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Co-Movements in Relative Commodity Prices and International Capital Flows: A Simple Model

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CO—MOVEMENTS IN RELATIVE COMMODITY PRICES AND
INTERNATIONAL CAPITAL FLOWS: A SIMPLE MODEL

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Co-Movements in Relative Commodity Prices and International

Capital Flows: A Simple Model

Suppose a number of countries produce a commodity which employs local labor and a type of capital that is internationally mobile. Within the framework of a specific-factors model the paper argues that there is a presumption about the international movement of capital when the relative price of that industry using that capital rises on world markets. Capital flows towards countries less heavily involved in producing the commodity; internal labor flows contribute towards worldwide industry dispersion; and the volume of international trade in that commodity tends to fall.

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I. INTRODUCTION

Fluctuations in the composition of world demand may cause a particular commodity to experience periods during which price is high relative to other commodities to alternate with periods during which price is relatively low. A number of countries may share not only in the production of such a commodity but also in the use of some factor (call it capital) specific to its production but capable of being relocated from one country to another. That is, some productive activities may combine local factors with inputs which have international markets. What can be said about the location of internationally mobile capital as shifts in demand result in changes in relative commodity prices? Is there anything systematic about the likely degree of international concentration or diversification of production over periods in which a commodity's price is alternatively high and low?

The purpose of this article is to sketch out a simple model in which a presumption does exist about the location of internationally mobile capital, the relative concentration of production, and the volume of international trade in a commodity during the course of a cycle in its price relative to the prices of other commodities. The model is a variant of the sector-specific general equilibrium production model in which one type of capital is internationally mobile so that rates of return remain equalized among countries. The presumption is that when a commodity's price is relatively high compared with other commodities, real capital specifically used to produce that commodity tends to leave regions that are relatively large producers. Furthermore, this tendency of international capital mobility to

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encourage a dispersion of world production when a commodity's price is relatively high and a concentration of the world's production when price is low is enhanced by the mobility within each country of factors used jointly with other sectors. Finally, international trade in a commodity experiencing such a price cycle tends to be "second-best" compared with own production in the sense that the volume of trade tends to contract precisely when the commodity's price is high relative to other commodities.

II. THE PRESUMPTION ABOUT INTERNATIONAL CAPITAL FLOWS

Production structures within countries are assumed to follow the sector-specific model as described in Jones [1975]; mobile labor is combined with each of several types of specific capital goods in producing outputs. In one activity capital is assumed to be internationally mobile, although retaining its sectoral specificity. Such mobility serves to equalize the return to this factor in all areas in which it is employed. Although commodities are traded, technologies and factor endowments are not assumed to be the same, so the returns to local specific factors and national wage rates can differ from country to country.

Although the argument can be posed in the context of a many-country trading world, the logic is more easily revealed in a two-country setting. Suppose both home and foreign countries each produce a number of traded commodities and one of these, say x_1, makes use of a specific factor, say K_1, which is mobile internationally. Such mobility ensures that the rental on type-1 capital at home, r_1, is kept in line with the foreign return, r_1^*. Assuming free trade and no transport costs, each return depends both on the

common world price of the first commodity, p_1, and the volume of the home country's stock of type-1 capital that has been located abroad (k). I assume arbitrarily that technology and original ownership patterns of factor endowments lead the home country to be an exporter of type-1 capital so that k is positive. If the price of the first commodity varies relative to an assumed constant value for all other commodities, the consequent equilibrating response of capital flows can be determined from equilibrium condition (1):

$$(1) \qquad r_1(p_1,k) = r_1^*(p_1,k)$$

All other productive factors are assumed immobile between countries.

Equation (1) can be differentiated to yield solution (2) for the capital flow that serves to equilibrate rentals when the relative price of the first commodity rises:

$$(2) \qquad \hat{k} = \{(\gamma_1^* - \gamma_1) / (\delta_1^* + \delta_1)\} \, \hat{p}_1.$$

The terms in the denominator are positive. δ_1^*, for example, is defined as the relative rise in the rate of return abroad that would be associated with a one percent cutback in the quantity of home capital sent abroad.[∨] The γ_1 terms in (2) reveal the relative effect which a rise in p_1 would have in each country on the rental return to type-1 capital if there were no international capital mobility. Given the structure of the model both γ_1 and γ_1^* are positive, and each exceeds unity. This reflects the fact that in a world characterized by sector-specific capital, the rise in any commodity price enhances the return to the type of capital used in that sector by a magnified amount since the

wage rate does not rise by as much, relatively, as does price. What is left open is whether a rise in p_1 causes the return to type-1 capital to rise by more *abroad* or at home. If γ_1^* exceeds γ_1, equation (2) reveals that a capital outflow from the home country would be required to equilibrate rentals when p_1 rises.

Although a comparison of γ_1 with γ_1^* is required in order to see in which direction capital flows internationally in the course of changes in the relative price of the first commodity, it proves convenient first to ask about the effect of the price change on the wage rate in each country as of fixed location of capital. As is familiar from specific-factors models, any individual commodity price increase serves to stimulate the wage rate, but by a smaller relative amount. Thus if p_1 alone rises, at home

$$(3) \qquad \hat{w} = \left\{ [\lambda_{L1}(\sigma_1 \,/\, \theta_{K1})] \,/\, \underset{j}{\Sigma}\lambda_{Lj} \,(\sigma_j \,/\, \theta_{Kj}) \right\} \hat{p}_1$$

In this expression σ_j is the elasticity of substitution between labor and specific-capital in sector j and θ_{Kj} is the distributive share of capital in sector j. The combined term, (σ_j/θ_{Kj}), is the elasticity of (mobile) labor's marginal product schedule in the jth sector and the denominator in (3) is a weighted average of such elasticities for the entire economy. The weights, λ_{Lj}, refer to the fraction of the economy's labor force devoted to producing the jth commodity.

To highlight the assumptions which lead to the presumption as to the effect of price changes on capital flows, I define new symbols which allow equation (3) to be rewritten as

(4) $\hat{w} / \hat{p}_1 = \theta_1 i_1 s_1$

Taking these in reverse order, s_1 refers to the elasticity of demand for labor
in the first sector, _relative_ to the economy-wide average value for the
elasticity of demand for labor. This latter term is the denominator in
equation (3), and the numerator of s_1 is σ_1/θ_{K1}. If sector 1 exhibits the
same elasticity of demand for labor as does the economy as a whole, s_1 would
have value unity. The term, i_1, refers to a different aspect of the
technology, viz., the _relative_ degree of labor intensity of the first sector
when compared to the economy overall. This translates into a comparison of
the fraction of the labor force used in the first sector with the share in the
national product represented by output of the first sector. The term, θ_1,
expresses this relative output share. Equation (4) thus exhibits the change
in the wage rate relative to a rise in commodity 1's price as dependent on the
product of three terms--the relative substitution and labor intensity terms
for the first sector, and the share of the first sector in the national
income.

The presumption about the effect of capital flows follows most readily if
the following two "neutrality" assumptions are adopted: (i) For each country
the elasticity of demand for labor in the first sector is neither greater than
nor less than the average over the entire economy for that country. Thus
technology may exhibit more substitutability in one economy than another; the
assumption is that sector 1's degree of substitutability matches that in the
economy as a whole for each country separately. (ii) The first sector in each
country is neither labor-intensive nor capital-intensive relative to the

economy as a whole. That is, the fraction of the labor force used to produce x_1, λ_{L1}, is assumed to match the share which the first commodity commands of national income produced (θ_1). These assumptions together imply that:

$$(5) \qquad \hat{w} = \theta_1 \hat{p}_1$$

Thus if production of the first commodity bulks larger in national income in the home country than it does abroad, a rise in p_1 faced by both countries in common will drive the wage rate up relatively more at home than abroad.

The terms γ_1 and γ_1^* refer to the effect of the price rise on returns to sector-specific capital, and these are linked to the effects on the wage rates. For example, at home the competitive profit equation of change,

$$(6) \qquad \theta_{L1}\hat{w} + \theta_{K1}\hat{r}_1 = \hat{p}_1.$$

can be solved for $\hat{r}_1/\hat{p}_1$:

$$(7) \qquad \hat{r}_1/\hat{p}_1 = [1 - \theta_{L1}(\hat{w}/\hat{p}_1)] / \theta_{K1}$$

Given the two earlier assumptions, from (5),

$$(8) \qquad \hat{r}_1/\hat{p}_1 = [1 - \theta_{L1}\theta_1] / \theta_{K1}$$

If a further assumption is now made that in the first sector home capital's distributive share, θ_{K1}, is relatively comparable to the share abroad, θ_{K1}^*, γ_1^* exceeds γ_1 if and only if θ_1^* is smaller than θ_1.

These assumptions together imply that if the production of the first commodity bulks relatively larger in the national income of the home country

than it does abroad, a rise in commodity 1's relative price causes the return to internationally mobile type-1 capital to rise in both (all) countries, but especially so in the foreign country. When a commodity's price rises relative to other commodities, internationally mobile capital specifically used to produce that commodity will tend to flow from relatively large producing areas to countries in which production is relatively less important. The pressure on wages to rise is greater in the country in which production of the good is relatively high, so that the return to capital, although increasing relative to the commodity price, will rise by an even greater amount in the other country. In this sense when the commodity is faring well, internationally mobile capital used in its production becomes more dispersed.

The connection between the relative importance of production in a country (θ_1) and the effect of a price rise on the return to capital (γ_1) is illustrated in Figure 1. If the economy produces nothing but good 1, γ_1 is unity, implying that in the absence of international factor flows, a price rise increases by the same relative amount the return to capital and the wage rate. By contrast, if θ_1 is relatively small, the price rise does little to raise wages and capital becomes a larger gainer. If the wage rate were unaffected by the price rise, the rental on sector-specific capital would rise by the multiple $1/\theta_{K1}$.

Figure 1

It is, perhaps, useful to distinguish this scenario from the oft-repeated observation that when the price of some resource, e.g. gold, rises significantly relative to other goods, world production not only rises, but gets dispersed to countries with previously abandoned mines. The argument in this case concerns Ricardian rent. It is assumed that originally there exists

a distribution of qualities of ore-bearing land such that, as the price of gold rises, previously neglected mines get exploited. But the international location of such mines is arbitrary. Suppose they were to exist primarily in South Africa and the Soviet Union; a rise in gold's relative price would then eventuate in increased concentration rather than diffusion of gold production. By contrast, the presumption put forth in this paper rests upon the asymmetric effect of price rises on wages and therefore rates of return among countries.

III. THE PRESUMPTION ABOUT RELATIVE INTRA-NATIONAL FACTOR FLOWS

A rise in commodity 1's relative price is unambiguously of benefit to type-1 capital throughout the world, although inducing a reallocation from relatively large producing areas to countries in which production does not represent as large a fraction of the national income. But there is a further reallocation of resources: Within each country the mobile factor, labor, is attracted to the first sector. This reallocation is not as powerful in changing the distribution of 1's production among countries since it represents, in each, a transfer of resources towards the production of good 1. Nonetheless, much the same argument as that applied to the differential impact of the price rise on relative returns to sector-specific capital can be utilized to put forth a presumption that relatively large producers expand output relatively less during good times in the price cycle.

Let e_1 represent the general equilibrium elasticity of supply of x_1 at home assuming no international capital mobility, defined as in (9):

$$(9) \qquad e_1 \equiv \hat{x}_1 / \hat{p}_1 \Big|_{\overline{k}} .$$

With labor the only mobile factor, output in the first industry increases if and only if the price rises relative to the wage rate. Indeed, ✔

$$(10) \qquad e_1 = \theta_{L1}(1 - \hat{w}/\hat{p}_1) \cdot (\sigma_1/\theta_{K1})$$

If the same assumptions are made as those leading up to relationship (5), substitution reveals that:

$$(11) \qquad e_1 = (1 - \theta_1) \cdot \theta_{L1} \cdot \sigma_1/\theta_{K1}$$

If, in addition to the earlier assumption that factor shares are roughly comparable between countries, it is also assumed that elasticities of substitution for the same commodity are equivalent among countries, the elasticity of supply tends to be lower the greater the fraction of a nation's resources already devoted to producing the commodity.

Figure 2

Figure 2 illustrates the general relationship between relative production share and price elasticity. If a country becomes completely specialized in producing the first commodity, it cannot pour new resources into its production unless they are made available from other countries. That extreme case of a zero value for e_1 is approached in a continuous fashion as a country pours relatively more resources into commodity 1. As the price of commodity 1 rises, all producing countries shift labor towards extra production, but relatively the rise is greater in regions in which production is a relatively small part of the national income. This presumptive effect of size on supply elasticity working through intra-national labor mobility thus tends to reinforce the effect of flows of internationally mobile but occupationally specific capital.

IV. INTERNATIONAL TRADE OVER A COMMODITY PRICE CYCLE

The presumption about international capital flows and production changes over the course of a commodity price cycle in which increases in the relative price of commodity 1 are followed by declines, translates into a presumption as to the volume of international trade in that commodity if the structure of demand is roughly comparable across countries.

Given such an assumption about demand, the pattern of trade reflects asymmetries in production. Thus if the home country channels relatively a higher fraction of its resources into producing the first commodity than does the foreign country, the home country will export the first commodity. As the price of the first commodity rises relative to others, type-1 capital tends to flow abroad, serving to lower the extent of concentration in production. The effect of the international capital flow is reenforced by intra-country labor mobility in lowering the x_1/x_1^* ratio. As for demand, suppose the price rise for commodity 1 is reflective of a change in tastes in both countries towards the first commodity, of roughly similar proportional amounts. Since the home country is an exporter of the commodity which has gone up in price, its real income rises and that of the foreign country falls as the terms of trade change. If substitution terms in demand are roughly comparable, the ratio D_1/D_1^* might rise. Therefore as p_1 goes up the output share of the exporting country falls and its demand share, if it changes at all, could rise. This is the argument behind the presumption that the volume of international trade in commodity 1 contracts. By contrast, in that phase of the cycle in which commodity 1's relative price is lower than normal, production tends to be more concentrated and international trade tends to expand to fill this increased

asymmetry in production. In a sense commodity trade is "second best"; when a commodity's price is relatively high, direct production tends to take over in supplying each country's needs, whereas in bad times the concentration in production leaves much of demand to be satisfied via the indirect route of commodity trade.

Figure 3   The general presumption argument is summarized in Figure 3. The horizontal axis shows prices for commodity 1 under the assumption that all other commodity prices are constant. The first commodity is the one that requires, for its production, a specific type of capital which is internationally mobile. The value of p_1 at the origin is its "average" value over the price cycle. Two curves are drawn, each corresponding to a different assumption as to which country devotes a greater fraction of its national income to producing the first commodity when relative prices are at their average level. The top curve adopts the assumption, made in earlier sections of this paper, that the home country concentrates more of its resources in producing the first commodity. As p_1 rises relative to other goods this relative degree of concentration falls, both because capital flows abroad and because internal factor readjustments are easier abroad (the general equilibrium elasticity of supply is higher). The bottom curve reverses the original assumption, but illustrates as well the tendency for production to be less concentrated when prices are relatively high. If taste patterns are comparable, the volume of trade in the first commodity tends to be lower when p_1 is relatively higher.

V. CONCLUDING REMARKS

The Classical Paradigm, wherein final consumer goods are freely traded on world markets but all factors of production are trapped by a nation's boundaries, no longer characterizes most models of international trade. In its place a different view has emerged, one in which productive activities may combine local factors with inputs which have international markets. In this paper I have sketched out a simple model in which a presumption exists about the way in which changes in relative commodity prices cause a factor which is traded on world markets to be reallocated. With sufficiently similar technologies across countries, a rise in the price of a commodity will drive up the returns to national factors more in countries which are relatively heavy producers of that commodity, and this tends to squeeze the amount which such countries can offer to the internationally mobile factor. As a consequence, the mobile factor tends to relocate in countries that are not as heavily committed to the production of the commodity which has risen in price. Asymmetries in the extent to which purely national factors in each country can be reallocated towards the sector which has benefitted from a price rise reinforce this tendency towards a greater degree of diffusion in a world industry in good times for its output, and a greater degree of concentration when world relative price falls. To the extent that such production changes dominate trade patterns, they suggest that the relative volume of trade in a commodity whose price has risen will contract.

Presumption is not the same thing as certainty, and the earlier analysis suggests several ways in which alternative conclusions may emerge. For example, with reference to equation (4) suppose that although the home country

is assumed to be a relatively more important producer of commodity 1 (whose price has risen), so that θ_1 exceeds θ_1^*, this commodity may be produced by significantly more labor-intensive methods abroad ($\underline{i}^*$ exceeds $\underline{i}$). If so, a price rise may heat up the wage rate to a greater extent abroad, thus encouraging internationally mobile capital to relocate in the home country. The presumption argument in the body of the paper utilized the assumption that the commodity making use of international capital was "typical" in its labor-intensity and elasticity of demand for labor when compared with other sectors in each country, and therefore that technologies were somewhat similar between countries.

The changes in relative commodity prices were considered to be caused by relative shifts in tastes. This simplified the argument in comparison to that required should markets be disturbed, say, by technical progress in some sectors, since in this case supply changes are more difficult to disentangle. However, the underlying rationale for the asymmetry in the way in which price changes affect relatively large and small producing regions remains intact.

Other questions can be raised in the framework of this simple model. In a companion piece I have asked about the effect which taxing trade has on commodity prices when some factor of production has a world market [1987]. For example, is an export tax less apt to improve welfare (via a terms-of-trade change) if capital used in the export sector is internationally mobile? Will taxing world trade in a commodity by some countries tend to raise or lower its price to consumers and producers in other countries? Once again, questions like these admit of presumptive answers given a sufficient degree of symmetry in technology, with trading patterns primarily reflective of asymmetries in endowments of factors which do not get traded on world markets.

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FOOTNOTES

[*]Professor, University of Rochester. Thanks are due the National Science Foundation for support in Grant # SES – 8510697.

[1]Thus $\delta_1^* \equiv -\{\partial r_1^*/\partial k\} \cdot (k/r_1^*)$. As well, $\delta_1 \equiv \{\partial r_1/\partial k\} \{k/r_1^*\}$, which must be positive.

[2]For any sector consider the term λ_{ij}/θ_j. If this exceeds unity the jth sector can be termed factor-i-intensive relative to the economy as a whole. This ratio also equals the term θ_{ij}/θ^i, the comparison of factor i's distributive share in the jth sector with factor i's distributive share in the national income.

[3]The assumption of complete specialization for the home country was made in Jones and Dei [1983]. In that model a price rise always encourages an outflow of capital from the home country.

[4]The proof is straightforward: with K_1 held constant, $\hat{x}_1$ equals $-\hat{a}_{K1}$ which, in turn, is $-\theta_{L1}\sigma_1(\hat{w} - \hat{r}_1)$. By (6) this yields expression (10). Note that the general equilibrium supply elasticity, e, allows for the effect of price changes on the wage rate.

[5]I ignore here the real income effects of the rise in the return to type-1 capital.

[6]The suggestion that gains to one factor tend to inhibit the possible returns to another is analogous to the phenomenon of Dutch Disease, wherein favorable price movements in one sector of a trading community spell difficulties for other trading sectors. (See, for example, Corden and Neary, 1982.) A more general discussion of a trading world in which some inputs have world markets and others only national ones is found in Jones [1980].
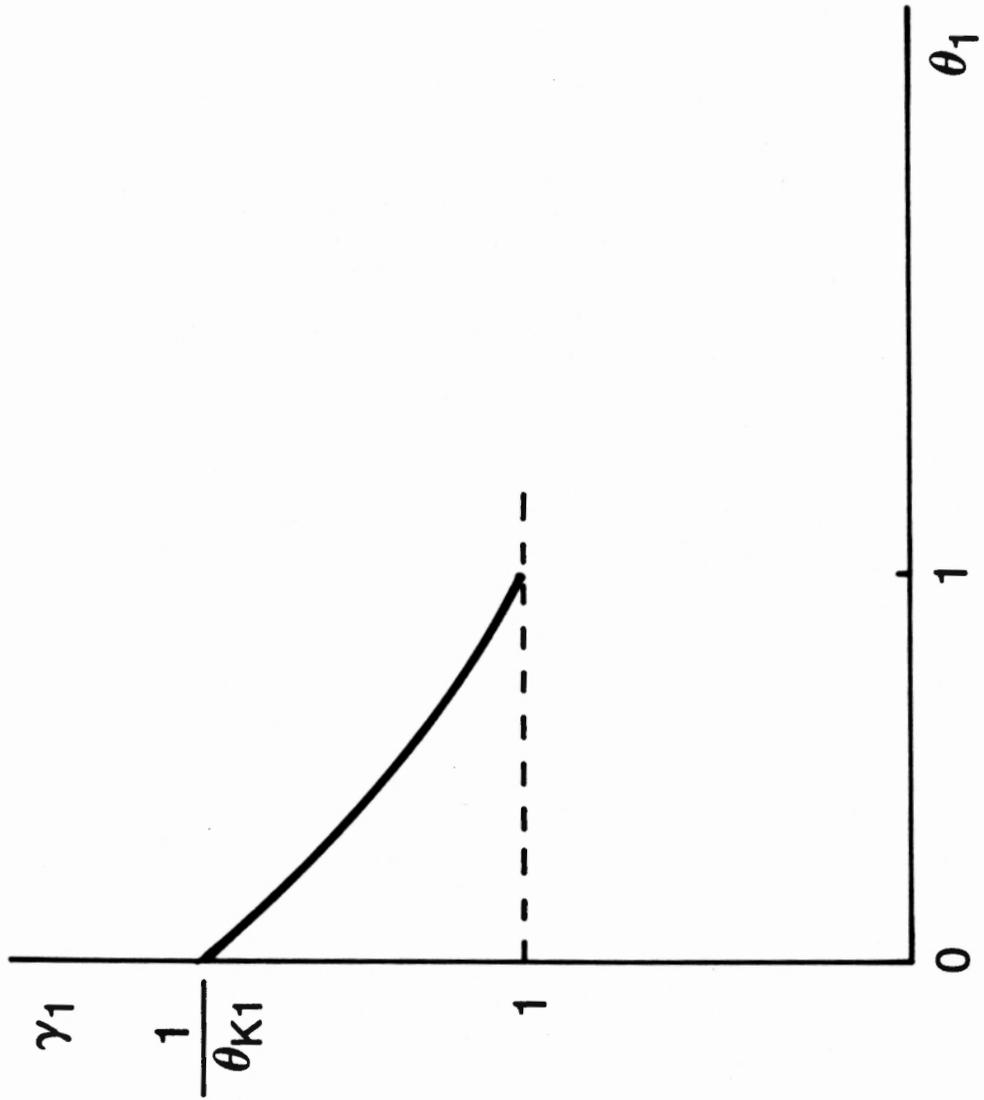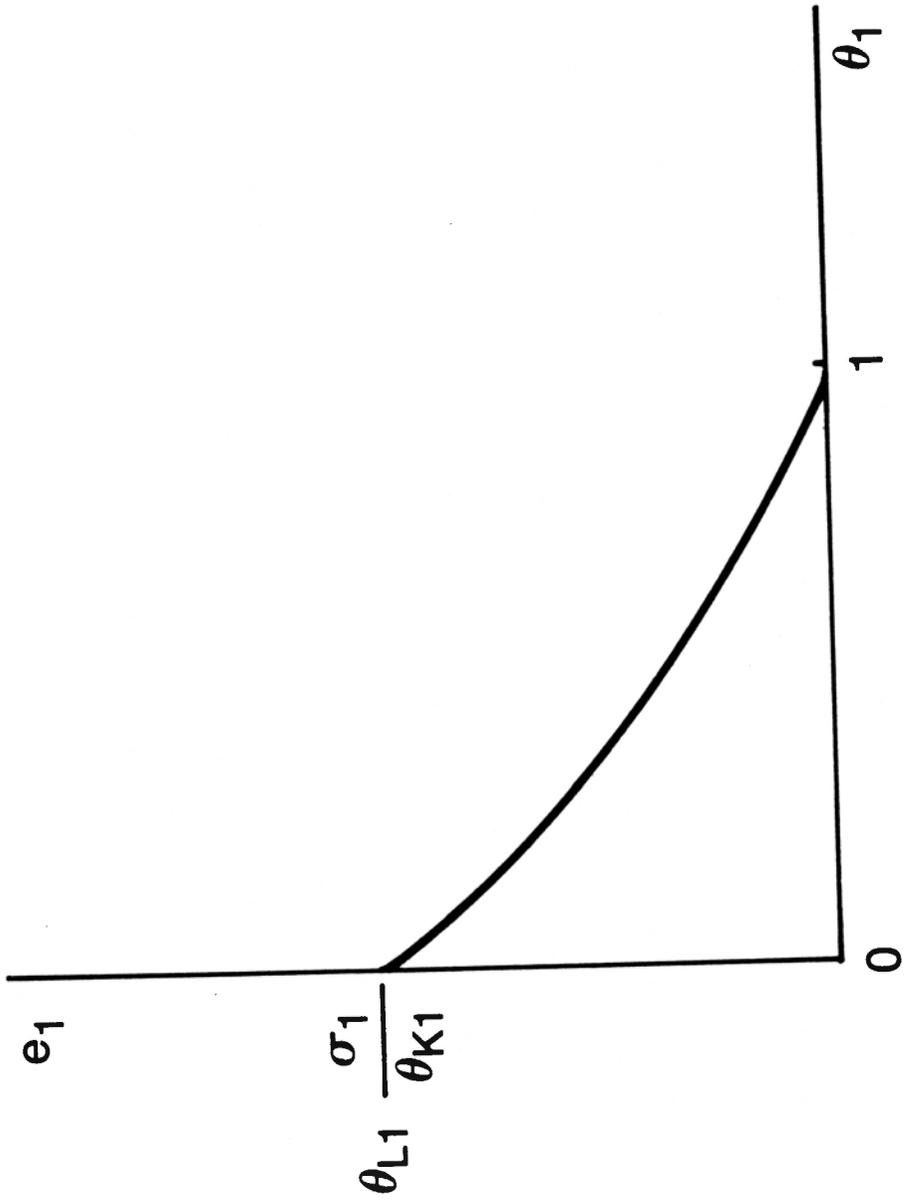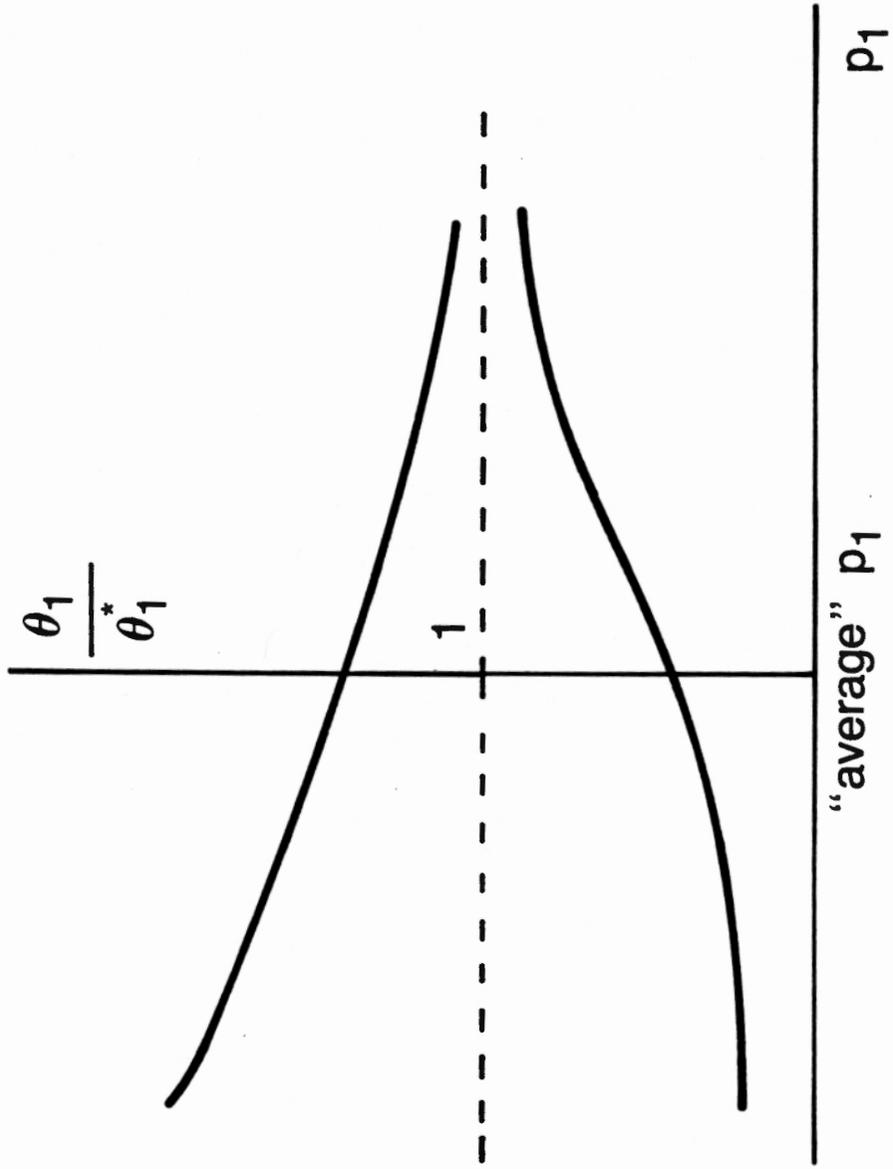
Figure 1

Figure 2

Figure 3

$\dfrac{\theta_1}{\theta_1^*}$

1

"average" p_1

p_1

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