WP/99/134

INTERNATIONAL MONETARY FUND

European I Department

Macroeconomic and Sectoral Effects of Terms-of-Trade Shocks: The Experience of the Oil-Exporting Developing Countries

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IMF WORKING PAPER

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Abstract

This paper investigates the impact of long-run terms-of-trade shocks. Analytically, we show that, if capital goods are largely importable or the labor supply is sufficiently elastic, then natural-resource booms increase aggregate investment and worsen the current account, but Dutch 'Disease' effects are weak. We then examine 18 oil-exporting developing countries during 1965-89. Favorable terms-of-trade shocks increase investment and (especially government) consumption, but reduce medium-term savings; hence, the current account deteriorates. Nontradable output increases, in response to real appreciations, but Dutch Disease effects are strikingly absent. Investment, consumption, and nontradable output respond more to a terms-of-trade decline than to an increase.

JEL Classification Numbers: F41, F43.

Keywords: Terms of trade, natural resources, Dutch Disease.

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[1]Corresponding author: Spatafora. We are greatly indebted to W. Brainard, P. Cashin, K. Hamada, T. Krueger, P. Levy, O. Linton, P. Mauro, W. Nordhaus, A. Rodríguez-Clare, C. Sims, T.N. Srinivasan, and World Bank seminar participants for many helpful comments.

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I. INTRODUCTION[2]

Variations in world prices are an important source of risk and instability for the less-developed countries (LDC). The typical developing economy derives about half its export earnings from primary commodities; not only are the prices of such goods extremely volatile, but they also undergo sustained periods of rise and decline, so it is often difficult to insulate the economy from such shocks. To provide an example of the magnitudes involved, the World Bank's index of non-oil real commodity prices has exhibited a trend decline of about 1.5 percent per annum since 1948, cumulating to a reduction of more than half over the last 50 years.[3] Over the next decade, the World Bank is forecasting that this trend will continue. What is the impact of these long-run movements in the external terms of trade on key macroeconomic variables?

A huge literature[4] addresses precisely this question. The major contribution of this paper lies in analyzing a ready-made natural experiment: the experience in the 1970s and 1980s of the oil-exporting LDC. These countries experienced a major increase in the world price of their main export over 1973–81, followed by a smaller, but still substantial, decline over 1981–89. Specifically, real oil prices[5] rose from an index of 1.0 in 1973 to 5.83 in 1981, and then fell back to 2.42 in 1989.[6,7] These dramatic changes had a huge impact on the economies involved, and therefore represent an important research opportunity to better understand the impact of terms-of-trade shocks.

There are also a number of more specific reasons for interest in this episode. First, the central theme of intertemporal models is the importance of distinguishing between permanent versus transitory, and anticipated versus unanticipated changes in the terms of trade. The major long-run changes in oil prices closely approximate unanticipated events that were widely seen as permanent once they occurred. Specifically, the 1973–74 and 1979–80 oil-price increases were not widely anticipated, but quickly became perceived as irreversible. The long decline beginning in 1981 was also not widely anticipated. It probably took longer for it to be accepted as a long-

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[2] Portions of the paper are based on research carried out for Word Bank Policy Research Working Paper No. 1410.

[3] Reinhart and Wickham (1994) provide rigorous evidence that the reduction in commodity prices is mostly secular, and has been accompanied by an increase in their volatility.

[4] Selected contributions are discussed below (Appendix V, available upon request, provides a full theoretical and empirical survey).

[5] Defined as nominal oil prices deflated by U.S. producer prices.

[6] Nominal oil prices rose from $2.70 in 1973 to $34.31 in 1981, and then fell back to $16.31 in 1989.

[7] We do not proceed beyond 1989 to avoid the complications associated with the Gulf War.

run phenomenon, but at least by 1986, when oil prices had fallen by 25 percent, the 1981 levels were long considered a thing of the past.[8]

Second, the time span of the rise and decline in oil prices is fairly long (eight or nine years), so it is credible to believe that we can observe the type of intermediate-run adjustment for which many models are designed. Third, the movements in oil prices were large. Hence, there is much variation in the explanatory variable and, if there are regularities in the response, we should be able to estimate them precisely. Fourth, terms-of-trade changes were so dominant for these countries over this period that omitted-variable bias should not constitute a severe problem.

Fifth, we have both a rise and a decline in oil prices, so that we can try to detect asymmetries in the responses. Sixth, measurement problems associated with index numbers are less of an issue for oil exporters, since oil is relatively homogeneous. Finally, there is a large literature about the causes of the major oil-price movements, so questions about causality are tractable. Further, for many of the countries and most of the variables we examine, it seems reasonable to view the terms of trade as predetermined.

On a broader note, the paper has two distinctive features. First, empirical studies of growth and development have almost unanimously excluded the oil-exporting LDC from analysis, on the grounds that such countries are somehow different, and their performance is less amenable to explanation using standard economic variables. In contrast, we focus on precisely these hitherto-neglected countries.

In addition, while there is a growing awareness of the potential importance of terms-of-trade shocks in explaining macroeconomic performance,[9] few empirical studies have explicitly analyzed the link between the terms of trade and investment.[10] In contrast, this is the very mechanism we emphasize.

Our broad conclusion is that an examination of the data for oil exporters suggests the emphasis in most theoretical articles is misplaced. We find that the impact on investment is crucial to understanding the effect of terms-of-trade shocks on the current account and on long-run growth.

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[8] We document all these assertions in Section IV.

[9] For example, Barro and Sala-i-Martin (1995) find, in a cross-country growth regression, that an increase in the annual growth rate of the terms of trade by one standard deviation, amounting to 3.6 percentage points in the 1965–75 period, raises the growth rate of real per capita GDP by 0.4 percentage points.

[10] There are exceptions. Morley (1992), in a panel analysis of LDC stabilization programs, and Etherington and Yainshet (1988), in a time-series analysis of the Ethiopian economy, find a significant link between the terms of trade and domestic capital formation. See also Warner (1994), discussed in footnote 36.

Yet the literature is filled with current account models that hold investment constant, and long-run trade models that treat the capital stock as an endowment which is unaffected by terms-of-trade shocks. Conversely, Dutch Disease effects are examined extensively in the literature, but we fail to find any evidence that the Dutch Disease is a major phenomenon. On the other hand, terms-of-trade shocks do have a major impact on the output of all main categories of nontradables, and real exchange rate appreciations are a key mechanism in triggering this expansion. We also find that public expenditure responds more strongly than private expenditure to a terms-of-trade shock. Finally, investment, consumption, and nontradable output respond more strongly to a decline than to an increase in the terms of trade, perhaps because physical bottlenecks limit the ability to increase imports of investment and consumption goods.

This paper also makes a (relatively minor) theoretical contribution. Specifically, after the early analyses of Laursen and Metzler (1950) and Harberger (1950), the theoretical literature on terms-of-trade shocks bifurcated into two essentially independent strands. The Dutch Disease literature built on the tradable–nontradable dichotomy originated by Swan (1956) and Salter (1959), and stressed the sectoral impact of terms-of-trade shocks.[11] These models, however, were developed in an essentially static framework, which facilitated the analysis of production relationships but left many dynamic questions unaddressed. In particular, savings and aggregate investment were not explicitly modeled, and trade was assumed to be balanced.

In contrast, the "intertemporal choice" literature, following Sachs (1981), explicitly modeled the savings (and sometimes investment) decision, and provided a more complete neoclassical theory of the impact of terms-of-trade shocks on the current account.[12] The key insight was that the effect of a terms-of-trade shock depends critically on its persistence, and on whether it is anticipated. However, in order to analyze intertemporal issues, these models drastically simplified the production sector, typically assuming either an endowment economy, or else an economy completely specialized in producing one good. This arbitrarily ruled out Dutch Disease effects.

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[11] Corden and Neary (1982) and Corden (1984) provide excellent summaries. See also Wijnbergen (1984, 1984b) and Neary and Wijnbergen (1984). At its simplest, an increase in the relative price of exportables to importables exerts two effects. First, it increases aggregate wealth and hence demand for nontradables. This raises the price of nontradables relative to importables (and possibly exportables), drawing resources into the former and out of the latter—the *spending* effect. Second, the shock raises the value marginal product of factors in the exportable sector, drawing resources out of both importables and nontradables—the *resource-movement* effect. After the shock, importable output must decrease. In contrast, nontradable output could grow or shrink: the spending effect acts to raise it, the resource-movement effect to lower it.

[12] See Sen (1994) for an overview. This large literature includes Obstfeld (1982a, 1982b, 1983), Dornbusch (1983), Svensson and Razin (1983), Persson and Svensson (1985), Bean (1986), Matsuyama (1987), Edwards (1989), Sen and Turnovsky (1989), Schmidt-Hebbel and Serven (1993), Backus (1993), and Backus, Kehoe, and Kidland (1994).

The impact of terms-of-trade shocks on oil-exporting LDC, however, can only be fully understood in the context of a model which possesses two characteristics. First, it must have sufficient sectoral disaggregation to capture the distinct response of the nontradable sector and Dutch Disease effects. Second, there must be intertemporal dimension, so that savings and investment decisions may be properly modeled. To this end, we develop below a simple model which integrates the two previous approaches. While we should stress that none of the main ingredients of our model are new, their combination within an analytically tractable framework *is*.[13] In addition, we develop the point that, for most LDC, capital goods are substantially importable.[14] This turns out to have crucial implications.

Specifically, we show that the impact of a positive terms-of-trade shocks on aggregate investment, even *outside* the directly favored sector, is positive if a sufficient share of capital goods is importable, the aggregate labor supply is sufficiently elastic, or the nontradable sector is sufficiently capital-intensive. Under these same conditions, the impact on the current account and trade balance is negative. Further, if a sufficient share of capital goods is importable and the aggregate labor supply is sufficiently elastic, then Dutch Disease effects are weak.

The rest of this paper is organized as follows. Section II presents the model. Section III describes the data. Section IV sets out the econometric framework and analyzes some important econometric issues. Section V presents the main empirical results. Section VI concludes.

II. The Model

We now present a dynamic model linking wealth, and in particular the terms of trade, to consumption, output, and investment in both importable and nontradable sectors, the equilibrium real exchange rate, and the current account. The model integrates the literature on the sectoral effects of a terms-of-trade shock with the insights of the intertemporal-choice approach. It therefore provides a simple but unified analytical framework to help organize the discussion and interpret the later findings. This section only describes the main results; the more technical aspects of the model are discussed in Appendix I.

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[13] The two strands of the literature have been partially integrated in Bruno and Sachs (1982), Ostry and Reinhart (1992), and Gavin (1990, 1992), as well as in the large literature on open-economy real business cycle (RBC) models, e.g., Mendoza (1992). However, Bruno and Sachs and all the RBC models rely on numerical simulations; Ostry and Reinhart focus exclusively on consumption rather than production; and Gavin assumes that there is no aggregate investment, that either importables or nontradables are not produced domestically, and that the economy faces exogenously given terms of trade. In contrast, our model is analytically tractable, allows for aggregate investment, allows production of both importables and nontradables, and remains valid even when the economy can influence its terms of trade.

[14] This was first stressed by Schmidt-Hebbel and Serven (1993).

The basic model is designed to capture several important structural features of oil-exporting LDC. First, capital goods, and in particular machinery and equipment, are to a significant degree importable. Second, there is a large nontradable sector. Third, such countries are imperfectly insured against terms-of-trade shocks. Finally, the oil sector largely constitutes an "enclave" which does not participate in domestic factor markets, and hence does not compete for resources with other sectors.[15]

We allow for capital accumulation in the aggregate, and assume "perfect foresight";[16] optimal behavior by agents; short-run capital specificity, but long-run capital mobility between sectors; perfect international capital mobility; and full employment. Hence, the model is best suited for analyzing events in the medium- to long-run, when aggregate demand effects on output may be ignored.

The key intuition behind the model is as follows. Consider an economy facing a given world interest rate, and imperfectly insured against shocks to the natural-resource sector. A natural-resource boom then increases national wealth. This increases the demand for nontradables, which acts to increase the price of nontradables relative to importables. In turn, this has two effects. First, for a given sectoral allocation of labor, and so long as capital goods are importable, investment in nontradables increases. Second, assuming that the natural-resource sector constitutes an enclave, labor is drawn out of the importable and into the nontradable sector. Hence, output and investment decrease in the importable sector (the Dutch Disease), but again increase in the nontradable sector. Since nontradable investment increases, the supply of nontradables gradually rises over time. This acts to reduce nontradable prices, after their initial increase, that is, the real exchange rate initially overshoots its new long-run equilibrium.

Formally, there are three sectors. The first sector produces tradable natural resources. The second sector produces all other tradables; we refer to it as the 'importable' sector. The third sector produces nontradables. The prices of natural resources, importables, and nontradables are, respectively, p^r, p^m, and p^n, all expressed in units of foreign currency. Let p^m be the numéraire. Then p^r and p^n constitute the relative prices of natural resources and of nontradables in terms of importables.

Natural resources are not consumed domestically. If both natural-resource exports and gross

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[15] Hence, we may ignore the "resource-movement" effect discussed in footnote 11.

[16] As is standard, this should be interpreted as stating that (i) agents attach a zero *ex ante* subjective probability to those random shocks which we later examine, including unanticipated changes in the terms of trade, and (ii) agents correctly forecast the future time paths of all variables, *conditional* on such shocks not occurring.

While internally consistent, such an assumption may seem suspicious, and may indeed prove misleading, if in fact agents repeatedly experience random shocks. See footnote 25.

imports are strictly positive,[17] the external terms of trade are well-defined and equal to p^r. Assuming that PPP holds for the consumption-weighted set of tradables,[18] and holding constant the price of foreign nontradables, $1/p^n$ can be interpreted as a consumption-based measure of the real exchange rate.

The relative price of nontradables adjusts to equate the domestic demand and supply of nontradables. In contrast, the relative price of natural resources is set on the world markets. We consider two alternatives. First, the terms of trade are exogenous. Second, the economy, either by itself or as part of a cartel, is small in the world market for importables, but large in the market for natural resources.[19] Rather than specialize to one of these options, we conduct the analysis in terms of natural-resource wealth. In Section II.D, we discuss the relationship between changes in this measure and terms-of-trade shocks.

We first assume that production only requires freely importable capital goods, mobile labor, and non-reproducible sector-specific inputs. We then present some extensions, dealing with investment in the natural resource sector; changes in the labor supply, through immigration, unemployment, underemployment, and leisure; competition for labor by the natural-resource sector; natural resources as intermediates; nontradable capital goods; and adjustment costs in consumption.

A. The Baseline Model

Technology and endowments

The production function for natural resources, Q^r, is

$$Q^r = \mathrm{Q}^r(T^r), \tag{1}$$

where T^r denotes sector-specific inputs. Hence, the natural-resource sector does not compete for inputs with other sectors. We abstract from the issue of the optimal time pattern of oil production, and instead treat the natural-resource sector as a "black box," producing an exogenous flow of output. For now, we also abstract from investment and capital accumulation in the natural-resource sector.

The production functions for importables, Q^m, and nontradables, Q^n, are

$$Q^i = \mathrm{Q}^i(K^i, L^i, T^i), \ \ \{\mathrm{Q}^i_{12}, \mathrm{Q}^i_{13}, \mathrm{Q}^i_{23}\} > 0, \ \ i = m, n, \tag{2}$$

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[17] We show below that this must hold for sufficiently low levels of inherited foreign debt.

[18] This is weaker than requiring PPP to hold either for the set of all goods, or for the production-weighted set of tradables.

[19] That is, the economy can influence its terms of trade through the volume of its natural-resource exports, but *not* through the volume of its net trade in importables.

where $Q^m(\cdot)$ and $Q^n(\cdot)$ are linear homogeneous, increasing in each argument, globally concave, and satisfy the Inada conditions; K^m and K^n denote, respectively, the capital stock in importables and in the nontradable sector, henceforth referred to as "importable capital" and "nontradable capital"; L^m and L^n denote, respectively, the labor employed in the importable and in the nontradable sector; labor is freely mobile across sectors; and the sector-specific inputs T^i, whose total supply is fixed, are henceforth suppressed. We also assume that natural resources are not used as intermediates.

We assume a constant labor force, and normalize its size to unity so that all variables are implicitly expressed per domestic worker. In particular, L^m is the share of the labor force employed in importables, whereas

$$L^n = 1 - L^m \tag{3}$$

is the share of the labor force employed in nontradables. Each capital stock evolves according to

$$\dot{K}^i(t) = J^i(t) - \delta K^i(t), \; i = m,n \tag{4}$$

where J^i is gross sectoral capital formation, and δ is the depreciation rate, assumed constant across sectors. We treat both capital goods as part of the 'importable' aggregate, that is, we assume they are tradable at a fixed price in terms of all other (non–natural-resource) tradables.

Investment incurs convex adjustment costs.[20] We assume that such costs only involve the use of importables, and denote total sectoral adjustment costs by

$$A^i(J^i\text{-}\delta K^i) \equiv (J^i\text{-}\delta K^i)\, a^i(J^i\text{-}\delta K^i), \; i = m,n,$$

$$\text{where} \quad a^i(0) = 0, \; a^{i\prime} > 0, \; 2\,a^{i\prime} + (J^i\text{-}\delta K^i)\, a^{i\prime\prime} > 0$$

$$\Rightarrow \quad A^i(0) = 0 = A^{i\prime}(0), \; A^{i\prime\prime} > 0. \tag{5}$$

This formulation embodies two assumptions. First, replacement investment incurs no adjustment costs. Hence, the stationary-state supply of capital is infinitely elastic. Second, total adjustment

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[20] Convex adjustment, or "installation," costs capture the notion that conceiving, approving, and implementing a given investment project over a very short period of time is much more expensive than carrying it out gradually. Hence, it is in general optimal to smooth out over time any investment response to shocks. A related approach is the "gestation lag" or "time-to-build" formulation, which postulates that it is physically impossible to complete an investment project in less than some minimum time frame.

Adjustment costs can be viewed as "internal" or "external" to the investing firm. The former interpretation emphasizes organizational inertia and the difficulties of managing a rapidly growing firm; the latter focuses on capacity constraints among suppliers of capital goods. At the macroeconomic level, the two approaches are fundamentally equivalent.

costs are non-negative and convex in investment, that is, both installation and removal are costly.[21] Let

$$I^i \equiv [J^i + A^i(J^i - \delta K^i)], \quad I \equiv \Sigma_{i=m,n} I^i \tag{6}$$

denote, respectively, gross sectoral and gross total investment spending, inclusive of adjustment costs.

Consumption and production

The infinitely-lived, representative consumer-producer[22] maximizes

$$V(t) = \int_t^\infty e^{-\rho(s-t)} U[C^m(s),C^n(s)]\, ds, \quad \rho > 0, \tag{7}$$

$$U(C^m,C^n) \equiv \{[(C^m)^{1-\alpha}(C^n)^{\alpha}]^{1-\sigma} - \sigma\} / (1-\sigma), \quad \alpha \in (0,1), \sigma \geq 0, \tag{8}$$

where ρ is the pure rate of time preference; C^m and C^n denote, respectively, the consumption of importables and of nontradables; greater values of α represents a shift in tastes towards nontradables; $1/\sigma$ is the constant intertemporal elasticity of substitution in consumption; and we implicitly assume a unitary intratemporal elasticity of substitution between importables and nontradables.

Agents can freely borrow and lend abroad, subject to the exogenously given world real interest rate r on loans denominated in importables. The flow budget constraint is

$$dD(t)\,/\,dt = rD(t) + C(t) + I(t) - Q(t), \tag{9}$$

$$C \equiv C^m + p^n C^n, \quad Q \equiv p^r Q^r + Q^m + p^n Q^n, \tag{10}$$

where D is foreign debt, C is total consumption, and Q is total output, all measured in terms of importables. This formulation embodies two assumptions. First, interest payments are denominated in importables; one interpretation is that the debt is denominated in importables,

[21] The specific functional form in (5) is chosen because it allows an explicit derivation of the global dynamics.

[22] We adopt the fiction of a representative consumer-producer for simplicity. Given the absence of market failures, there are several alternative (and equivalent) ways to decentralize the command optimum.

and agents pay a fixed (inflation-adjusted) interest rate.[23,24] Second, domestic residents own the entire domestic output and bear all the risk of fluctuations in its value, that is, foreign investment only takes the form of lending.[25]

We rule out Ponzi-type schemes, in which agents borrow ever-increasing amounts from the rest of the world, by imposing a transversality condition, stating that asymptotically foreign debt cannot grow at a rate greater than r:

$$\lim_{t \to \infty} e^{-rt} D(t) = 0 . \tag{11}$$

(9) and (11) yield the intertemporal budget constraint, stating that the present discounted value[26]

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[23] Gavin (1990) argues that this assumption is reasonable for most developing countries. It is surely closer to the truth than assuming that, say, Saudi Arabia's debt is denominated in oil. The assumption that foreign debt is denominated in importables strengthens (weakens) the wealth effect of an increase in the terms of trade if net foreign assets are initially negative (positive). The determinants of the equilibrium denomination of debt contracts probably include both history and, as discussed in footnote 25, factors related to optimal risk diversification.

[24] Since (9) can be rewritten as $d\tilde{D}(t)/dt = \left(r - \dot{p}^r / p^r\right)\tilde{D}(t) + \tilde{C}(t) + \tilde{I}(t) - \tilde{Q}(t)$, where $\tilde{D} \equiv D/p^r$, $\tilde{C} \equiv C/p^r$, $\tilde{I} \equiv I/p^r$, and $\tilde{Q} \equiv Q/p^r$, this is equivalent to assuming that the debt is denominated in natural resources, but the interest rate automatically adjusts to offset any capital gains or losses due to terms-of-trade shocks.

[25] If domestic residents repeatedly experience terms-of-trade shocks, one might expect them to seek insurance against such disturbances by selling shares in the exportable sector to foreign residents, in exchange for claims on foreign assets. Depending on the precise source of the shocks, and on the diversifiability of the shocks at the level of the world economy, the optimal hedging strategy might reduce, eliminate, or even reverse the wealth effects associated with changes in the terms of trade; see Backus (1993).

In practice, the oil exporters engaged in minimal international portfolio diversification before the oil-price shocks. Indeed, they largely nationalized their domestic oil sectors. The reasons appear to have been mainly ideological and political. Specifically, foreign ownership of domestic natural resources was seen as a relic of colonialism and imperialism. Linked to this, the oil exporters felt they could not obtain good returns while foreign companies were running their oil industry.

[26] Throughout this paper, all discounting is at rate r, unless otherwise specified.

of consumption, C, plus the inherited foreign debt, $D(t)$, must equal the present value of output, Q, net of investment spending and adjustment costs, I:

$$\int_t^\infty e^{-r(s-t)} C(s)\, ds + D(t) = \int_t^\infty e^{-r(s-t)} [Q(s) - I(s)]\, ds. \quad \textbf{(12)}$$

Let R denote the annuity on natural-resource wealth, defined as the present value of natural-resource output in terms of importables:

$$R(t) \equiv r \int_t^\infty e^{-r(s-t)} p^r(s)\, Q^r(s)\, ds. \quad \textbf{(13)}$$

Throughout, we refer to an increase in either the price or the output of natural resources as a "natural-resource boom." Note that such a boom produces a discrete increase in wealth, R, as soon as it is anticipated, rather than when it actually occurs. The greater the expected persistence of the boom, the greater the increase in wealth.

Equilibrium

We briefly list the model's equilibrium conditions before turning to the main results. First, domestic demand and supply of nontradables must be equal at all points in time:

$$C^n(t) = Q^n(t), \forall t. \quad \textbf{(14)}$$

On the demand side, there is a fixed relationship between spending on the two consumption goods at any moment:

$$[\alpha / (1 - \alpha)]\, C^m(t) = p^n(t)\, C^n(t). \quad \textbf{(15)}$$

We assume that

$$r = \rho, \quad \textbf{(16)}$$

so that the model possesses a stationary state. Next, we note that since this is a dynamic multi-sectoral model, both the *inter*-temporal and the *intra*-temporal elasticities of substitution play a role. In general, movements in the consumption of the two goods when out of stationary state are negatively (positively) correlated if the intertemporal elasticity of substitution is smaller (greater) than unity [cf. Brock (1988)]. Intuitively, given a unitary *intra*-temporal elasticity of substitution, if the intertemporal elasticity of substitution is smaller than unity, then agents prefer to rearrange their consumption bundle rather than shift total consumption over time. Hence, consumption of importables and of nontradables is negatively correlated during any period of transition. For simplicity, we now set

$$\sigma = 1. \quad \textbf{(17)}$$

Consumption of importables is then constant along any perfect-foresight path, although it may still respond to unanticipated shocks:

$$C^m(t) = C^m, \forall t. \quad \textbf{(18)}$$

Using the intertemporal solvency condition, consumption of importables then equals the annuity on net national tradable wealth, $W(t)$, defined as the present value of tradable output net of investment spending, minus the inherited foreign debt, all measured in terms of importables:

$$C^m = r\,W(t), \;\; W(t) \equiv \int_t^\infty e^{-r(s-t)}\,[Q^m(s) - I(s)]\,ds + R(t)/r - D(t). \tag{19}$$

On the supply side, labor market equilibrium requires that the value marginal product of labor be equated across sectors:

$$Q^m{}_2(K^m,L^m) = p^n\, Q^n{}_2(K^n,1\text{-}L^m). \tag{20}$$

Further, investment in each sector is chosen so that the cost of installing an extra unit of capital, given by its price (≡ 1) and the marginal adjustment cost, equals the shadow value of installed capital, q^i:

$$1 + A^{i\prime}[J^i(t)\text{-}\delta K^i(t)] \;\geq\; q^i(t), \;\; K^i \geq 0, \text{ complementary slack}, \;\; i = m, n, \tag{21}$$

This establishes that net investment is increasing in q^i. In turn, q^i evolves over time according to

$$(r + \delta)\, q^i(t) - \dot{q}^i = p^i\, Q^i{}_1[K^i(t),L^i(t)] + \delta\, A^{i\prime}[J^i(t)\text{-}\delta K^i(t)] \tag{22}$$

$$\Rightarrow \qquad r\, q^i(t) - \dot{q}^i \leq p^i\, Q^i{}_1[K^i(t),L^i(t)] - \delta, \;\; K^i \geq 0, \text{ complementary slack}, \;\; i = m, n, \text{ by (21)}. \tag{23}$$

(22) states that the "user cost" of installed capital must equal its value marginal product. The user cost is the sum of interest and depreciation charges, net of capital gains. The value marginal product of installed capital is the sum of its value marginal product in production, and of its marginal contribution to reducing the cost of installing a given flow of investment goods.

In general, the evolutions of the two sectors' capital stocks are linked. Changes in one sector's capital stock will induce a shift of labor between sectors; in turn, this may also change the price of the other sector's output relative to capital goods. Both factors will alter the other sector's value marginal product of capital, and hence its investment incentives. Nevertheless, given certain assumptions discussed in Appendix I, this intersectoral linkage vanishes. The model may then be efficiently summarized by combining the dynamic equations for K^i and for q^i to yield two phase diagrams, one for each sector, as shown in Figure 1. For each sector i, the horizontal axis measures K^i, while the vertical axis measures q^i. The $\dot{K}^i = 0$ locus is a horizontal line at the price of capital (unity). Also, a higher K^i is associated with a lower sectoral value marginal product of installed capital. In equilibrium, it must therefore be associated with a lower user cost of installed capital, that is, either a lower q^i or a higher $\dot{q}^i$. Hence, the $\dot{q}^i = 0$ locus is a downward-sloping line; to its right, q^i grows over time, and conversely to its left.

Natural-resource booms

We now analyze the impact of natural-resource booms. Assume that the economy is initially in stationary state. Let there be a discrete increase in R, that is, a previously unanticipated (current or future) natural-resource boom. The boom raises wealth, and hence demand for nontradables.

This acts to increase the price of nontradables, which in turn draws labor away from the importable and towards the nontradable sector. Nontradable investment is stimulated both by the increase in nontradable prices, *and* by the shift in labor towards the nontradable sector. The latter, however, *discourages* importable output and investment; this is the Dutch Disease.

Figures 2 and 3 illustrate the dynamics. When the shock occurs, neither the $\dot{K}^n = 0$ nor the $\dot{K}^m = 0$ locus change. The $\dot{q}^n = 0$ locus, and hence the nontradable saddle-path, shift up, whereas the $\dot{q}^m = 0$ locus, and hence the importable saddle-path, shift down. q^n, nontradable investment, and nontradable output increase discretely upon impact, and at all future dates are higher than in the absence of the shock. q^m, importable investment, and importable output decrease discretely upon impact, and at all future dates are lower than in the absence of the shock.

After the initial impact, and during the transition to the new stationary state, the nontradable capital stock and output increase monotonically, while net nontradable investment decreases monotonically. The importable capital stock and output decrease monotonically, while net importable investment increases monotonically. The relative price of nontradables *decreases* monotonically. Hence, nontradables prices initially *overshoot* their new stationary-state value. Here, real exchange rate overshooting arises not because of price stickiness, but simply because it is optimal to spread out changes in the capital stock over a discrete period of time.

In the new stationary state, the relative price of nontradables and the manufacturing capital-labor ratio will exceed their pre-shock value. Holding constant the price of foreign nontradables, this yields two corollaries. First, the short-run deviations from purchasing-power parity (PPP) exceed the long-run deviations. Second, even in the long-run, PPP does not hold.

The response of aggregate investment and of the aggregate capital stock is in general ambiguous. However, they will increase if labor reallocation only has a small impact on the marginal product of capital. To see this, let the marginal product of manufacturing capital be independent of the sectoral supply of labor. Then, upon impact, the price of nontradables and their share in total employment still increase discretely, but manufacturing investment is unaffected.[27] Hence, both nontradable *and* aggregate investment increase discretely, and must at all future dates be higher than in the absence of the shock. In the general case where labor reallocation *does* affect the marginal product of capital, the resource boom will raise the marginal product of capital in nontraded and lower it in the traded sector; the former provides a further boost to aggregate investment, while the latter reduces it.

A further effect is related to the capital intensities of the sectors. To see this, let the production function be linearly homogenous in capital and labor alone. Then, for a given stationary-state user cost of capital, the stationary-state capital-labor ratios in both sectors are uniquely

[27] If all labor is in fact immobile, manufacturing output is also unaffected.

determined. Hence, if nontradables are relatively capital-intensive (labor-intensive), the aggregate stationary-state capital stock increases (decreases). In turn, this implies an increase (decrease) both in "average" investment during the transition, and in stationary-state investment.

At the time of the boom, the instantaneous change in savings is

$$\Delta S(t) = \Delta [p^r(t)\, Q^r(t) - R(t)] + \Delta [Q^m(t) - r \textstyle\int_t^\infty e^{-r(s-t)}\, Q^m(s)\, ds] + \Delta\, r \textstyle\int_t^\infty e^{-r(s-t)}\, I(s)\, ds. \qquad \textbf{(24)}$$

The first term on the R.H.S. depends on the change in the anticipated time path of natural-resource export earnings. It is positive for a transitory increase in natural-resource prices. It may be positive even for a permanent price increase, so long as natural resources output is expected to decline over time, e.g., because oil reserves will be quickly exhausted. It must be negative for an anticipated future increase in natural-resource prices or output. The second term is positive, since importable output is expected to decline over time. The last term corresponds to the change in "permanent" aggregate investment. As discussed above, it is in general ambiguous. The intuition behind (24) is that agents want to smooth consumption over time.

The instantaneous change in the trade balance and current account is

$$\Delta [S(t) - I(t)] = \Delta [p^r(t)\, Q^r(t) - R(t)] + \Delta [Q^m(t) - r \textstyle\int_t^\infty e^{-r(s-t)}\, Q^m(s)\, ds] + \Delta [r \textstyle\int_t^\infty e^{-r(s-t)}\, I(s)\, ds - \mathrm{I}(t)]. \qquad (25)$$

The first and second term on the R.H.S. were discussed above. The last term is negative if and only if aggregate investment increases discretely upon impact.[28]

B. Extensions

Investment in the natural-resource sector

We now allow for investment in the natural-resource sector. Assume first that the natural-resource boom involves an exogenous increase in the value marginal product of capital in the natural-resource sector. For instance, the boom may involve a discovery of natural-resource reserves, perhaps itself induced by an exogenous increase in natural-resource prices, and exploitation of these reserves may require new investment. As before, the shock exerts wealth effects. In addition, optimal natural-resource investment increases. Hence, aggregate investment is more likely to increase, and the current account is more likely to decline.

Assume instead that the boom reflects an increase in natural-resource prices that is triggered by policy-induced restraints on output. Then, optimal natural-resource investment is likely to

[28] We assume that the depreciation rate is sufficiently low, so that the (monotonic) decline in net investment along the transition path is accompanied by a decline in *gross* investment. If the economy was not initially in stationary state, the sign of the last term also depends on the shape of the adjustment cost functions.

decrease. Hence, aggregate investment is less likely to increase, and the current account is less likely to decline.

Changes in the labor supply: unemployment, immigration, and leisure

As argued above, an increase in wealth raises the demand for nontradables, which acts to increase the price of nontradables and hence the demand for labor by the nontradable sector. With a constant labor supply, this induces an increase in domestic wages, a movement of labor away from the importable sector, and a reduction in its output and investment.

Many developing countries, however, are characterized by substantial unemployment or underemployment. Several also face an abundant supply of potential immigrant workers, both skilled and unskilled.[29] All this implies an extremely elastic aggregate labor supply, which acts to moderate the rise in wages, and to increase output and investment in all sectors. In particular, it must weaken any Dutch Disease.

Assume, as a polar case, a perfectly elastic labor supply at a fixed wage rate in terms of importables, either because of wage rigidities combined with unemployment, or else because labor can be freely purchased on the world markets.[30] Then, in effect, the various sectors of the economy do not compete for inputs. Hence, there can be no Dutch Disease, that is, importable output and investment are completely unaffected by natural-resource booms or preference shocks. Note, however, that if the shock induces immigration, the total labor force increases, and output of importables *per domestic worker* falls.

In addition, the shocks may affect the demand for leisure. Specifically, an increase in wages induces substitution away from leisure, whereas the increase in wealth raises demand for leisure. If the latter effect dominates, the total labor supply shrinks. This induces a further increase in wages, and acts to reduce output and investment in all sectors. In particular, it reinforces any Dutch Disease.

Competition for labor by the natural-resource sector

We assumed the natural-resource sector constitutes an "enclave" which does not participate in domestic factor markets, and hence does not compete for resources with other sectors. This

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[29] On the other hand, governments may be unwilling to countenance large-scale immigration.

[30] In general, the wage rate relevant to immigration decisions presumably depends on the price of a consumption-weighted basket of importables and nontradables. The greater the weight which potential immigrants place on nontradables, and the greater the impact of a natural-resource boom on the relative price of nontradables, the smaller the response of immigration to the boom. In theory, a natural-resource boom may even induce net emigration, reinforcing any Dutch Disease. Empirically, this latter case does not seem relevant.

assumption is justifiable for oil exporters, but may not hold more generally. In particular, it may prove misleading when analyzing exporters of labor-intensive commodities, such as coffee or cocoa. We now relax it.

Assume first that the natural-resource boom involves an exogenous increase in the value marginal product of labor in the natural-resource sector. For instance, let the boom stem from an exogenous increase in the relative price of natural resources. Then labor moves towards the natural-resource sector, and away from the rest of the economy. This "resource-movement effect" reinforces any Dutch Disease, and may also imply a net fall in nontradable output and investment. However, it is likely to encourage investment in the natural-resource sector.

Assume instead that the boom reflects an increase in natural-resource prices that is triggered by policy-induced restraints on output. Then labor moves *towards* the other sectors. This increases their output and investment, and in particular weakens any Dutch Disease.

Natural resources as intermediates; nontradable capital goods; and adjustment costs in consumption

We assumed that all natural resources are exported. However, resources like oil may enter into domestic production as intermediates. Assume that the natural-resource boom reflects an increase in world natural-resource prices, *and* that this increase is passed through to domestic producers. Then, the increase in the price of natural-resource intermediates acts to contract the relatively natural-resource-intensive sector; assuming small differences in relative factor intensities, it also acts to contract the other sector. Hence, it is likely to reinforce any Dutch Disease, and may imply a net fall in nontradable output and investment. However, most large oil exporters have historically insulated domestic agents from fluctuations in the world price of oil.

We also assumed fully tradable capital goods. We now consider the other extreme, when capital goods (and adjustment costs in investment) are completely nontradable. A natural-resource boom raises the price of nontradables. If capital goods are tradable, this acts to stimulate nontradable investment, without discouraging importable investment. But if capital goods are nontradable, the rise in the latter's price acts to discourage importable investment, while no longer stimulating nontradable investment. Hence, the presence of nontradable capital goods acts to reduce output and investment in all sectors. In particular, it reinforces any Dutch Disease.

Finally, we assumed there were no costs to rapid adjustment of consumption, which therefore responds instantaneously to changes in permanent income. However, in the short-run it may be very difficult to change consumption levels. For instance, downward adjustments may incur substantial political resistance, whereas upward adjustments may be hindered by physical bottlenecks.[31] To the extent that consumption adjusts slowly to its new equilibrium after a shock,

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[31] Sachs (1981) points out that "cement-carrying ships were trapped for months outside the inadequate port at Lagos, Nigeria, after the post-1973 boom in spending."

the wealth effects described above only set in with a lag, and natural-resource booms are likely to be associated with short-run increases in the current account.

C. Summary

The intuition behind the model, and its formal predictions, is as follows. A natural-resource boom increases national wealth. This raises the consumption of importables. In addition, it increases the demand for nontradables, which acts to increase the price of nontradables relative to importables. In turn, this has two effects. First, for a given sectoral allocation of labor, so long as some fraction of the capital goods is importable, investment in nontradables increases; and so long as some fraction of the capital goods is nontradable, investment in importables decreases. Second, assuming that the natural-resource sector constitutes an enclave, labor is drawn out of the importable and into the nontradable sector. Hence, output and investment decrease in the importable sector (the Dutch Disease), but again increase in the nontradable sector. Since nontradable investment increases, the supply of nontradables gradually rises over time. This acts to reduce the price of nontradables, after its initial increase. In other words, the real exchange rate initially overshoots its new long-run equilibrium.

Aggregate investment is likely to increase under the following circumstances. First, if capital goods have a large tradable content. Second, if Dutch Disease effects are weak, for instance because the aggregate labor supply is very elastic, or else because labor is substantially immobile across sectors. Third, if the expanding nontradable sector is more capital-intensive than the contracting importable sector. Fourth, if natural-resource investment responds strongly to the shock.

The response of the current account is more likely to be negative if aggregate investment increases, if the natural-resource boom is perceived as largely permanent, and if importable output is not expected to decline through Dutch Disease effects.

A shift in private preferences towards nontradables, or an increase in government spending that falls mainly on nontradables, also raises demand for nontradables. Hence, the implications for importable and nontradable output and investment are analogous to those of a natural-resource boom. However, consumption of importables decreases rather than increases.

D. The Link Between Natural-Resource Wealth and the Terms of Trade

So far, we have conducted the analysis in terms of R, the annuity on natural-resource wealth, measured in terms of importables. We now clarify the relationship between changes in R and terms-of-trade shocks.

In the model, so long as imports are strictly positive, the terms of trade are well-defined and equal to p^r. Even in this simple case, the relationship between the response of the terms of trade and of R to a shock generally depends both on the source and nature of the shock, and on the economy's ability to influence world natural-resource prices.

In an intertemporal setting, a shock affects wealth as soon as it is anticipated, rather than when it actually occurs. Hence, if the shock is foreseen sufficiently far in advance, the economy's response will be largely complete by the time we observe any change in the terms of trade. Again, if a shock is expected to be largely transitory, its effect on wealth is minimal, whatever the change in the terms of trade. In what follows, we therefore assume the shocks are completely unanticipated, and are expected to display some persistence.

Assume that p^r is exogenous to the economy. First, let there be an increase in p^r. Then R must increase. The greater the anticipated persistence of the shock, and the more natural-resource output is free to respond through optimal changes in investment, the greater the increase in R. Second, let there be an increase in natural-resource output and exports, for instance, because of a discovery of natural-resource reserves. Then R increases without any corresponding change in the terms of trade.

Now let the economy, either by itself or as part of a cartel, be large in the world market for natural resources. First, let there be an increase in foreign demand for domestic natural resources. Then, both p^r and R increase. Second, let there be an increase in natural-resource output and exports. If the increase occurs because of a cartel breakdown, and so long as the country had initially joined the cartel to promote its *economic* interests, then both p^r and R decrease. If instead the increase reflects greater productivity in the natural-resource sector, say because of a discovery of natural-resource reserves, then p^r decreases but, assuming that optimal export taxes are in place, R increases.

In summary, an increase in the terms of trade *must* imply an increase in R, if two conditions are met. First, the change in the terms of trade must be unanticipated and must be expected to display some persistence. Second, either the terms of trade must be exogenous, or else the terms-of-trade shock must reflect the strengthening and weakening of a cartel, and/or a change in foreign demand for domestic exports. In contrast, productivity shocks to the natural-resource sector of a large natural-resource exporter may cause the terms of trade and R to diverge.

Even if the above conditions are met, an increase in R need *not* be associated with an increase in the terms of trade. Specifically, if the volume of natural-resource exports or reserves changes over time, then R will change without any corresponding change in the terms of trade. Again, if countries differ in the size of the exportable sector, or in their perceptions about the persistence of a shock, then the impact of a given terms-of-trade shock on R must also differ across countries. Hence, changes in the terms of trade are at best an imperfect measure of changes in natural-resource wealth. This caveat applies *a fortiori* to changes in total wealth.

III. THE DATA

We consider the period 1965–89. Our sample consists of the following 18 oil-exporting countries: Algeria, Bahrain, Congo, Ecuador, Egypt, Gabon, Indonesia, Iran, Iraq, Kuwait, Mexico, Nigeria, Oman, Saudi Arabia, Syria, Trinidad and Tobago, United Arab Emirates, and Venezuela.

All variables are measured at an annual frequency. For each country, on the expenditure side we examine consumption and investment (by the private sector, by the government, and in the aggregate), savings, the trade balance, and GDP. At a sectoral level, we analyze value added in the oil sector and the non-oil sector. The non-oil sector is further broken down into the following categories: agriculture, manufacturing, construction, public utilities, and services. Services are in turn disaggregated into transportation and communications, wholesale and retail trade, and other services. Within the non-oil sector, agriculture and manufacturing are best seen as tradables, and the other categories as nontradables. All the above variables are expressed per worker, and in constant local currency. The latter practice diverges from the definition used in the theoretical model, where importables were the numéraire. However, we do also examine the relative price of nontradables to importables, as proxied (in the absence of better measures) by the CPI-based real exchange rate.

As explanatory variables, we employ the terms of trade, interacted with each country's average trade ratio over the sample period; a debt crisis dummy; and the world real interest rate. Appendix II provides a full description of the data used and its sources. Figure 4 plots each country's terms of trade. As expected, these all increase sharply in 1973–74 and again in 1979–80, decline steadily after 1981, and collapse in 1986. Figures 5, 6 and 7 provide scatter plots of investment, the trade balance, and value added in the non-oil sector, respectively, against the terms of trade; in each case, we depict the *deviations* from the country-specific means. The partial correlation is positive for investment and for non-oil value added, and strikingly negative for the trade balance.

IV. ECONOMETRIC FRAMEWORK AND ISSUES

A. Interpretation of the Terms of Trade

Throughout, we interpret changes in the terms of trade as a measure of changes in wealth. Our justification is as follows. First, the major changes in the price of oil were largely unanticipated, and were expected to display some persistence. Specifically, the main oil price increases were triggered by essentially unpredictable historical events, that is, the 1973–74 Arab-Israeli war, the 1978–79 Iranian revolution, and the start of the Iran-Iraq war in 1980. In addition, surveys of informed participants in the oil market during the 1980s suggest four conclusions.[32] First, the long price decline starting in 1981 was not anticipated. Second, it quickly led to a wave of successive reductions in both short- and long-term forecasts of oil prices. Third, at any given point in time, the economically relevant agents generally expect slow, constant growth in oil prices. Fourth, market expectations are predominantly adaptive and extrapolative.

Next, consider the source of terms-of-trade shocks. For non-OPEC oil exporters, the terms of trade are best seen as exogenous. Even for OPEC members, terms-of-trade shocks mainly reflected two factors. First, the strengthening and weakening of the OPEC cartel. Second, changes in foreign demand for their oil, stemming from the emergence of new oil producers, the development and exploitation of alternative energy sources, and business cycles abroad. For most countries, productivity shocks to the domestic oil sector, that is, unanticipated discoveries or depletions of oil reserves, have had a minor impact on oil prices.

As argued in Section II.D, increases in the terms of trade then imply an increase in wealth.[33] The converse, however, need not hold. Given that oil production and reserves change over time and differ across countries, changes in the terms of trade are at best an imperfect measure of changes in wealth. We control for this by interacting the terms of trade with the trade ratio, defined as [(exports + imports) / 2 GDP]. We use the average trade ratio over the sample period, for the following reason. If some countries can respond to an increase in the terms of trade by shifting resources over time towards their export sector, then using the initial-year trade ratio yields a downward-biased estimate of the increase in their wealth. Conversely, using the post-shock trade ratio neglects the opportunity and adjustment costs associated with the resource shift, and yields an upward-biased estimate of the wealth increase. Again, to the extent that the movements in resources are anticipated, using the current-year trade ratio yields a misleading picture of the timing of the wealth increase. Using the average trade ratio hopefully minimizes such problems. In any event, the results are not very sensitive to the precise measure used.

Finally, measurement of the terms of trade may be subject to index-number problems for two main reasons. First, even for a given producer, oil is not completely homogenous: some oil exporters have successfully diversified into oil refining. Second, the share of non-oil tradables in exports changes over time. However, given that the terms of trade are heavily correlated both across countries, and with the price of oil relative to U.S. manufactures, these problems appear to be minor.

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[32] See Manne, A., and Schrattenholzer, L. (1984, 1986a, 1986b, 1988, 1989, and 1991).

[33] To the extent that productivity shocks in the oil sector led to a fall in the terms of trade but an increase in wealth, this should if anything bias our results *against* the conclusions of the model.

B. Estimation

Throughout, we use a panel rather than a time-series methodology since, if the underlying assumptions are satisfied, this allows for more precise estimates and renders omitted-variable bias a less serious problem (see Section IV.C). We have no strong priors and theory provides little guidance on the speed at which our variables adjust to terms-of-trade shocks. Hence, we take a flexible, data-determined approach to dynamics. Specifically, we estimate the regression equation

$$\ln y_{it} = \alpha_i + \beta(L)\,\overline{TR_i}\,\ln TOT_{it} + \gamma CONTROL_{it} + \varepsilon_{it}. \tag{26}$$

The i subscript refers to the country, and the t subscript to the year. y denotes each of the dependent variables,[34] TOT denotes the terms of trade, and $\overline{TR_i}$ denotes a country's average trade ratio over the sample period. $\beta(L)$ is a polynomial in the lag operator, whose order is chosen using the Schwartz Information Criterion, and whose elements, multiplied by the relevant country's average trade ratio, denote the elasticity of the dependent variable with respect to the terms of trade at various lags. *CONTROL* denotes the control variables, which include a debt crisis dummy, the world real interest rate, and a linear time trend. We control for the debt crisis because it is a conceptually distinct phenomenon from a terms-of-trade shock; our results are strengthened to the extent that the crisis was itself caused by the downturn in the price of oil. We use the world real interest rate because it raises fewer endogeneity problems than domestic real interest rates, and because most of the countries in our sample were relatively well integrated into the world capital markets, at least until the onset of the debt crisis. We use a time trend to capture the effects of technological progress and other underlying sources of growth.

In (26), the intercept α varies across countries. These country-specific effects reflect the cross-country heterogeneity in the absolute size of the dependent variable, stemming from differences both in the underlying economic structure and in the units of measurement. We do not allow for year-specific effects. Since the countries in our sample, by construction, rely heavily on oil for their exports, the shocks to their terms of trade are heavily correlated. Time effects would essentially soak up this cross-country common component of terms-of-trade shocks, leaving only the very small cross-country *differences* in the shocks. This would inevitably make any estimated response insignificant.

In allowing for country-specific effects, we compute both the fixed-effects (FE) and the random-effects (RE) estimators. These estimators differ in both their efficiency and their consistency properties. The FE estimator is asymptotically efficient if the country effects are treated as fixed regressors, or if the model is to be analyzed conditional on the effects present

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[34] Observed values for savings, the trade balance, and oil-sector value added are occasionally negative. Hence, we transform these variables into country-specific indices, and run the regressions in levels rather than logs.

in the observed sample, as is the case for in-sample predictions. The RE estimator is asymptotically efficient if the country effects are treated as random and if the model is to be analyzed unconditionally, as is the case for out-of-sample forecasts. In addition, the FE but not the RE estimator remains consistent if the country effects are correlated with the explanatory variables. Both for this last reason, and because the differences in the estimates are minor, we focus on the results from FE estimation.

Analysis of the residuals from a preliminary regression suggests the presence of first-order autocorrelation, cross-country heteroskedasticity, and cross-country correlation. We assume that the disturbances in all countries share a common AR(1) process and a common cross-country correlation. We then estimate the autoregressive coefficient, use the Prais-Winsten transformation to remove the autocorrelation, estimate the country-specific variances, and the cross-country error correlation, compute the FGLS estimator, and iterate to convergence. The results are reported in Appendix III, Table 1, and are discussed in Section V.

Next, we carry out a series of specification tests. First, we test the hypothesis that there are country-specific effects, that is, α varies across countries. Under FE estimation, this involves a standard F test. Under RE estimation, we employ the Breusch and Pagan (1980) Lagrange Multiplier (LM) test. In all regressions, both the F and the LM test statistic are significant at the 1 percent level. We therefore reject the null of no country-specific effects. Since the LM test statistic has a block-diagonal information matrix, its use in a pretest does not affect the standard errors of the other estimators we compute.

Second, we test the hypothesis that the long-run elasticity with respect to the terms of trade is constant over time. To do this, we allow the estimated coefficients on the terms of trade to differ across the sub-periods 1965–80 and 1981–89. Since these roughly correspond to the periods of rising and of falling terms of trade, this also allows us to examine whether the responses to positive and to negative terms-of-trade shocks differ. The results of the F-test are reported in Appendix III, Table 2, and are discussed in Section V.

Third, we test the hypothesis that the long-run elasticity with respect to the terms of trade is constant across countries. The results of the F-test are reported in Appendix IV, available upon request. The null hypothesis of stability across countries is often rejected. The rejection is hardly surprising, given that we are dealing with such a broad sample of countries, but it does imply that we must determine how representative the panel estimates are. Accordingly, Appendix IV also presents each country's estimated response to changes in the terms of trade.

C. Omitted-Variable Bias

Omitted-variable bias needs to be treated differently in a panel context. As shown in Appendix II, a necessary and sufficient condition for consistency of the country-by-country OLS estimator of the coefficients on the terms of trade is that, asymptotically, the terms of trade be orthogonal to any omitted variables. In contrast, a necessary and sufficient condition for consistency of the panel estimator is that, asymptotically, a weighted average of the biases in the country-by-country OLS estimates be zero.[35]

Hence, the panel estimator can be consistent even if the terms of trade are *not* asymptotically orthogonal to the omitted variables in any one country. What matters is that the country-specific asymptotic biases be negatively correlated across countries, so that they average to zero. This last assumption is more credible to the extent that the relationship between the omitted variables and the terms of trade is idiosyncratic to each country and not positively correlated across countries. To the extent that the omitted variables are world variables which affect all countries, then the country-specific asymptotic biases will have the same signs. We therefore control for the debt crisis and the world interest rate. It might also be desirable to control for world output. However, since periods of rising oil prices coincided with changes in OECD activity that would have depressed growth in our sample, and vice-versa, this should strengthen the links we find between terms-of-trade changes and activity variables.

D. Non-Stationarity

There are two ways to interpret our econometric model. First, we may view the terms of trade, which are driven mainly by the world price of oil, as a fixed regressor. (26) is then the mechanism generating the rest of the data. The presence or absence of stationarity is not an issue here.

Alternatively, we may treat the terms of trade as generated by some time-series statistical model. Here, the order of integration of our data is an issue. We take a flexible approach to the spurious regression problem, adopting the Prais-Winsten adjustment for first-order serial correlation in the residuals. Blough (1992) demonstrates that, if the variables in the regression are I(1) and not cointegrated, this procedure is asymptotically equivalent to differencing the data before estimating the model. In addition, the procedure avoids the misspecification problems associated with differencing when the regression variables are cointegrated.

V. Results

By construction, the estimated response to a terms-of-trade shock is proportional to each country's trade ratio (except for when we examine coefficient stability across countries). Hence, in the discussion below, all references to the absolute value of the elasticity of any

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[35] The panel estimator assigns a relatively large weight to countries where either the sample terms-of-trade variance, or the trade ratio, is relatively large. By construction, the countries in our sample rely heavily on oil for their exports, so that the variability of their terms of trade is similar. Hence, more open economies receive a larger weight. Intuitively, in such countries the impact of terms-of-trade shocks is larger, and hence can be estimated more precisely.

given variable with respect to the terms of trade refer implicitly to a hypothetical country whose trade ratio equals the sample average, 33.37 percent.

A. The Importance of Investment

Overall, we find strong evidence of a positive relationship between terms-of-trade shocks and investment. Panel estimates suggest the 95 percent confidence interval (0.067, 0.382) for the mean long-run elasticity of aggregate investment with respect to the terms of trade. This investment response helps explain why the trade balance was strongly negatively related to terms-of-trade shocks, even though the export-price effect in isolation should cause a higher trade surplus.

Investment responds more strongly to a decline than to an increase in the terms of trade, even after controlling for the debt crisis. This suggests that adjustment costs are substantially larger for increases than for decreases in the capital stock. Specifically, the positive response to a favorable terms-of-trade shock may be choked off by physical bottlenecks arising, for instance, from inadequate transportation infrastructure and port facilities, which limit the ability to import capital goods. We now examine what the available evidence says about the sectoral breakdown and the causes of this investment response.

It is likely that much of this investment occurred in the nontradable sector of the economy. Although data on investment by sector are simply not available for most of these countries,[36] so that this claim cannot be supported directly, much of the other data are supportive. First, we do have evidence that, in the long run, output expanded in nontradable sectors such as construction and services. It is reasonable to view this increase as partly due to a higher capital stock in these sectors.

Second, our model concludes that, in any given sector, private investment is determined by the ratio of marginal q (the present value of the value marginal product of capital) to the relevant price deflator for investment goods. We know that the relative price of nontradables to importables is positively associated with terms-of-trade shocks. Also, Appendix III, Table 3, shows that the countries in our sample import many capital goods. Further, the world prices of capital goods relative to most noncommodity tradables did not change dramatically over the period. Hence, the price of nontradables relative to physical capital, and therefore the price incentive for investment in the nontradable sector, probably rose in the 1970s and declined in the 1980s.

The model also suggests that the relative price changes should stimulate investment in the oil

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[36] Warner (1994) shows that private investment in Mexican nontradables did decline over 1981–85. This study also suggests that an important mechanism for the investment decline was the reduction in the price of nontradables relative to imported equipment, and that the terms-of-trade deterioration can explain most of the decrease in this relative price.

sector. Although this would probably hold for countries experiencing exogenous changes in their export prices, OPEC raised oil prices in the 1970s partly through a deliberate policy of output restriction. Hence, for much of our period the oil sector was engineering price changes, rather than passively responding to them. In a setting where countries exercise their power in the world oil market, it is *a priori* unclear which way the incentives for investment in the oil sector work. Oil production quotas may be seen as a permanent ceiling on oil production, leaving little reason to invest in the oil sector's productive capacity. On the other hand, an increase in such capacity may strengthen one's hand in the periodic quota negotiations; in addition, there is still an incentive for cost-reducing investment.

We do know that real oil output per worker fell between 1973 and 1981. Perhaps the countries invested in modernizing the oil sector, rather than in expanding its capacity. Perhaps they did invest in expanding capacity, but just did not use this capacity fully over the period. We simply do not have the data to pin this down very precisely.

B. Consumption, Savings, and the Trade Balance

As expected, after a permanent, positive terms-of-trade shock, consumption increases. Panel estimates suggest the 95 percent confidence interval (0.107, 0.194) for the mean long-run elasticity of consumption with respect to the terms of trade. As with investment, consumption responds more strongly to a decline than to an increase in the terms of trade, even after controlling for the debt crisis. Again, this suggests that adjustment costs are substantially larger for increases than for decreases in consumption. For instance, the positive response to a favorable terms-of-trade shock may be choked off by physical bottlenecks in supply. Alternatively, it may prove psychologically difficult to increase consumption levels rapidly, whereas the capital markets may quickly enforce any required downward adjustment.

Government consumption responds more strongly than private sector consumption, particularly when we allow for a structural break over time. Three interpretations are possible. First, oil rents generally accrue to the government, which may find it politically advantageous to spend directly, rather than rebate the revenues to the private sector through lower taxes or higher transfer payments. Second, governments may systematically view shocks as more permanent than do private agents. Third, private demands for publicly-provided goods and services may be characterized by relatively high income elasticity.

Panel estimates suggest the 95 percent confidence interval (-.226, -.0618) for the mean long-run elasticity of savings with respect to the terms of trade. Given the negative impact on savings, and the strong response of investment, the trade balance should be expected to decrease. Indeed, this was the estimated response, which proved statistically significant both in the aggregate, and for 10 individual countries.[37]

C. Nontradable Prices and Quantities

Increases in the terms of trade are very strongly associated with real exchange rate appreciations, that is, increases in the relative price of nontradables. Panel estimates suggest the 95 percent confidence interval (-.515, -.413) for the mean long-run elasticity of the real exchange rate with respect to the terms of trade. Thirteen countries out of 18 displayed a significant response.

The shocks are also associated with significant increase in value added within the nontradable sector, and in particular in construction and services. This confirms the importance of spending effects as a key mechanism in the transmission of terms-of-trade shocks to the rest of the economy: higher wealth leads to greater demand for nontradables, and hence to an increase in their relative prices and quantities. As with investment and consumption, nontradable output generally responds more strongly to a decline than to an increase in the terms of trade. Again, this presumably reflects physical bottlenecks.

D. Dutch Disease Effects

The literature strongly focuses on Dutch Disease effects. Here, the two non-oil tradables, that is, agriculture and manufacturing, are the closest approximation we have to a Dutch Disease sector. Yet we failed to detect clear contractions in either in response to an increase in the price of oil. Oil value-added did respond negatively, but this simply reflects the imposition of OPEC quotas: the oil sector is not best seen as facing exogenously given terms of trade, since part of OPEC's strategy at the time clearly was to engineer price rises by restraining output.

The absence of a Dutch Disease may be partly explained by either the compression in oil output, or by its being an "enclave" sector which does not participate in domestic factor markets. Both factors act to reduce the pull of resources away from non-oil sectors. Still, as discussed above, the "spending effect" was operational, increasing relative prices and output in the nontradable sector. To the extent that nontradables compete with agriculture and manufacturing for scarce factors of production, or that nontradables are themselves intermediate inputs into other sectors, one might have expected a bout of the Dutch Disease.

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[37] Similar results apply for the current account. This does not contradict the view that current-account surpluses from the oil-rich countries helped finance loans to the LDC and thereby triggered the debt crisis. The point is that this "petrodollars" story only applies in the shortrun. In the medium run, the time frame over which the model is estimated, the response of consumption and investment turns the surplus into a deficit.

E. Growth

Given that the relative prices between oil and other products changed so dramatically over the period, and given that the oil sector is so important in our sample, very serious index-number problems arise in even defining and measuring aggregate output. We do not feel that it is analytically useful to talk about the aggregate economy, and instead separate the oil from the non-oil sector. The former has already been mentioned. Within the non-oil aggregate, we do see an effect on GDP, reflecting mainly the expansion in nontradables. Panel estimates suggest the 95 percent confidence interval (0.0711, 0.162) for the mean long-run elasticity of non-oil value added with respect to the terms of trade. Given our evidence on investment, this response is best seen as driven by capital formation in the nontradable sector.

F. Some Problems with Extrapolation

When interpreting and above all extrapolating our results, several issues must be considered. First, the causes of the oil-price shock were different from the causes of the forecast future increase in primary commodity prices. In our sample, export prices rose largely because of oligopolistic coordination aimed at reducing output. Some responses might well be different for truly exogenous terms-of-trade shocks. In particular, both investment and output in the favored sector would probably increase. Since output was no longer constrained, we should also expect a bigger increase in wealth and hence consumption.

Second, our results need only be valid for a permanent change in the terms of trade. A temporary terms-of-trade shock may lead to some intertemporal substitution in consumption and investment, but is unlikely to cause a permanent change in output.

Third, an economy's response to an increase in the price of primary commodities clearly hinges on how dependent it is on primary exports. Its investment response also depends on what share of its capital goods is importable.

Fourth, we might expect the availability of external finance to be a crucial factor interacting with changes in the terms of trade, and oil exporters in the 1970s probably enjoyed better access to the world capital markets than is true of the developing world today. On the other hand, this might well change if trends in commodity prices changed.

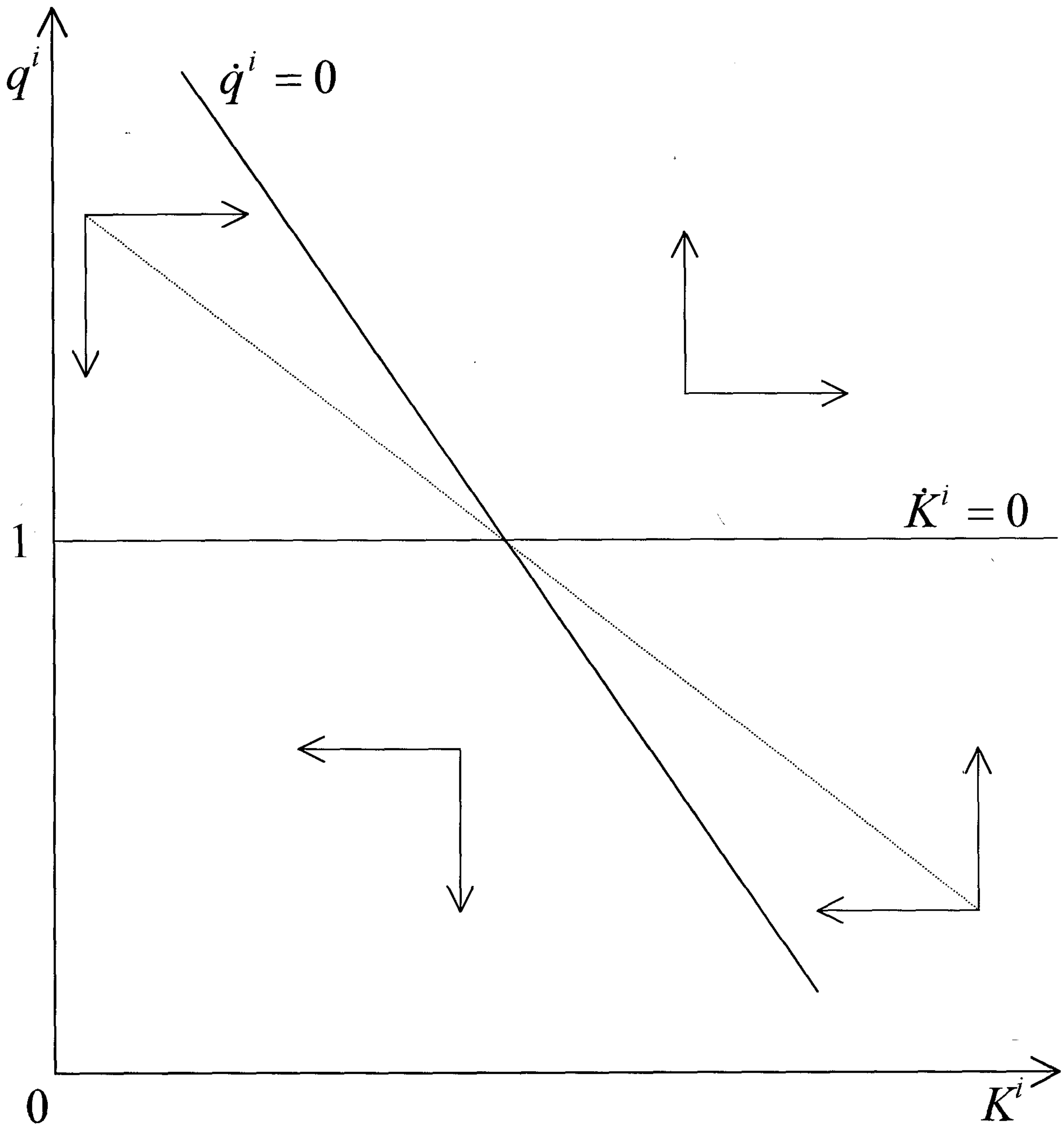
Finally, it is occasionally argued that oil exporters in the 1970s and 1980s wasted a large portion of their windfall revenues on prestige projects with small economic returns. If so, and if developing countries have by now learned the lesson, they may be able to put their luck to better use next time around.

VI. Conclusions

We considered a panel of oil exporters that import a significant fraction of their capital goods. We found that terms-of-trade shocks have a small, negative impact on savings; a strong, positive impact on investment; and a negative impact on the trade balance. There is also evidence of a long-run effect on output, particularly of nontradables. Real exchange rate appreciations are a key mechanism in triggering this expansion. We failed to find any evidence that the Dutch disease is a major phenomenon. The response of expenditure to terms-of-trade shocks was larger for the public than for the private sector. Finally, investment, consumption, and nontradable output responded more strongly to a decline than to an increase in the terms of trade, perhaps because physical bottlenecks limited the ability to increase imports of investment and consumption goods.

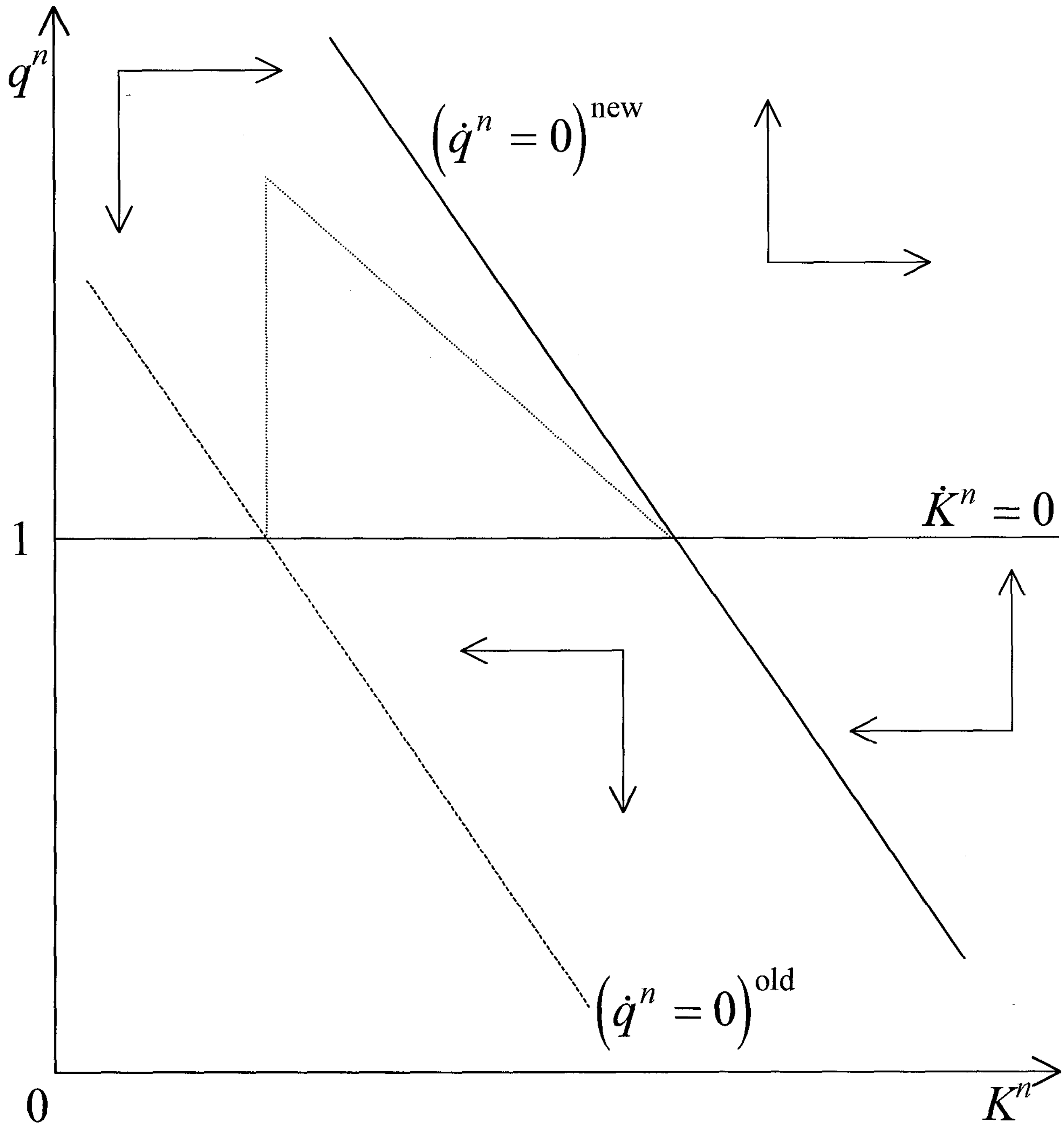
As previously discussed, estimating an in-sample response to a terms-of-trade shock is much easier than forecasting an out-of-sample response. While our qualitative results may hold in quite general contexts, our quantitative estimates will not. Still, we can obtain some idea of the potential impact of changes in commodity prices on the growth rate of commodity exporters. As a lower bound, assume that the commodity sector does not grow at all, that the economy's trade ratio is 25 percent, that the non-commodity sector accounts for 75 percent of GDP, and that it responds like the non-oil sector in our sample. If trend commodity prices were to stabilize, rather than continue decreasing at a rate of 1.5 percent per annum, then the trend annual growth rate of per capita GDP at constant prices would increase by about 0.1 percent. To the extent that commodity output increased, and that this did not pull resources away from the rest of the economy, the growth effect would be magnified.

Figure 1. Dynamics of investment and capital in sector *i*.



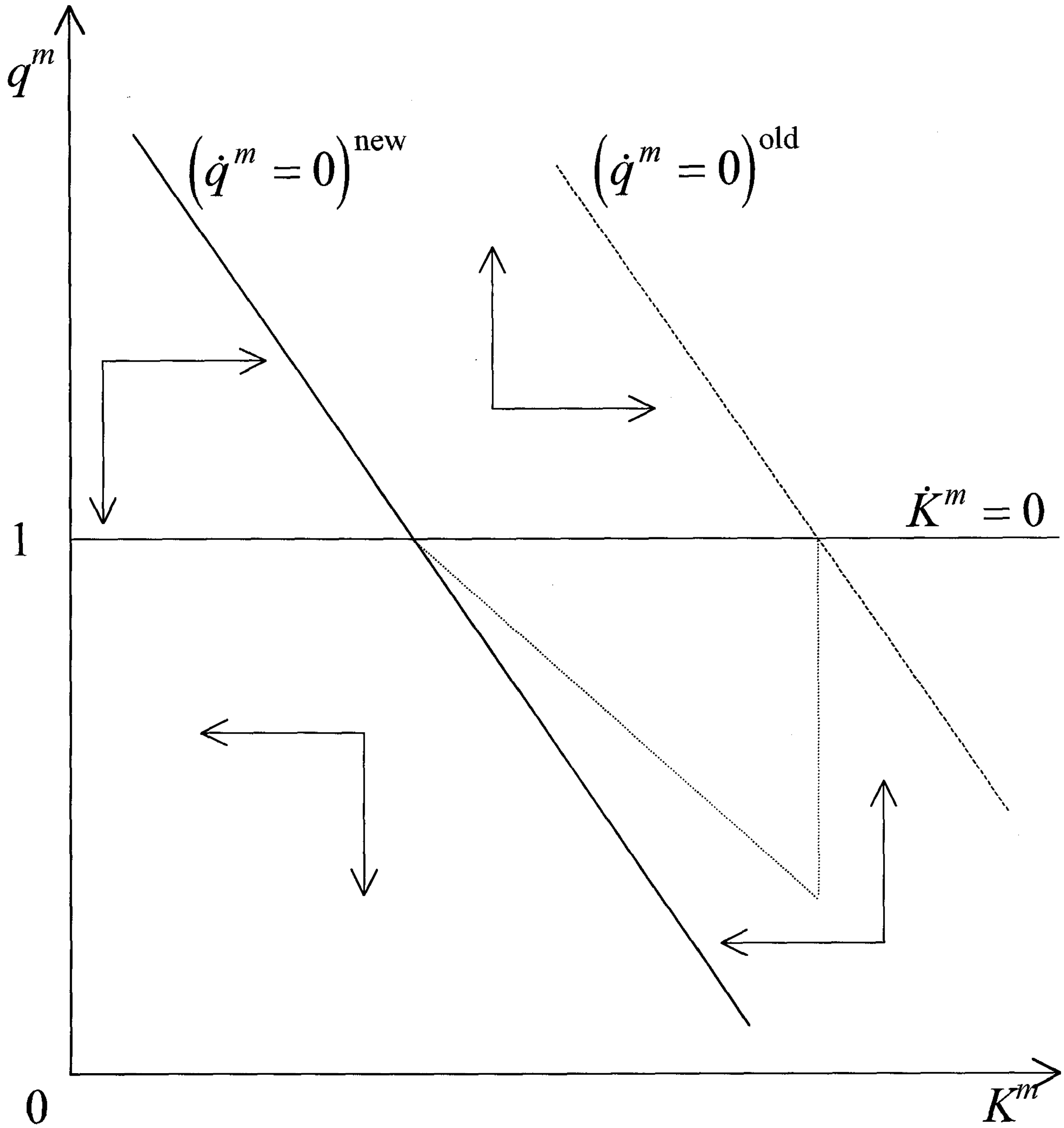
Short dashes and arrows represent the saddle-path.

Figure 2. Response of investment and capital in the nontradable sector to a natural-resource boom or to a shift in tastes towards nontradables.



Long dashes represent the pre-shock $\dot{q}^n = 0$ locus. Short dashes and arrows represent the response of nontradables to the shock. Only the post-shock arrows of motion are shown.

Figure 3. Response of investment and capital in the importable sector to a natural-resource boom or to a shift in tastes towards nontradables.



Long dashes represent the pre-shock $\dot{q}^m = 0$ locus. Short dashes and arrows represents the response of importables to the shock. Only the post-shock arrows of motion are shown.

Figure 4. Terms of Trade versus Year.

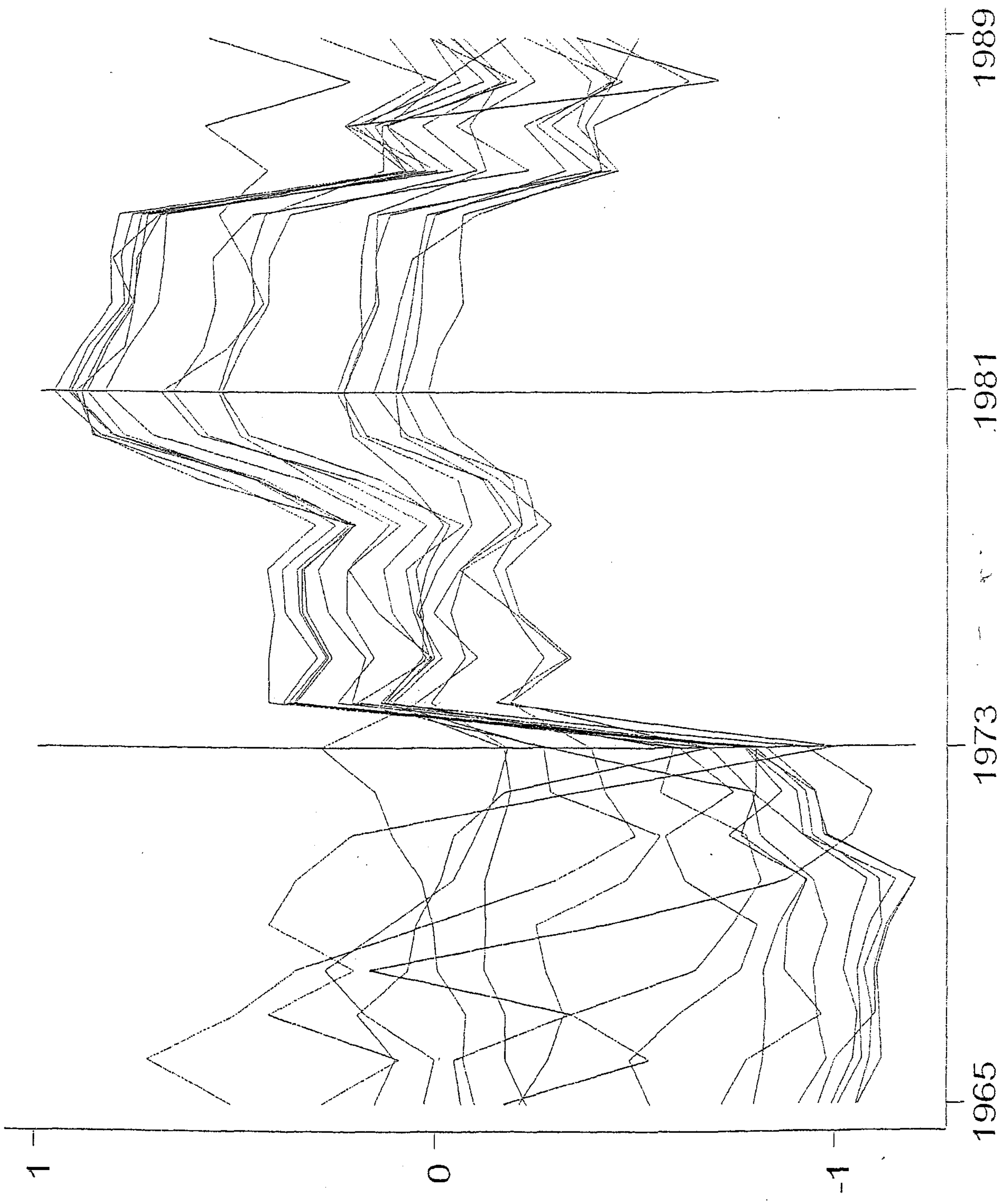


Figure 5. Investment versus Terms of Trade.

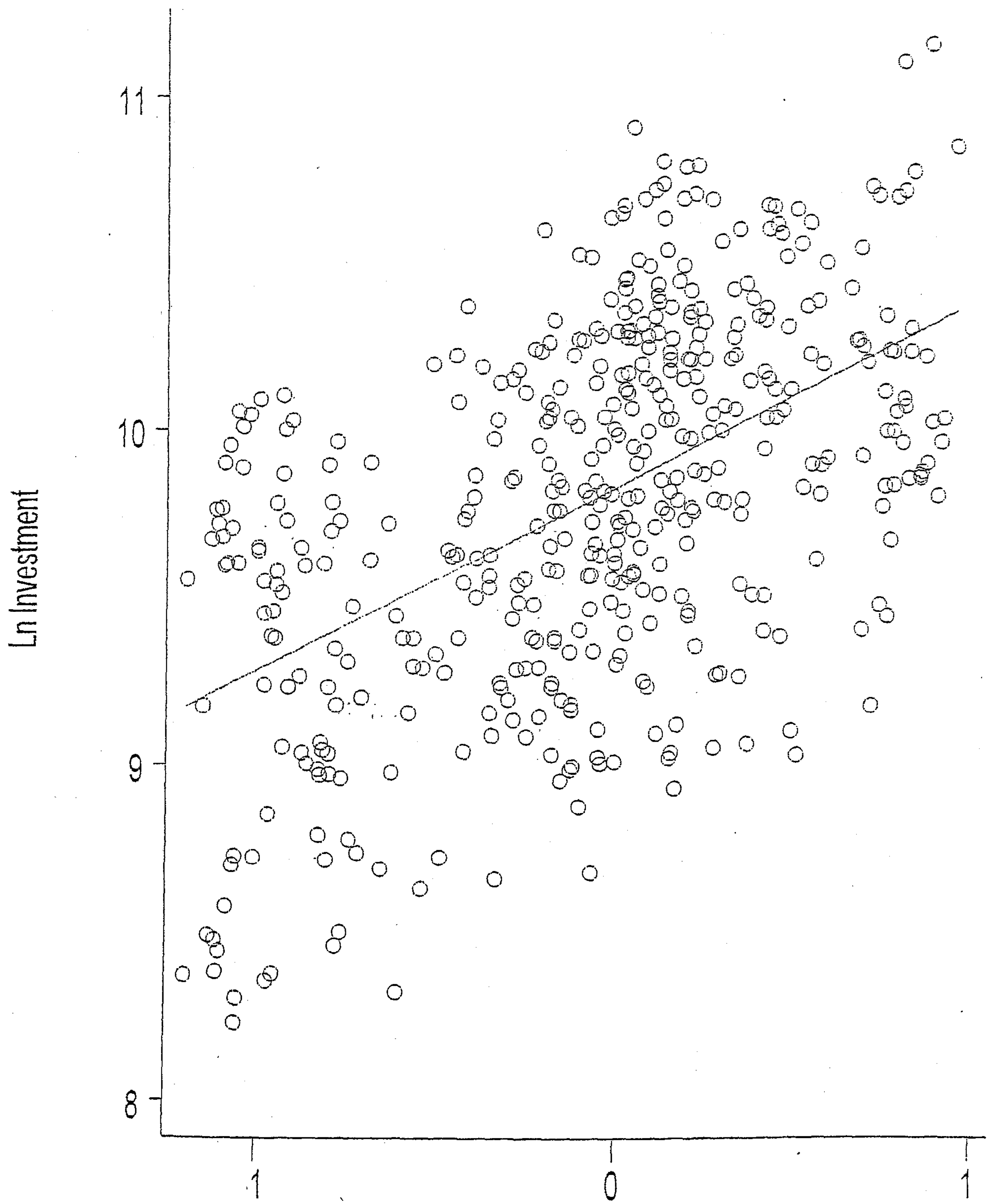


Figure 6. Trade Balance versus Terms of Trade.

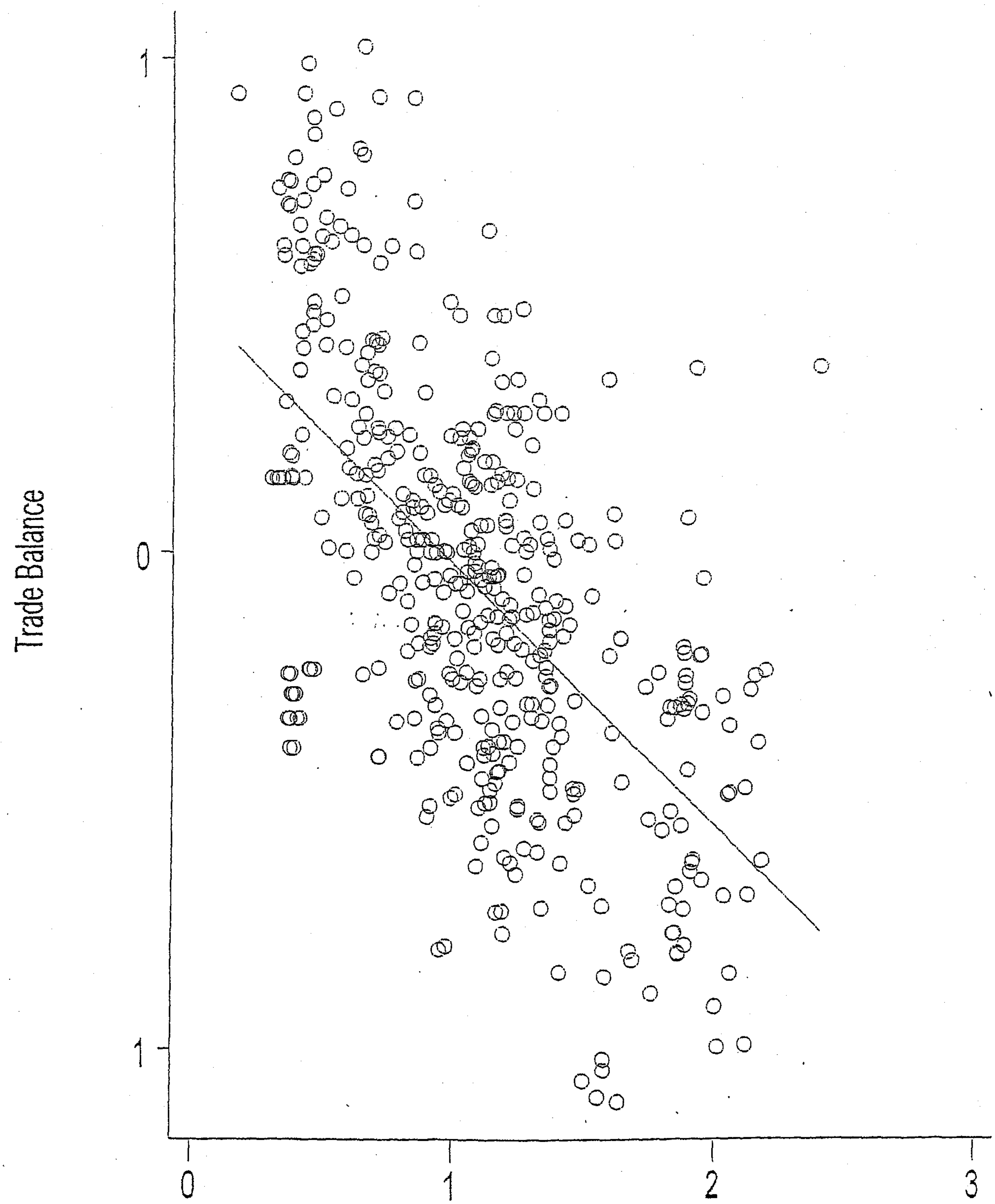
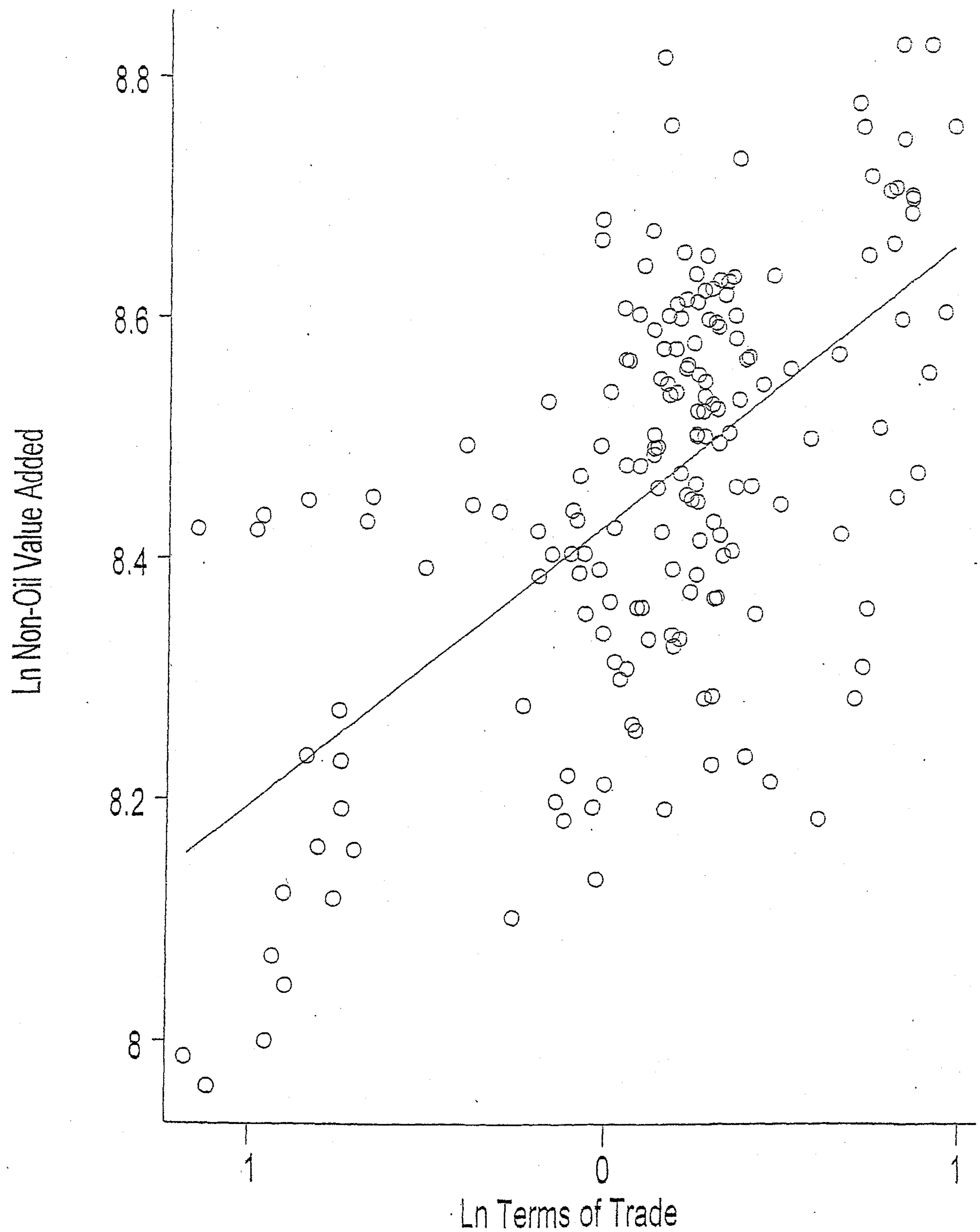


Figure 7. Non-Oil Value Added versus Terms of Trade.



THE MODEL

A. The Baseline Model

i. Equilibrium

Substituting (14) into the flow budget constraint (9) yields the current account surplus,

$$- dD(t) / dt = S(t) - I(t), \tag{27}$$

where $S \equiv p^r Q^r + Q^m - C^m - rD$ **(28)**

are gross national savings. Substituting (14) into the intertemporal budget constraint (12) yields the external solvency constraint, stating that the present value of trade surpluses must equal the inherited foreign debt:

$$\int_t^\infty e^{-r(s-t)} [p^r(s) Q^r(s) + Q^m(s) - I(s) - C^m(s)] ds = D(t). \tag{29}$$

The Hamiltonian is

$$H(t) = e^{-\rho t} U(t) + e^{-rt} \lambda \{[Q(t) - C(t) - I(t)] + \Sigma_{i=m,n} [q^i(t) (J^i - \delta K^i)]\}, \tag{30}$$

where λ is the shadow value of income, and $q^i(t)$ is the shadow value of installed capital in sector i in terms of uninstalled capital. Maximizing with respect to C^m, C^n, L^m, J^m, J^n, K^m, and K^n yields the stated F.O.C. Further, the time-paths for consumption of importables and of nontradables are linked by

$$\frac{\dot{C}^m(t)}{C^m(t)} = \frac{r-\rho}{\alpha+\sigma(1-\alpha)} + \frac{\alpha(1-\sigma)}{\alpha+\sigma(1-\alpha)} \frac{\dot{C}^n(t)}{C^n(t)}. \tag{31}$$

We now assume (16), so that the model possesses a stationary state.[38] Throughout, note that demand for nontradables, and hence equilibrium nontradable output, is always strictly positive. In contrast, the importable sector is inactive if mobile labor is essential to production *and* is all employed by the nontradable sector. For now, we assume incomplete specialization. Later, we discuss under what conditions complete specialization can arise, and its implications.

Consider first the special case where there is no (aggregate or sectoral) investment, so that capital is simply one of the non-reproducible sector-specific inputs.

Proposition 1. Let there be no investment. Then, along any perfect-foresight path, C^m, C^n, Q^m,

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[38] Let $\sigma = 1$ (the case where $\sigma \neq 1$ is discussed in the main text). If $r > \rho$, then consumption of importables (and spending on nontradables) grows without bound, which in turn implies that net foreign assets grow without bound. Hence, the country eventually begins to affect the world interest rate. If instead $r < \rho$, then the country runs its wealth down as far as it can. To avoid these difficulties, we set $r = \rho$. We could also obtain convergence to a stationary state by specifying a time-path for r that converges to ρ.

Q^n, L^m and p^n are constant.

Proof. Without investment or capital, the labor market equilibrium condition, (20), simplifies to

$$Q^m{}_1[L^m(t)] = p^n(t)\, Q^n{}_1[1\text{-}L^m(t)]. \tag{32}$$

By (32), p^n is a monotone, increasing function of L^n and hence of Q^n. By (14), p^n is a monotone, increasing function of C^n: $p^n = \mathrm{f}(C^n)$, $\mathrm{f}' > 0$. Substitute for p^n into (15), and take logarithms and time-derivatives, to obtain

$$\frac{\dot{C}^m(t)}{C^m(t)} = \frac{\dot{C}^n(t)}{C^n(t)}\left\{1+\frac{C^n(t)\,\mathrm{f}'[C^n(t)]}{\mathrm{f}[C^n(t)]}\right\}, \quad \mathrm{f}'>0. \tag{33}$$

Substitute into (31). By (16), both C^m and C^n are constant. By (15), p^n is constant. By (32), L^m is constant. Hence, Q^m and Q^n are constant. **QED**.

Intuitively, with no investment, there are no adjustment costs or other frictions. Hence, the economy is always in stationary state,[39] that is, it displays no transitional dynamics, responding instantaneously to unanticipated shocks.

Proposition 2. Let there be no investment. Then, the importable share in total employment, L^m, is given by

$$\phi(L^m,\alpha) = R(t) - rD(t), \tag{34}$$

where $\phi(L^m,\alpha) \equiv [(1\text{-}\alpha)/\alpha]\, Q^m{}_1(L^m)\, Q^n(1\text{-}L^m) / Q^n{}_1(1\text{-}L^m) - Q^m(L^m)$. **(35)**

Proof. By Proposition 1 and the external solvency constraint, (29), consumption of importables simplifies to

$$C^m = Q^m + [R(t) - rD(t)]. \tag{36}$$

(14), (15), (32) and (36), taken together, imply (34) and (35). **QED**.

$\phi(L^m,\alpha)$ is decreasing in both L^m and α. Hence, a discrete increase in R, that is, a previously unanticipated (current or future) natural-resource boom, reduces L^m. This is a Dutch-Disease result. A natural-resource boom raises wealth and hence demand for nontradables. In turn, this demand stimulus draws resources away from the importable and towards the nontradable sector. Likewise, an increase in α, that is, a shift in tastes towards nontradables, draws resources away from importables and reduces L^m.

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[39] Throughout, we define a stationary state as an equilibrium in which all variables are constant, except possibly for natural-resource output and hence foreign debt.

Proposition 3. Let there be no investment. Given L^m, the equilibrium relative price of nontradables is

$$p^n = \mathrm{Q}^m{}_1(L^m) \,/\, \mathrm{Q}^n{}_1(1\text{-}L^m). \qquad \textbf{(37)}$$

Proof. Use the F.O.C. for labor market equilibrium, (32). **QED**.

Hence, the effect of the exogenous variables on p^n is the opposite of their effect on L^m. That is, both a natural-resource boom and a shift in preferences towards nontradables raise the equilibrium relative price of nontradables.

We now return to the general case, allowing for investment. Since this incurs adjustment costs, the economy need not always be in stationary state. We now assume (17).

Proposition 4. Along any perfect-foresight path, both p^nC^n and p^nQ^n are constant. Hence, $dp^n / dQ^n < 0$, that is, the price and the output of nontradables move in opposite directions.

Proof. (17) and (31) imply (18). By (18), along any perfect-foresight path, C^m is constant. By (15), p^nC^n is constant. By (14), p^nQ^n is constant. **QED**.

Imports equal

$$C^m + I(t) - Q^m(t) = [r \textstyle\int_t^\infty e^{-r(s-t)}\, Q^m(s)\, ds - Q^m(t)] + [I(t) - r \int_t^\infty e^{-r(s-t)}\, I(s)\, ds] + [R(t) - rD(t)], \qquad \textbf{(38)}$$

which is strictly positive for sufficiently low levels of inherited debt. By (28),

$$S(t) \equiv [p^r(t)\, Q^r(t) + Q^m(t)] - \{r \textstyle\int_t^\infty e^{-r(s-t)}\, [Q^m(s) - I(s)]\, ds + R(t)\}. \qquad \textbf{(39)}$$

Hence, savings are positive (negative) if the current value of tradable output exceeds (falls short of) the "permanent" value net of investment spending. Intuitively, agents want to smooth consumption over time.

By (4), (5), and (21),

$$\dot{K}^i(t) = J^i(t) - \delta K^i(t) = \mathrm{f}\left[q^i(t)\right],\ \ \mathrm{f}(1) = 0,\ \ \mathrm{f}' > 0,\ \ i = m,n, \qquad \textbf{(40)}$$

that is, net investment is an increasing function of q^i.

Integrating (23) forward over time and using the transversality conditions,

$$\begin{aligned} q^i(t) &= \textstyle\int_t^\infty e^{-(r+\delta)(s-t)}\, \{p^i\, \mathrm{Q}^i{}_1[K^i(s),L^i(s)] + \delta\, \mathrm{A}^i{}'[J^i(s)\text{-}\delta K^i(s)]\}\, ds \\ &= \textstyle\int_t^\infty e^{-r(s-t)}\, p^i\, \mathrm{Q}^i{}_1[K^i(s),L^i(s)]\, ds - \delta / r,\ \ i = m, n. \end{aligned} \qquad \textbf{(41)}$$

Hence, the shadow price of installed capital equals the present value of all its future value marginal products. This completes the model. There are seven key equations: (14), (15), (18), (19), (20), (23) and (40).

Proposition 5. Assume free disposal of capital goods, and let net investment $(J^i - \delta K^i)^0$ be optimal for *some* parameters. If $(J^i - \delta K^i)^0 \leq (J^i - \delta K^i)^1$, then $(J^i - \delta K^i)^0 + A[(J^i - \delta K^i)^0] \leq (J^i - \delta K^i)^1 + A[(J^i - \delta K^i)^1]$. That is, the levels of net investment exclusive and inclusive of adjustment costs move in the same direction.

Proof. With free disposal, $q^i \geq 0$. Let net investment x be optimal for some parameters. By (21), $A'(x) \geq -1$. Let $x \leq y$. Then

$$A(y) = A(x) + \int_{k=x}^{y} A'(k)\,dk \geq A(x) + [-k]_{k=x}^{y} = A(x) - y + x \leq A(x). \quad \textbf{QED.} \qquad \textbf{(42)}$$

Proposition 5 applies even to negative investment levels, so long as they are optimally chosen. Intuitively, agents will not remove installed capital if the proceeds from its resale are insufficient to cover the costs of removal.

ii. Stationary State and Dynamics

First, we analyze the stationary state. Let an asterisk * denote stationary-state values. By definition, $\dot{K}^{i*} = 0$, $i = m, n$. Hence, (40) reduces to

$$J^{i*} = \delta K^{i*}, \quad q^{i*} = 1, \quad i = m, n. \qquad \textbf{(43)}$$

Intuitively, stationary-state investment by assumption incurs no adjustment costs. Hence, the cost of uninstalled capital equals the replacement cost of installed capital, which in turn must equal its shadow price. By (23),

$$p^{i*}\, Q^i_1(K^{i*}, L^{i*}) = r + \delta, \quad i = m, n. \qquad \textbf{(44)}$$

Consider two special cases. First, assume that the importable and nontradable sectors only compete for inputs which are in fact available on the world market at a fixed price. Formally, let all labor be sector-specific. Then, (44) uniquely determines the stationary-state importable capital stock, and hence output, as a negative function of the stationary-state user cost of capital, $(r + \delta)$:

$$K^{m*} = f(r+\delta), \; f' < 0. \qquad \textbf{(45)}$$

(45) holds even if labor is mobile, so long as its sectoral allocation does not affect the marginal product of importable capital. But, in this case, importable output is no longer uniquely determined.

Second, assume that *all* factors are mobile across sectors. Formally, let each production function be linear homogeneous in capital and labor *alone*. Then, in each sector, the marginal products of both capital and labor depend only on the sectoral capital-labor ratio. So long as the importable sector is active, (44) uniquely determines the stationary-state importable capital-labor ratio as a negative function of $(r + \delta)$:

$$\frac{K^{m*}}{L^{m*}} = f(r+\delta), \; f' < 0. \qquad \textbf{(46)}$$

Then, (20) and (44) uniquely determine both the stationary-state nontradable capital-labor ratio, *and* the stationary-state relative price of nontradables, again as a function of $(r + \delta)$:

$$\frac{K^{n^*}}{L^{n^*}} = \mathrm{g}(r+\delta), \mathrm{g}' < 0, \tag{47}$$

$$p^{n^*} = \bar{\mathrm{h}}(r+\delta), \tag{48}$$

where h′ >/=/< 0, according as nontradables are relatively more, equally, or relatively less capital-intensive than importables. Hence, the stationary-state real exchange rate is uniquely determined by the cost of capital and the technological parameters. This is a variant of Factor Price Equalization: given two goods and two factors, given incomplete specialization, and given the prices of one good (the importable) and one factor (capital), the prices of the other good (the nontradable) and the other factor (labor) are uniquely determined.

We now return to the general case and construct two phase diagrams, one in (K^m, q^m) space and the other in (K^n, q^n) space. By (40) and (23),

$$\dot{K}^i >/=/< 0, \text{ according as } q^i >/=/< 1, \; i = m,n, \tag{49}$$

$$\dot{q}^i >/=/< 0, \text{ according as } q^i >/=/< [p^i \, \mathrm{Q}^i{}_1(K^i,L^i) - \delta] \,/\, r, \; i = m, n. \tag{50}$$

Next, (14), (15), (20) and (18) imply

$$[\alpha / (1 - \alpha)] \, C^m = \mathrm{F}(K^m,L^m,K^n) \equiv \mathrm{Q}^n(K^n,1\text{-}L^m) \, \mathrm{Q}^m{}_2(K^m,L^m) \,/\, \mathrm{Q}^n{}_2(K^n,1\text{-}L^m), \tag{51}$$

where, along any perfect-foresight path, the L.H.S. of (51) and therefore F(·) is constant.

Proposition 6. Along any perfect-foresight path, for given K^n, $\{d(K^m/L^m) / dK^m$, dL^m / dK^m, $dQ^m / dK^m\} > 0$. That is, the importable capital stock, capital-labor ratio, share in total employment, and output all move in the same direction. Hence, $d\mathrm{Q}^m{}_1(K^m,L^m) / dK^m < 0$.

Proof. Consider (51). Along any perfect-foresight path, F(·) is constant. For given K^n, F(·) is increasing in K^m and decreasing in L^m. Also, for given K^m/L^m, F(·) is decreasing in K^m, or equivalently L^m. **QED**.

Proposition 7. Along any perfect-foresight path, for given K^m, $dQ^n / dK^n > 0 > dp^n / dK^n$. That is, the nontradable capital stock and output move in the opposite direction as the price of nontradables.

Proof. For given K^m, let K^n increase. There are two possibilities: (i) L^n does not decrease. Then Q^n increases. By Proposition 4, p^n decreases. (ii) L^n decreases. Then L^m increases. Hence, $\mathrm{Q}^n{}_2(K^n,L^n)$ increases, while $\mathrm{Q}^m{}_2(K^m,L^m)$ decreases. By (20), p^n decreases. By Proposition 4, Q^n decreases. **QED**.

Proposition 8. Along any perfect-foresight path, for given K^m, $d(K^n/L^n) / dK^n > 0$. That is, the nontradable capital stock and capital-labor ratio move in the same direction. Hence, $d\mathrm{Q}^n{}_1(K^n,L^n) / dK^n < 0$.

Proof. Consider (51). Along any perfect-foresight path, F(·) is constant. For given K^m, F(·) is increasing in L^n. Also, for given K^n/L^n, F(·) is increasing in K^n and L^n. **QED**.

By (50) and Proposition 6, for given K^n, all along the $\dot{q}^m = 0$ locus, $dq^m / dK^m < 0$. By (50), Proposition 7, and Proposition 8, for given K^m, all along the $\dot{q}^n = 0$ locus, $dq^n / dK^n < 0$. Hence, for each sector, *and for a constant capital stock in the other sector*, the dynamics of investment and capital are as shown in Figure 1. Each sector *i* in isolation displays saddle-point stability. If $K^i < K^i*$, then q^i exceeds unity and net investment is positive. Over time, the capital stock, q^i, net investment, and output all converge monotonically to their stationary-state values.

If all labor is immobile across sectors, then the two sectors and their phase diagrams are in fact independent. Labor mobility, however, introduces both intra- and inter-temporal linkages across sectors. First, if an unanticipated shock induces a sectoral reallocation of labor, either or both $\dot{q} = 0$ loci may shift. Second, and more awkward, any future change in the capital stock of either sector may induce a future sectoral reallocation of labor. In turn, this may shift the other sector's *future* $\dot{q} = 0$ locus. This event would be anticipated by rational agents, and would therefore affect the other sector's (current) saddle-path. We now investigate further this intertemporal linkage.

Proposition 9. Along any perfect-foresight path, for given K^m, sign $[dQ^m{}_1(K^m,L^m) / dK^n]$ = sign (dL^m / dK^n) = sign $[Q^n{}_1(K^n,L^n)\, Q^n{}_2(K^n,L^n) - Q^n(K^n,L^n)\, Q^n{}_{12}(K^n,L^n)]$.

Proof. Consider (51). Along any perfect-foresight path, F(·) is constant. For given K^m, F(·) is decreasing in L^m.

Also, sign (dF / dK^n)= sign $\{d[Q^n(K^n,L^n) / Q^n{}_2(K^n,L^n)] / dK^n\}$

$$\equiv \text{sign}\,[Q^n{}_1(K^n,L^n)\, Q^n{}_2(K^n,L^n) - Q^n(K^n,L^n)\, Q^n{}_{12}(K^n,L^n)]. \quad \textbf{QED}. \qquad \textbf{(52)}$$

Proposition 10. Along any perfect-foresight path, for given K^n, $dL^n / dK^m < 0$, $dQ^n{}_1(K^n,L^n) / dK^m < 0$, $dp^n / dK^m > 0$, sign $\{d[p^n\, Q^n{}_1(K^n,L^n)] / dK^m\}$ = sign $[Q^n{}_1(K^n,L^n)\, Q^n{}_2(K^n,L^n) - Q^n(K^n,L^n)\, Q^n{}_{12}(K^n,L^n)]$.

Proof. By Proposition 6, along any perfect-foresight path, for given K^n, $dL^m / dK^m > 0$. Hence, (i) $dQ^n{}_1(K^n,L^n) / dK^m < 0$. (ii) $dQ^n / dK^m < 0$. By Proposition 4, $dp^n / dK^m > 0$.

Further, by (20) and (51),

$$p^n\, Q^n{}_1(K^n,L^n) = F(\cdot)\, Q^n{}_1(K^n,L^n) / Q^n(K^n,L^n), \qquad \textbf{(53)}$$

where, along any perfect-foresight path, F(·) is constant. Since $dL^m / dK^m > 0$,

$$\text{sign}\,\{d[p^n\, Q^n{}_1(K^n,L^n)] / dK^m\} = \text{sign}\,\{d[Q^n{}_1(K^n,L^n)/Q^n(K^n,L^n)] / dL^m\}$$

$$\equiv \text{sign}\,[Q^n{}_1(K^n,L^n)\, Q^n{}_2(K^n,L^n) - Q^n(K^n,L^n)\, Q^n{}_{12}(K^n,L^n)]. \quad \textbf{QED}. \qquad \textbf{(54)}$$

Proposition 11. Let $Q^n(K^n,L^n) = F(K^n,L^n)^\beta$, where F is linear homogeneous and $\beta \in (0,1)$. Let σ be the local elasticity of substitution between capital and labor. Then sign $[Q^n{}_1(K^n,L^n)Q^n{}_2(K^n,L^n) - Q^n(K^n,L^n)\, Q^n{}_{12}(K^n,L^n)]$ = sign $(\sigma - 1)$.

Proof. Let $Q(K,L) = F(K,L)^{\beta}$, where $\beta \in (0,1)$. Then

$$Q_K Q_L - Q Q_{KL} = \beta F^{2(\beta-1)} (F_K F_L - F F_{KL}) \quad (55)$$

$$\Rightarrow \quad \text{sign}(Q_K Q_L - Q Q_{KL}) = \text{sign}(F_K F_L - F F_{KL}). \quad (56)$$

Also, $$\sigma \equiv -[\partial(K/L) / \partial(Q_K/Q_L)] [(Q_K/Q_L) / (K/L)] \quad (57)$$

$$= -[d(K/L) / d(F_K/F_L)] [(F_K/F_L) / (K/L)]. \quad (58)$$

Let $k \equiv K / L$. If F is linear homogeneous,

$$F(K,L) = L\, F(K/L,1) \equiv L\, f(k) \quad (59)$$

$$\Rightarrow \quad F_K(K,L) = f'(k), \;\; F_L(K,L) = f(k) - k f'(k), \;\; F_{KL}(K,L) = -f''(k)\, k / L. \quad (60)$$

Hence, $$d(F_K/F_L) / d(K/L) = f(k) f''(k) / [f(k) - k f'(k)]^2 \quad (61)$$

$$\Rightarrow \quad \sigma - 1 = (F_K F_L - F F_{KL}) / (F F_{KL}) \quad (62)$$

$$\Rightarrow \quad \text{sign}(\sigma - 1) = \text{sign}(F_K F_L - F F_{KL}). \quad (63)$$ **QED.**

By (50), Proposition 9, and Proposition 11, the impact of a change in K^n on the $\dot{q}^m = 0$ locus is ambiguous, but vanishes if the nontradable production function is Cobb-Douglas. Intuitively, an increase in nontradable capital has two effects. First, it increases the marginal product of nontradable labor. Second, it increases the output of nontradables, and hence reduces their price. The impact on the *value* marginal product of nontradable labor is in general ambiguous. It depends negatively both on the elasticity of substitution between capital and labor in nontradable production, and on the elasticity of substitution between importables and nontradables in consumption. If these elasticities equal unity, the two effects cancel out. If instead the impact is positive, labor is pulled away from importables, which reduces the value marginal product of importable capital and discourages importable investment.

By (50), Proposition 10, and Proposition 11, the impact of a change in K^m on the $\dot{q}^n = 0$ locus is ambiguous, but vanishes if the nontradable production function is Cobb-Douglas. Intuitively, an increase in importable capital increases the value marginal product of importable labor, and hence pulls labor away from the nontradable sector. In turn, this has two effects. First, it reduces the marginal product of nontradable capital. Second, it reduces the output of nontradables, and hence increases their price. The overall impact on the *value* marginal product of nontradable capital is in general ambiguous. It depends positively on the elasticity of substitution between capital and labor in nontradable production, and negatively on the elasticity of substitution between importables and nontradables in consumption. If these elasticities equal unity, the two effects cancel out. If instead the impact is positive, nontradable investment is encouraged.

Hence, if the nontradable production function is Cobb-Douglas, future changes in the capital stock of either sector do not affect the other sector's saddle-path, so that we may ignore the intertemporal linkage across sectors. We focus on this case to ease the graphical exposition.

iii. Natural-Resource Booms and Preference Shocks

We now use (49) and (50) to analyze the impact of natural-resource booms and preference shocks. Assume that the economy is initially in stationary state. Let there be a discrete increase in R or an increase in α, that is, a previously unanticipated (current or future) natural-resource boom, or a shift in tastes towards nontradables.

Proposition 12. Upon impact, the relative price of nontradables p^n, the share of labor employed in nontradables L^n, and nontradable output Q^n increase discretely, whereas importable output Q^m decreases discretely.

Proof. Assume that p^n does not increase discretely. For given L^n, the $dq^n / dt = 0$ locus does not shift up, and the $dq^m / dt = 0$ locus does not change. Further, by (20), L^n does not increase discretely. Hence, the $dq^n / dt = 0$ locus does not shift up, the $dq^m / dt = 0$ locus does not shift down, Q^n does not increase discretely, and Q^m does not decrease discretely. Hence, q^n, $J^n - \delta K^n$, and K^n do not increase at any point in time, while q^m, $J^m - \delta K^m$, and K^m do not decrease at any point in time. By definition, optimal changes in J^m cannot act to decrease the L.H.S. of (12); by Proposition 10, they cannot act to decrease $\int_t^\infty e^{-r(s-t)} [Q^m(s) - I(s)]\, ds$. By Proposition 5, $\int_t^\infty e^{-r(s-t)} [Q^m(s) - I(s)]\, ds$ does not decrease discretely. By (19), if R has increased, then C^m increases discretely, whereas if α has increased, then C^m does not decrease discretely. Hence, $[\alpha/(1-\alpha)]\, C^m$ increases discretely. By (15), C^n increases discretely. By (14), C^n cannot increase discretely. Contradiction. Hence, p^n increases discretely. By (20), L^n increases discretely. Hence, Q^n increases discretely and Q^m decreases discretely. **QED**.

Proposition 13. In the new stationary state, the relative price of nontradables and the importable capital-labor ratio exceed their pre-shock value.

Proof. As discussed above, in the new stationary state, K^m is lower and K^n higher than their pre-shock values. Use (20) and (44). **QED**.

The response of aggregate investment and the aggregate capital stock is in general ambiguous. Consider again the two special cases discussed in Section (ii) above. First, assume that the importable and nontradable sectors only compete for inputs that are in fact available on the world market at a fixed price. Formally, let all labor be sector-specific. Upon impact, the price of nontradables again increases discretely, encouraging nontradable investment. However, importable employment, investment, and output are now unaffected.[40] Hence, both nontradable *and* aggregate investment increase discretely, and at all future dates are higher than in the absence of the shock.

Second, assume that all factors are mobile across sectors. Formally, let each production function be linear homogeneous in capital and labor alone. Then, the stationary-state capital-labor ratios

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[40] Even if labor is mobile, importable investment is unaffected so long as the sectoral allocation of labor does not change the marginal product of importable capital. But in this case importable employment and output decrease.

in both sectors are uniquely determined by $(r + \delta)$. Hence, if nontradables are relatively capital-intensive (labor-intensive), the aggregate stationary-state capital stock increases (decreases). In turn, this implies an increase (decrease) both in 'average' investment during the transition, and in stationary-state investment.

Finally, note that if the shock is large enough, the capital stock and employment in the importable sector are driven to zero, i.e., the importable sector becomes inactive. Then, any further shocks *must* increase aggregate investment. We now return to the general case.

Proposition 14. If R increases, then C^m increases, but by less than R. If α increases, then C^m decreases.

Proof. (i) Let R increase. By Proposition 12, upon impact, p^nQ^n increases discretely. By (14), p^nC^n increases discretely. By (15), C^m increases discretely. (ii) Let R or α increase. As argued above, J^n increases at all points in time. By Proposition 12, upon impact, L^m and hence Q^m decrease discretely. These responses acts to decrease $\int_t^\infty e^{-r(s-t)} [Q^m(s) - I(s)]\, ds$. If agents were behaving optimally before the shock, the decline is moderated, but cannot be reversed, by the induced reductions in I^m, L^m, and Q^m. By (19), C^m decreases relative to R. **QED**.

Data Description and Sources; Omitted-Variable Bias

A. Data Description and Sources

We consider the period 1965–1989. Our sample consists of the following 18 oil-exporting countries: Algeria, Bahrain, Congo, Ecuador, Egypt, Gabon, Indonesia, Iran, Iraq, Kuwait, Mexico, Nigeria, Oman, Saudi Arabia, Syria, Trinidad and Tobago, United Arab Emirates, and Venezuela.

For all countries, fuels accounted for over 50 percent of total exports over at least half the sample period; for most countries, fuels accounted for over 70 percent of total exports over at least three-quarters of the sample period. We use annual data on the following variables:

1. Terms of Trade (TOT), computed as Merchandise Exports Deflator US Dollar (USD) / Merchandise Imports Deflator USD, base 1987 = 1.0.

2. Trade Ratio (TR), computed as [(Exports + Imports) / 2 GDP]. All the underlying variables are measured at current market prices, Local Currency Unit (LCU).

3. A Debt Crisis dummy (DEBT), set to unity for Ecuador, Mexico, Nigeria and Venezuela over 1982–1989, and to zero in all other cases.

4. World Real Interest Rate (INTEREST RATE), as computed by Barro and Sala-i-Martin. We also experimented with alternative measures based on LIBOR rates.

5. An OPEC membership dummy (OPEC). The members of OPEC, and their year of accession, are as follows. 1961: Iran, Iraq, Kuwait, Saudi Arabia, Venezuela; Qatar. 1962: Indonesia, Libya. 1967: Abu Dhabi (later United Arab Emirates). 1969: Algeria. 1971: Nigeria. 1973: Ecuador. 1975: Gabon.

6. The Real Exchange Rate, or relative price of tradables to nontradables. This is computed as USA WPI USD / local CPI USD, index 1987. We also experimented with an alternative measure, computed as USA GDP deflator USD / local GDP deflator USD, index 1987.

7. Gross Domestic Product (GDP), constant 1987 market prices, LCU.

8. Gross National Product (GNP), constant 1987 market prices, LCU.

9. Consumption, constant 1987 prices, LCU.

10. Private Consumption, constant 1987 prices, LCU.

11. General Government Consumption, constant 1987 prices, LCU.

12. Gross Domestic Savings, constant 1987 prices, LCU.

13. Fixed Investment, constant 1987 prices, LCU.

14. Private Fixed Investment, constant 1987 prices, LCU.

15. General Government Fixed Investment, constant 1987 prices, LCU.

16. Balance of Merchandise Trade, constant 1987 prices, LCU.

17. Value added in the Oil Sector, constant prices, LCU.

18. Value added in the Non-Oil Sector, constant prices, LCU.

19. Value added in Agriculture, constant prices, LCU.

20. Value added in Manufacturing, constant prices, LCU.

21. Value added in Construction, constant prices, LCU.

22. Value added in Public Utilities, constant prices, LCU.

23. Value added in Services, constant prices, LCU.

24. Value added in Transportation and Communications, constant prices, LCU.

25. Value added in Wholesale and Retail Trade, constant prices, LCU.

26. Value added in Other Services, constant prices, LCU.

27. Total Labor Force.

Variables 7–26 were transformed into per worker values using variable 27.

Variables 1, 2, 6–16 and 27 were taken from the World Bank's DAD database, and variables 3–5 are as described above. They are available for all countries for the whole period. Exception: Mexico's terms of trade were obtained from the Mexican central bank, and are not available for 1965.

Variables 19, 20 and 23 were taken from the World Bank's World Data tables, and all other variables came from World Bank Country Economic Memoranda. They were not available for Iraq, nor before 1969.

In all cases, the ultimate sources are national central banks, national statistical services, and estimates by World Bank missions.

B. Omitted Variable Bias

For any given variable x and country i, define the mean over time and the deviations from the country mean, respectively, as

$$\bar{x}_i = \frac{1}{T}\sum_{t=1}^{T} x_{it}, \quad \hat{x}_{it} = x_{it} - \bar{x}_i. \tag{64}$$

Re-written in terms of deviation data, (26) becomes

$$\hat{y}_{it} = \beta \, \overline{TR_i} \, \hat{TOT}_{it} + \varepsilon_{it}, \tag{65}$$

where, for notational simplicity, we suppress the logarithmic transformation, and ignore any included lags and controls. Let the true model be instead

$$\hat{y}_{it} = \beta \, \overline{TR_i} \, \hat{TOT}_{it} + \gamma \, \widehat{OMITTED}_{it} + \varepsilon_{it}. \tag{66}$$

If (65) is estimated by OLS for each country i, the bias b_i in our estimator of β, treating the regressors as fixed, is

$$b_i = \frac{\sum_{t=1}^{T}\left(\overline{TR_i} \, \hat{TOT}_{it} \;\; \gamma \, \widehat{OMITTED}_{it}\right)}{\sum_{t=1}^{T}\left(\overline{TR_i} \, \hat{TOT}_{it}\right)^2}. \tag{67}$$

Hence, a necessary and sufficient condition for consistency of the country-by-country OLS estimates of β is that, asymptotically, the terms of trade be orthogonal to any omitted variables:

$$\operatorname*{plim}_{T\to\infty} \; b_i = 0. \tag{A1}$$

Now say that (65) is estimated in a panel context. The bias b in our estimator of β is then

$$b = \frac{\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\overline{TR_i} \, \hat{TOT}_{it} \;\; \gamma \, \widehat{OMITTED}_{it}\right)}{\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\overline{TR_i} \, \hat{TOT}_{it}\right)^2}$$

$$= \sum_{i=1}^{N} a_i b_i, \quad a_i \equiv \frac{\sum_{t=1}^{T}\left(\overline{TR_i} \, \hat{TOT}_{it}\right)^2}{\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\overline{TR_i} \, \hat{TOT}_{it}\right)^2}. \tag{68}$$

Hence, a necessary and sufficient condition for consistency of the panel estimates of β is that, asymptotically, a weighted average of the country-specific biases be zero:

$$\operatorname*{plim}_{NT\to\infty} \sum_{i=1}^{N} a_i \, b_i = 0 . \qquad \textbf{(A2)}$$

For any given set (or sequence) of weights, a_i, (A1) implies (A2) but not the reverse: there are many ways for (A2) to be satisfied without any of the countries individually satisfying (A1).

SUMMARY OF PANEL REGRESSIONS

Table 1. Panel Regression: $\ln y_{it} = \alpha_i + \beta(L)\ \overline{TR_i}\ \ln TOT_{it} + \gamma CONTROL_{it} + \varepsilon_{it},\ t = 1965–89$. $\beta(L)$ is constant across sub-periods and countries.

Dependent Variable	Terms-of-Trade Sum of Coeff.	Terms-of-Trade T-statistic	Terms-of-Trade Sum of Beta Coeff.	R^2	NT
Real Exchange Rate	-1.391	-18.005	-.819	.5564	414
Consumption	.4505	6.84	.3874	.3735	414
Private Consumption	.3552	5.132	.3123	.2762	414
Government Consumption	.5164	6.037	.3382	.3788	414
Savings	-.4309	-3.449	-.2706	.2226	360
Investment	.8710	6.268	.3975	.1493	414
Private Investment	.9952	4.733	.3025	.1095	414
Government Investment	.9760	6.453	.4096	.1545	414
Trade Balance	-.9634	-8.418	-.3758	.1627	432
GDP	-.1711	-1.714	-.1580	.1224	360
Oil Value Added	-.9575	-6.103	-.7192	.5886	177
Non-Oil Value Added	.3479	5.020	.4454	.5722	175
Agriculture	.04193	1.076	.0627	.0838	277
Manufacturing	.0399	0.676	.0428	.1171	228
Construction	.4983	4.408	.2765	.3010	190
Public Utilities	.0127	.169	.0088	.6405	156
Services	.1354	3.271	.1873	.1146	277
Transportation	-.0497	-0.549	-.0279	.5823	173
Trade	.1224	1.559	.0984	.4601	155
Other Services	.3012	4.696	.3832	.3957	173

Observed values for savings, the trade balance, and oil-sector value added are occasionally negative. Hence, we transform these variables into country-specific indices, and run the regressions in levels rather than logs. The control variables include DEBT, INTEREST RATE, and a linear time trend. Prior to estimation, all variables are quasi-differenced using the Prais-Winsten procedure. "Beta" denotes the beta coefficients, that is, the regression coefficients normalized by the ratio of the standard deviation of the regressor to the standard deviation of the dependent variable.

Table 2. Panel Regression: $\ln y_{it} = \alpha_i + \beta_{P(t)}(L)\ \overline{TR_i}\ \ln TOT_{it} + \gamma\ CONTROL_{it} + \varepsilon_{it}$. β(L) is unconstrained across the two sub-periods, 1965–80 and 1981–89.

Dependent Variable	Terms-of-Trade Sum of Coeff. 1965–80	Terms-of-Trade Sum of Coeff. 1981–89	P-value for Coeff. Stability	R^2	NT
Real Exchange Rate	-1.359	-.9255	0	.5969	432
Consumption	.3478	.6279	.05	.3796	414
Private Consumption	.1372	.2535	.17	.2239	432
Government Consumption	.2905	.8869	.001	.3821	414
Savings	-.1377	-.4060	.056	.2250	378
Investment	.6532	1.285	.039	.1575	414
Private Investment	.8185	1.356	.236	.1118	414
Government Investment	.6242	1.680	.002	.1767	414
Trade Balance	-.8622	-1.045	.042	.1702	432
GDP	-.1451	.0276	.402	.1735	378
Oil Value Added	-.1793	-.2375	.29	.2541	177
Non-Oil Value Added	.2733	.6053	.024	.5783	175
Agriculture	.0544	.0272	.641	.0867	277
Manufacturing	.01191	.0891	.419	.1226	228
Construction	.4300	.7055	.118	.3207	190
Public Utilities	-.0243	.1978	.049	.6515	156
Services	.0804	.2033	.052	.1264	277
Transportation	-.1195	.1599	.055	.5948	173
Trade	.1177	.1388	.826	.4530	155
Other Services	.2321	.4881	.054	.4187	173

Observed values for savings, the trade balance, and oil-sector value added are occasionally negative. Hence, we transform these variables into country-specific indices, and run the regressions in levels rather than logs. The control variables include DEBT, INTEREST RATE, and a linear time trend. Prior to estimation, all variables are quasi-differenced using the Prais-Winsten procedure. The P-value denotes the minimum significance level at which the F-test rejects the null hypothesis that the long-run elasticity with respect to the terms of trade is constant across sub-periods.

Table 3. Share of Capital Goods in Total Imports in 1973, 1981, and 1989.

Country	Share of capital goods in total imports in:		
	1973	1981	1989
Algeria	0.3720	0.3834	0.2570
Congo	0.3868	0.3874	0.3620
Ecuador	0.4117	0.4582	0.3397
Egypt	0.2477	0.2816	0.2303
Gabon	0.4066	0.4094	0.4009
Indonesia	0.4104	0.3536	0.3774
Iran	0.3779	0.2832	0.3884
Iraq	0.3297	0.5328	0.4478
Kuwait	0.3442	0.4103	0.2961
Mexico	0.4438	0.4707	0.3260
Nigeria	0.4012	0.4402	0.3812
Oman	0.3101	0.3908	0.3685
Saudi Arabia	0.3524	0.4047	0.3870
Syria	0.2369	0.2171	0.2592
Trinidad and Tobago	0.1313	0.2242	0.2729
United Arab Emirates	0.3801	0.3568	0.3025
Venezuela	0.4688	0.4344	0.4682

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