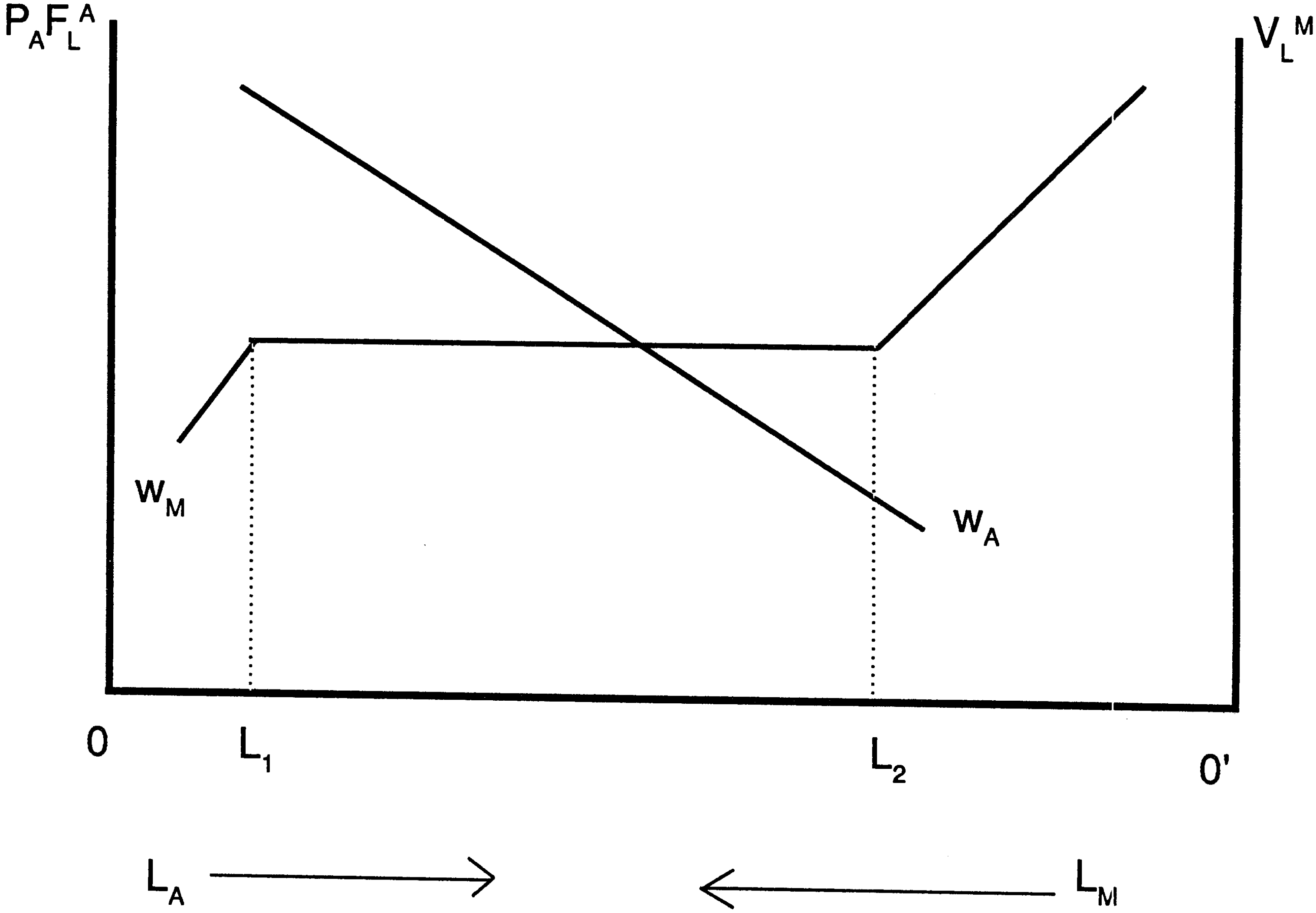

Figure 4

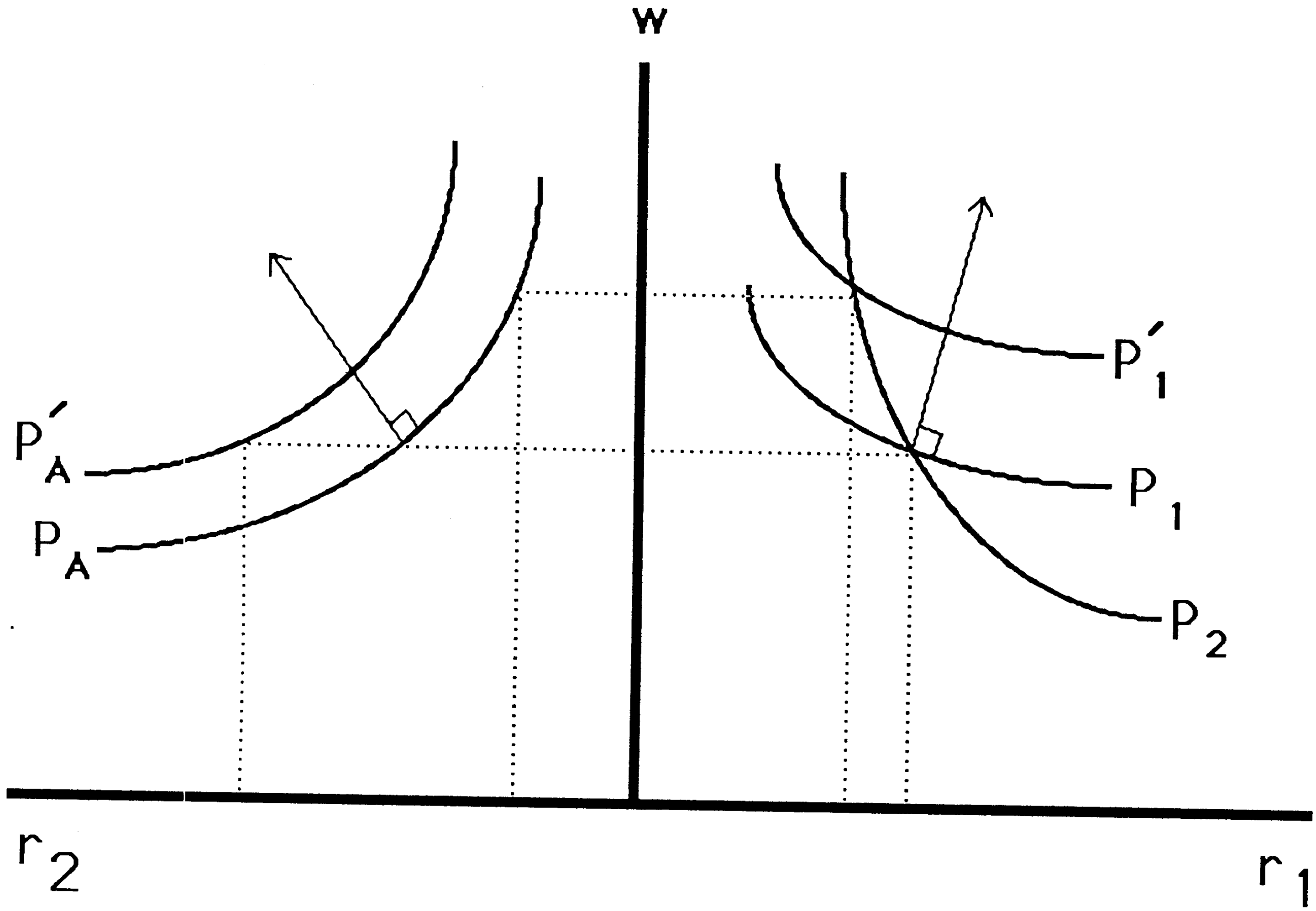

Figure 5

International Finance Discussion Papers

IFDP NUMBER	TITLES	AUTHOR(s)
	1990	
384	Three-Factor General Equilibrium Models: A Dual, Geometric Approach	Douglas A. Irwin
383	Modeling the Demand for Narrow Money in the United Kingdom and the United States	David F. Hendry Neil R. Ericsson
382	The Term Structure of Interest Rates in the Onshore Markets of the United States, Germany, and Japan	Helen Popper
381	Financial Structure and Economic Development	Ross Levine
380	Foreign Currency Operations: An Annotated Bibliography	Hali J. Edison
379	The Global Economic Implications of German Unification	Lewis S. Alexander Joseph E. Gagnon
378	Computers and the Trade Deficit: The Case of the Falling Prices	Ellen E. Meade
377	Evaluating the Predictive Performance of Trade-Account Models	Jaime Marquez Neil R. Ericsson
376	Towards the Next Generation of Newly Industrializing Economies: The Roles for Macroeconomic Policy and the Manufacturing Sector	Catherine L. Mann
375	The Dynamics of Interest Rate and Tax Rules in a Stochastic Model	Eric M. Leeper
374	Stock Markets, Growth, and Policy	Ross Levine
373	Prospects for Sustained Improvement in U.S. External Balance: Structural Change *versus* Policy Change	Catherine L. Mann
372	International Financial Markets and the U.S. External Imbalance	Deborah Danker Peter Hooper
371	Why Hasn't Trade Grown Faster Than Income? Inter-Industry Trade Over the Past Century	Joseph E. Gagnon Andrew K. Rose
370	Contractionary Devaluation with Black Markets for Foreign Exchange	Steven B. Kamin

Please address requests for copies to International Finance Discussion Papers, Division of International Finance, Stop 24, Board of Governors of the Federal Reserve System, Washington, D.C. 20551.

International Finance Discussion Papers

IFDP NUMBER	TITLES	AUTHOR(s)
	1989	
369	Exchange Rate Variability and the Level of International Trade	Joseph E. Gagnon
368	A Substitute for the Capital Stock Variable in Investment Functions	Guy V.G. Stevens
367	An Empirical Assessment of Non-Linearities In Models of Exchange Rate Determination	Richard A. Meese Andrew K. Rose
366	Equilibrium in a Production Economy with an Income Tax	Wilbur John Coleman II
365	Tariffs and the Macroeconomy: Evidence from the USA	Andrew K. Rose Jonathan D. Ostry
364	European Integration, Exchange Rate Management, and Monetary Reform: A Review of the Major Issues	Garry J. Schinasi
363	Savings Rates and Output Variability in Industrial Countries	Garry J. Schinasi Joseph E. Gagnon
362	Determinants of Japanese Direct Investment in U.S. Manufacturing Industries	Catherine L. Mann
361	The U.S. and U.K. Activities of Japanese Banks: 1980-1988	Henry S. Terrell Robert S. Dohner Barbara R. Lowrey
360	Policy Rules, Information, and Fiscal Effects in a "Ricardian" Model	Eric M. Leeper
359	A Forward-Looking Multicountry Model: MX3	Joseph E. Gagnon
358	Implications for Future U.S. Net Investment Payments of Growing U.S Net International Indebtedness	Lois E. Stekler William L. Helkie
357	U.S. Policy on the Problems of International Debt	Edwin M. Truman
356	International Economic Policy: The Role of Exchange Rates	Edwin M. Truman
355	An Econometric Analysis of UK Money Demand in *Monetary Trends in the United States and the United Kingdom* by Milton Friedman and Anna J. Schwartz	David F. Hendry Neil R. Ericsson
354	Encompassing and Rational Expectations: How Sequential Corroboration Can Imply Refutation	Neil R. Ericsson David F. Hendry