Capital Markets and Computable General Equilibrium Models: Comparative Statics Without Apology?

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Observing that many computable general equilibrium (CGE) models differ in their assumption about capital mobility, this paper examines the implications for policy simulations of the same CGE model under alternative assumptions about the capital market. Specifically, we take a typical CGE model of a developing country (Cameroon) and compare outcomes assuming no capital mobility with those when capital is perfectly mobile across sectors.

Two generic experiements—an increase in foreign savings ("the Dutch disease") and elimination of import tariffs—yield similar conclusions: The outcomes of policy simulations are broadly similar in the short-run (no capital mobility) and the long-run (perfect mobility). When they differ, the price changes are damped and quantity changes accented in the long run compared with the short run. This can be explained by the fact that supply curves are more elastic in the long-run. In some cases, this pattern is broken, due to the particular nature of the sector. We conclude that, while decisions on modeling the capital market should be based on the nature of the market and the relevant time-horizon, this decision is not crucial, as long as care is taken in interpreting the results.

1. INTRODUCTION

The last decade has witnessed a proliferation of computable general equilibrium (CGE) models of both industrialized and developing economies. Although they have many features in common, the industrialized country (IC) models can be distinguished from their developing country (DC) counterparts in at least one way: their treatment of the capital market. Typically, the IC models (for example, Johansen (1960, 1974), Dixon et al. (1977), or Shoven and Whalley (1984)) assume that capital, like labor, is perfectly mobile across sectors. By contrast,

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most DC models (for example, Dervis et al. (1982)) take capital to be fixed and sector specific, with labor the only variable factor of production.

Neither approach can be regarded as anything more than a crude, but in each case justifiable, approximation of how capital markets really work. In developing countries, these markets tend to be extremely thin—if they exist at all—and hence the assumption that capital flows to equalize its rate of return across sectors is difficult to corroborate. Moreover, even if financial markets did exist, the lower levels of education and training in developing countries would make the adjustment costs of adopting new technologies prohibitive. At the same time, one could argue that these are primarily short-term phenomena: if the discrepancies in the sectoral returns to capital were wide enough, and they persisted long enough, the barriers to mobility would be overcome and capital would flow to equalize rates of return. Thus, there is a possibility that CGE models of developing countries leave out an important part of the story in that the long-term effect of an exogenous shock may be quite different from the short-term one that is being portrayed.

Precisely the same argument, but now in reverse, can be made for CGE models of developed countries. The perfect malleability of capital normally assumed here may exaggerate the short-term structural changes arising from exogenous shocks.[1] Imperfect capital markets, differences in short- and long-run production technologies, and barriers to entry and exit will significantly reduce the mobility of capital. This could, in turn, lead to the actual outcomes of external shocks and policy changes diverging from those predicted by CGE models of developed countries.

The purpose of this paper is to investigate more closely the relationship between the "short-term" impact of an exogenous shock (no capital mobility) and the "long-term" one (perfect capital mobility). In a sense, both DC and IC models are misleading in that they focus solely on one of the two, whereas clearly both are important in evaluating the impact of, for example, a policy change. We take a typical CGE model of a developing country (Cameroon) and compare the outcomes of various experiments on the sectoral pattern of outputs, prices, imports, and exports in the short and long runs. Our major conclusion is that the numerical value of the solutions do differ but the qualitative nature of the results remains unchanged. In general, the

[1]Johansen (1974), among others, has made this point.

response of prices is less and that of outputs is greater in the long run than in the short run. Rarely does a sign reversal occur, and when it does it can be anticipated by the structure of the sector and the nature of the experiment.

In short, the assumption of fixed, sector-specific capital typical of DC models, and that of perfect malleability of IC models, can be made without apology. The focus on, respectively, short- and long-term effects is a justifiable approximation, especially considering that the alternative would require modeling the dynamics of the capital market, namely, the transition between the short and long runs.

The issue treated in this paper has been addressed from a theoretical viewpoint by Neary (1978), who looked at the implications of capital specificity in a two-sector model in the Heckscher-Ohlin-Samuelson tradition. Fullerton (1983) used an IC model to look at how restrictions on capital mobility reduce the welfare gains from reforming the U.S. corporate income tax. He concluded that transition losses in sectors that cannot disinvest reduce the welfare gains from the perfect mobility case. We will see a similar effect at play here; however, our focus is on the sectoral reallocation and not on welfare effects. Higgs (1986) examined the influence of capital mobility on the Australian agricultural sector. As we will show, his treatment of investment in this context is quite different from ours.

The plan of the paper is as follows. In Section 2 we present a simple two-sector version of the Cameroon CGE model. Analytical solution of this model highlights the relevant aspects of the capital market and helps us to interpret the results of the 11-sector model that follow; the section concludes with a description of the 11-sector model. In Section 3 we describe the results of our experiments with the Cameroon CGE model with and without capital mobility and interpret them. Section 4 contains our concluding remarks.

One issue that needs to be clarified before proceeding is our choice of experiments. CGE models are subjected to innumerable experiments, and we cannot reproduce all of them. We have chosen two classes of experiments that are more or less generic and for which the assumption of capital mobility may be crucial. The first is an increase in foreign capital inflow into the economy. The original Cameroon model was built to study the effects of increased foreign earnings (from oil) on the economy, so this experiment is in that spirit. Moreover, a large number of papers on CGE models of developing countries have the question of an increase or decrease in foreign inflows as their central theme. An increase represents countries reacting to a windfall (the "Dutch disease"), whereas a decrease would reflect an economy having to meet debt-service payments. In addition, to the extent that this shift in foreign inflows alters the pattern of sectoral output between tradables and nontradables, the assumption of fixed, sector-specific capital may be an important one.

The second class of experiments has to do with tariff reform. Inside a small open economy, perfect capital mobility should lead to specialization, with several domestic sectors ceasing to operate. However, import tariffs may provide sufficient protection to permit some of these sectors to continue operating. An experiment in which these tariff barriers are removed will shed light on whether it was these tariffs, or other aspects of the economy, that prevented full specialization from taking place. Furthermore, tariff reform is another favorite experiment among CGE modelers, for it encompasses all the general equilibrium effects that CGE models were designed to capture.

2. CGE MODELS WITH AND WITHOUT CAPITAL MOBILITY

2A. A Two-Sector Model

We begin by presenting a simple two-sector model that captures the essential features of the 11-sector CGE model of Cameroon. By solving the two-sector model analytically with and without capital mobility, we can ascertain which factors may cause results from the two versions to diverge. We do this for the Dutch disease experiment only. We compare the sector-specific capital model with one in which the total capital stock is fixed but intersectorally mobile.

Consider, therefore, the following model. There are two sectors labeled 1 and 2. Sector 1 is tradable and 2 nontradable. Both sectors' output is produced by Cobb-Douglas production functions using labor and capital only:

$$X_1 = L_1^{\alpha} K_1^{1-\alpha} \tag{A1}$$

$$X_2 = L_2^{\beta} K_2^{1-\beta} \tag{A2}$$

Each factor is paid its marginal product in each sector:

$$P_1 \alpha L_1^{\alpha-1} K_1^{1-\alpha} = P_2 \beta L_2^{\beta-1} K_2^{1-\beta} \tag{A3}$$

$$P_1 (1-\alpha) L_1^{\alpha} K_1^{-\alpha} = P_2 (1-\beta) L_2^{\beta} K_2^{-\beta}. \tag{A4}$$

There is full employment of both factors:

$$L_1 + L_2 = \bar{L} \tag{A5}$$

$$K_1 + K_2 = \bar{K}. \tag{A6}$$

The single household in this economy consumes the output of sector 2 and imports M. Its relative demand for these two goods is determinmed by a Constant Elasticity of Substitution (CES) utility function, giving rise to the following demand function:

$$X_2/M = k(P^*/P_2)^{\sigma} \qquad \text{(A7)}$$

where P^* is the (exogenous) price of the imported good. All the output of sector 1 is exported, so the balance of trade is given by

$$P_1X_1 + F = P^*M. \qquad \text{(A8)}$$

Because this is a small open economy, we take the price of good 1 as parametrically given (by the world price). Furthermore, we assume that F, the trade deficit, is fixed exogenously. Indeed, we will perform a comparative static simulation with a change in F.

With immobile capital, we would replace equations (A4) and (A6) with $K_i = \overline{K}_i$ $(i = 1,2)$.[2]

To obtain analytical solutions, the above system can be log-differentiated as follows: let lowercase letters represent the percentage change of the uppercase variable (e.g., $x = dX/X$).

$$x_1 = \alpha l_1 + (1-\alpha)k_1 \qquad \text{(A1')}$$

$$x_2 = \beta l_2 + (1-\beta)k_2 \qquad \text{(A2')}$$

$$(\alpha-1)l_1 + (1-\alpha)k_1 = (\beta-1)l_2 + (1-\beta)k_2 \qquad \text{(A3')}$$

$$\alpha l_1 - \alpha k_1 = p_2 + \beta l_2 - \beta k_2 \qquad \text{(A4')}$$

$$\lambda l_1 + (1-\lambda)l_2 = 0 \qquad \text{(A5')}$$

$$\mu k_1 + (1-\mu)k_2 = 0 \qquad \text{(A6')}$$

$$x_2 - m = \sigma(p^* - p_2) \qquad \text{(A7')}$$

$$\gamma x_1 + (1-\gamma)f = m \qquad \text{(A8')}$$

where $\lambda = L_1/\overline{L}$, $\mu = K_1/\overline{K}$, and $\gamma = P_1X_1/P^*M$. With immobile capital, $k_i = 0$ $(i = 1,2)$ and equations (A4′) and (A6′) would be dropped.

Consider first the case of immobile capital. Simple manipulation of (A1′)–(A5′) yields

[2]One might argue that in the long run the other elasticities in the system (particularly σ) would also be higher. The Armington assumption (A7) is a reduced-form expression of an observed, but not well-understood phenomenon, namely, intraindustry trade. To the extent that this arises from structural factors like consumer preferences and increasing returns to scale (which is precluded from the present model anyway), we can imagine that these factors may be dissipated over time. Since we are interested in the capital market, we abstract from this possibility in distinguishing between the short and long runs.

$$x_1 = \Phi p_2 \qquad \text{where } \Phi = -\alpha(1-\lambda)/[\lambda(1-\beta) + 1-\alpha] < 0 \tag{A9}$$

$$x_2 = \Omega p_2 \qquad \text{where } \Omega = \beta\lambda/[\lambda(1-\beta) + 1-\alpha] > 0. \tag{A10}$$

The parameters Φ and Ω may be interpreted as the (general equilibrium) elasticities of supply of goods 1 and 2, respectively. Solving for the remaining equations (the "demand side"), we obtain

$$p_2 = \frac{1-\gamma}{\Omega - \gamma\Phi + \sigma} f. \tag{A11}$$

Since $0 < \gamma < 1$, the relationship between p_2 and f is unambiguously positive. An increase in the foreign capital inflow ($f > 0$) is associated with appreciation of the real exchange rate ($p_2 > 0$).

From equations (A9) and (A10) it follows that an injection of foreign capital will lead to a decline in the tradable sector (1) and an expansion in the nontradable sector (2). If the foreign capital inflow is interpreted as oil revenues, then this is nothing more than the Dutch disease.

The intuition behind this result is straightforward. An increase in F widens the gap between expenditure (absorption) and income. This bids up the price of the nontraded goods in the system, including labor. Because sector 1's price is fixed by world prices, this leads to a contraction in labor demanded by this sector, and hence in output. Labor migrates to sector 2 (whose price is rising), raising output in that sector.

Can this result be reversed when mobile capital is introduced? That is, with mobile capital and labor, is it possible that sector 1 expands and sector 2 contracts for a given increase in F? The answer is no. Some algebraic manipulation reveals that the percentage changes in L_1 and K_1 associated with p_2 are given by

$$l_1 = \frac{-1}{(\alpha-\beta)\,[\lambda/(1-\lambda) - \mu/(1-\mu)\,]} p_2 \tag{A12}$$

$$k_1 = \frac{-1}{(1-\lambda)\,(\alpha-\beta)\,[\lambda/(1-\lambda) - \mu/(1-\mu)\,]} p_2. \tag{A13}$$

Thus, for a given increase in P_2, the impact on L_1 and K_1 depends inversely on the sign of

$$(\alpha - \beta)\,[\lambda/(1-\lambda) - \mu/(1-\mu)],$$

where $\lambda = L_1/\bar{L}$
and $\mu = K_1/\bar{K}$.

However, since $(\alpha - \beta)$ and $[\lambda/(1-\lambda) - \mu/(1-\mu)]$ will always be of the same sign (see below), it immediately follows that both L_1

and K_1 will shrink with the increase in P_2 that accompanies the rise in F. Therefore, sector 1's output will decline. This unambiguous result—namely, that factor intensities do not matter—cuts against the grain of the usual Heckscher-Ohlin trade models. The reason has to do with our choice of production technology. For Cobb-Douglas production functions, it is easy to show that

$$L_1/K_1 > L_2/K_2 \leftrightarrow \alpha > \beta \leftrightarrow \lambda/(1-\lambda) - \mu/(1-\mu) > 0.$$

and

$$L_1/K_1 < L_2/K_2 \leftrightarrow \alpha < \beta \leftrightarrow \lambda/(1-\lambda) - \mu/(1-\mu) < 0.$$

In sum, the traditional Dutch disease result is not reversed in this simple two-sector model by introducing capital mobility. An increase in F will lead to a decline in the traded goods sector (X_1) and an expansion of the nontraded sector (X_2) with *and* without capital mobility.

While the direction of the result is not reversed, its magnitude is amplified when capital mobility is introduced. From equations (A1), (A2), (A12), and (A13), the analogous supply elasticities in this case are

$$x_1 = \Phi' p_2 \tag{A14}$$

$$x_2 = \Omega' p_2 \tag{A15}$$

where

$$\Phi' = \frac{-[\alpha + (1-\lambda)(1-\alpha)]}{(1-\lambda)(\alpha-\beta)[\lambda/(1-\lambda) - \mu/(1-\mu)]} < 0$$

and

$$\Omega' = \frac{\beta\mu(1-\mu) + \lambda(1-\beta)}{(1-\lambda)(\alpha-\beta)[\lambda/(1-\lambda) - \mu/(1-\mu)]} > 0.$$

Again, some simple manipulation shows that if $\alpha > \beta$, both Φ' and Ω' are greater *in absolute value* than Φ and Ω. Thus, the introduction of capital mobility causes the Dutch disease effects—contraction of the tradables sector, expansion of nontradables—to be amplified. The intuition here is that, when oil revenues are spent domestically, the nontradables sector's price rises (because tradables' prices are fixed at world levels). The increased profitability of this sector attracts both labor and capital to it and away from the tradable sector. If capital were immobile, only labor will migrate, so that the output response will be less.

The argument for the nontradable sector can be summarized in a diagram (Figure 1). Let S^S and S^L represent, respectively, the short-

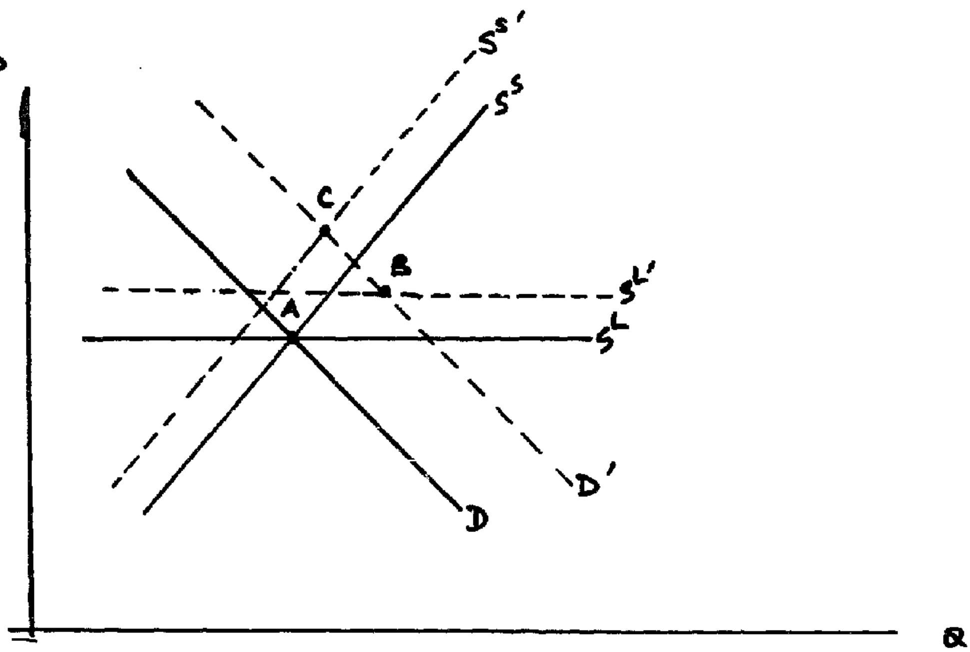

Figure 1. Partial equilibrium representation of the Dutch disease with and without mobility.

and long-run supply curves for sector 2. Note that, with constant returns to scale, the long-run supply curve is perfectly elastic. The initial equilibrium is A. The initial effect of the oil revenues is to push the demand curve D out. The increased demand for factors bids up their prices, causing the supply curves to shift to the left (in the case of S^L this translates to an upward shift). The short-run equilibrium is C and that of the long run is B. Note that the amplification of quantity changes and damping of price changes in the long run is unambiguous here.

The extension to the case of tariff reform is straightforward. Note that introducing tariffs affects equation (A7) only (the P^* in that equation is replaced by $P^*(1 + t)$, where t is the tariff rate). Thus, the entire "supply side" of the model is unaffected. Since our arguments above were based on looking just at this supply side, the same arguments go through for the tariff case.

Just as with the Dutch disease, the tariff reform case can be illustrated graphically (Figure 2). The demand curves for domestic goods shift in as imported goods become more attractive to consumers. The supply curves shift out as imported intermediate goods (and primary factors) become cheaper as result of the tariff elimination. Again, note that the long-run model accents the quantity shift and dampens the price shift vis-à-vis the short run.

Unlike the Dutch disease experiment, however, the *direction* of

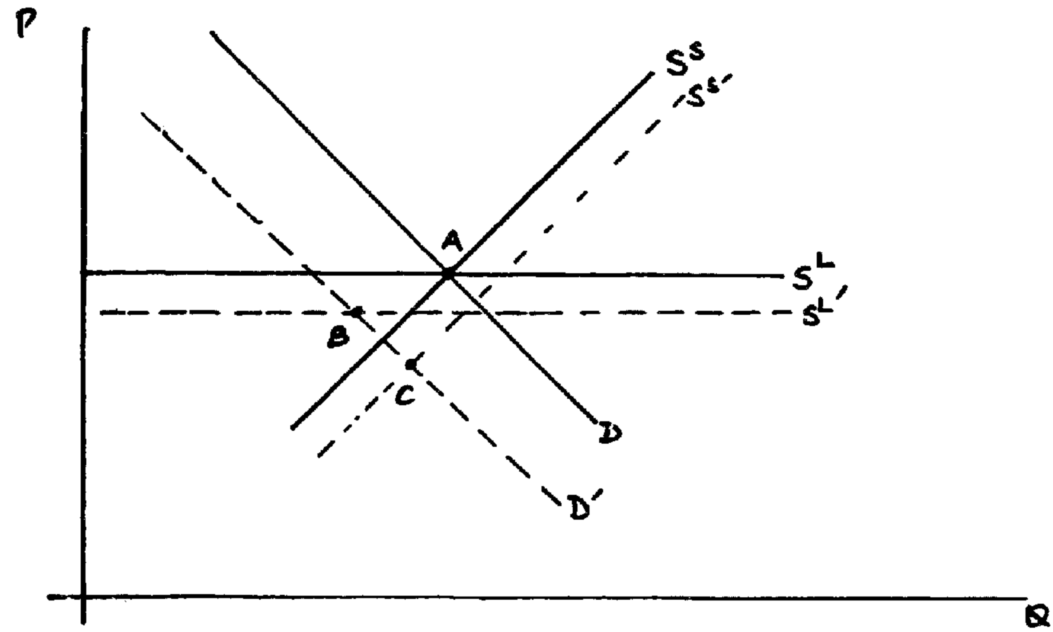

Figure 2. Partial equilibrium representation of the Dutch disease with and without tariff reduction.

change is ambiguous in this case. For goods that are strong substitutes with imports, the demand effect is strong enough to lead to a decrease in output. For goods that are not substitutable (exports and nontradables), the supply effect dominates and they register an increase in output. Nevertheless, whatever the direction of change, the relationship between the short and long runs established above still holds.

The results above depend crucially on, *inter alia*, our choice of Cobb-Douglas production functions and on the assumption of imperfect substitutability between domestic production and imports. While this may appear restrictive, it should be noted that a large class of CGE models (of both developing and industrialized countries) adopt this specification, and our two-sector model was meant to be representative of these higher-dimension models.

2B. The Multisector CGE Model

The CGE model that is used for the experiments that follow is essentially an eleven-sector version of the model in Section 2A. We first present the version with immobile capital and then show how it is modified to incorporate capital mobility.

The equations of the Cameroon model with fixed capital are given in Table 1. These are mainly extensions of the two-sector model of the previous section; however, a few additional points should be noted.

Table 1: Equations of the Cameroon CGE Model

I. Prices[a]

(1) $PM_i = \overline{PW}_i(1 + tm_i)\overline{ER}$

(2) $PE_i = \overline{PWE}_i(1 + te_i)\overline{ER}$

(3) $P_i = f(PD_i, PM_i)$

(4) $PS_i = S_i^e PE_i + (1 - S_i^e)PD_i$

(5) $PN_i = PS_i(1 - td_i) - \Sigma_j A_{ji} P_j$

II. Production and employment[b]

(6) $X_i^s = f(\overline{K}_i, L_{li}, \ldots, L_{mi})$

(7) $WL_k = PN_i(\delta X_i/\delta L_i)(\delta L_i/\delta L_{ki})/\gamma_{ki}$

(8) $A_{ji} = V_{ji}/X_i^s$

(9) $L_k^D = \Sigma_i L_{ki}$

(10) $L_k^D - \overline{L}_k^s = 0$

III. Foreign trade

(11) $E_i = g(\pi_i/PE_i)$

(12) $E_i/D_i = f(PE_i/PD_i)$

(13) $M_i/D_i = f(PD_i/PM_i)$

(14) $\Sigma\overline{PW}_i M_i - \Sigma\overline{PWE}_i E_i - \overline{F} = 0$

IV. Income and flow of funds; endogenous variables calculated

(15) GY: total government revenue

(16) Y_g: income of consuming groups

(17) TZ: total investment

(18) GC: total government consumption

(19) C_g: total consumption by consuming group

V. Product markets

(20) $ZD_i = \overline{SZ}_i TZ/\Sigma_j b_{ji} P_j$

(21) $Z_i = \Sigma_j b_{ji} ZD_j$

(22) $GC_i = \overline{SG}_i GC/P_i$

(23) $C_i = \overline{S}_i C/P_i$

(24) $V_i = \Sigma_j V_{ji}$

(25) $D_i = S_i^d(Z_i + GC_i + C_i + V_i)$

(26) $S_i^d = f(PD_i/PM_i)$

(27) $X_i^d = D_i + E_i$

(28) $X_i^D - X_i^s = 0$

[a]Endogenous variables: PM_i, domestic price of imports; PE_i, domestic price of exports; P_i, composite good price; PS_i, average price of domestic and export sales; PN_i, net price or value-added; PD_i, domestic price of domestic sales; S_i^e, export share in sectoral sales. Exogenous variables and functions: ER, exchange rate; tm_i, tariff rate; te_i, export-subsidy rate; td_i, indirect tax rate; A_{ji}, input–output coefficients; $f(-)$, equation (3), cost-function dual of the CES trade-aggregation function.

[b]Endogenous variables: X_i^s, sectoral production; L_{ki}, variable labor of category k in sector i.

First, in addition to assuming differentiation between imports and domestic goods in the same sector, we assume that exported and domestically consumed goods in the same sector are imperfect substitutes. This could be due to differences in quality or the difficulty of breaking into foreign markets for new exporters. Second, unlike the model in section 2A, the present model contains savings and investment. In the fixed-capital version, investment does not add to the capital stock in the short run, although investment goods are produced. This model is in the spirit of comparative statics analysis. In the alternative version, investment adds to the capital stock, which is akin to dynamic models. In both cases, the level of investment is equal to the level of savings, with the level of foreign savings (the current account deficit) specified exogenously.

2C. Modeling the Capital Market

The model just described represents the benchmark case, when capital is assumed to be sector specific and immobile. We now highlight the changes we make to this model to incorporate capital mobility.

The producer equilibrium of the Cameroon model can be summarized as follows:

$$X_i = f_i(\overline{K}_i, L_{1i}, L_{2i}, L_{3i}) \tag{C1}$$

$$PN_i \partial f_i / \partial L_{li} = \omega_{li} w_l \tag{C2}$$

$$\sum L_{li} = \overline{L}_l. \tag{C3}$$

where (C1) is the production function for sector i, with a given amount of sector-specific capital $\overline{K}_i$, (C2) the first-order condition for labor input, and (C3) says that total labor demand from all sectors must equal the given labor supply for each category of labor. We will henceforth refer to this as Model I. This formulation implies there is an upward-sloping marginal cost curve in each sector and that a pure economic rent will accrue to the fixed factor of production. Perhaps more important, the immobility of capital means this rent will increase or decrease in response to external shocks or policy changes.

In Model II, where capital is no longer sector specific, the producer equilibrium can be summarized as (C1)–(C3) and

$$PN_i \partial f_i / \partial K_{li} = P_i^K \tag{C4}$$

$$P_i^K = (\rho_i r + \delta_i) P_i^I \tag{C5}$$

$$\sum K_i = \overline{K}. \tag{C6}$$

The key difference here is that the given capital stock in the economy can now be shifted costlessly (and instantaneously) between sectors.

We introduce the user-cost of capital approach pioneered by Jorgensen (1963) to model the capital stock adjustment by sector. Equation (C4) sets the marginal product of capital equal to the price of a unit of capital services, P_i^K. Equation (C5) defines this service price as being proportional to the price of new investment goods, where the factor of proportionality is an annualized cost of these goods, namely, the gross rate of return to capital and the depreciation rate. Contrary to the original Jorgensen formulation, we assume that the gross rate of return to capital varies across sectors as multiples of the interest rate r. These multiples, ρ_i, which we assume are constant throughout, can be thought of as capturing differences in managerial skills and efficiency in utilizing capital equipment across sectors. This idea first originated in Johansen's (1960) initial work on the MultiSector Growth (MSG) model and is used in the present version of the MSG model with a formulation similar to the one above (see Forsund et al. 1985).

In the base case of Model II we calibrate the model to reproduce the same solution for prices and quantities as Model I. We do this by setting r arbitrarily at 7 percent and then calculating the ρ_is from the zero-profit condition:

$$PN_iX_i = \sum_l \omega_{li}w_lL_{li} + P_i^KK_i. \tag{C10}$$

This procedure means that whatever rent accrues to capital in Model I will also accrue in Model II when comparing base cases. If, however, a shock or policy change increases total demand for capital, this will put upward pressure on the interest rate, eliminating any extra pure rent relative to the base case. This model therefore ensures an efficient reallocation of the given capital stock as well in response to a shock.

Two things need to be noted about this model. The first is that we account for depreciation only as a component of income to/outlay on capital, whereas the logical counterpart of this, replacement investment due to wear and tear, is not accounted for. This has to do with the instantaneous nature of the model. Although we consider this to be a "long-run" model, there is no element of time pertaining to the mobility of capital. The second point to note is that this model distinguishes between old and new capital goods. Demand for old or used capital goods is described above, whereas investment in new capital goods by sector is determined so as to equilibrate the savings-investment balance on the one hand and the commodity markets on the other. Investment in new capital goods therefore have no capacity-generating effects.

Model III deals explicitly with these two points, namely, depreciation and the distinction between old and new capital goods. We assume now that the producer equilibrium in equations (C4)–(C9) above pertains to the optimal, end-of-period capital stock by sector, whereas the beginning-of-period capital stock by sector is determined by investments in earlier periods and is therefore exogenous. Current period gross investment by sector is thus determined as the difference between the desired capital stock and the stock carried over from the previous period:

$$I_i(t) = K_i(t) - (1 - \delta_i)K_i(t-1). \tag{C11}$$

The structure of the producer problem (C4)–(C9) is therefore formally identical in the two models, the only difference being that the current period total stock of capital is no longer exogenous but determined through (C11) and the savings-investment balance. However, the process of accumulation/decumulation of capital by sector—in other words, the working of the capital market—is now quite different. The modeling of the capital market in Model III is for all practical purposes identical to the formulation used in the MSG model (Forsund et al. 1985) and is similar to the Adelman-Robinson (1978) model.

The approach outlined above is the standard textbook way of comparing short- and long-run profit maximization of a firm, where capital is perfectly malleable in the long run but not in the short run and where there is perfect substitutability between capital of different vintages. An alternative approach might be the so-called putty-clay hypothesis, which is characterized by very limited (or no) substitution possibilities between capital of different vintages after the capital has been installed. This idea, expounded by Salter (1969) and Johansen (1972), has been implemented in a CGE model by Person (1983).[3]

3. RESULTS

3A. The Impact of Increased Foreign Savings

The simulation experiment we study here has widely become known as the "Dutch disease," the way a small open economy reacts to a one-shot infusion of extra export revenues through, for example, an increase in the price of oil. As discussed in the now vast Dutch disease literature, and more specifically in Benjamin and Devarajan (1985) for the case of Cameroon, this infusion will increase domestic prices of

[3] Higgs (1986) models investment in the flexible capital case as being a fixed fraction of sectoral output. Hence, his model is akin to our Model II, with a different investment function.

nontradables relative to tradables, leading to a movement of productive resources from sectors producing traded to those producing nontraded goods. We simulate this shock in all three versions of the Cameroon model by tripling the exogenous current account deficit from 27.2 to 81.6 billion CFA francs. This amounts to an increase in total savings of 0.8 percent.

The effect on domestic prices is reported in Table 2. In Model I, we see the typical Dutch disease pattern emerge. The real exchange rate appreciates; the domestic prices of the sectors most exposed to foreign competition (like cash crops) increase less than those of the nontraded sectors. When allowing for capital mobility, this pattern is damped. There is less real appreciation in Model II, and even less in Model III.[4] The only exception to this is the cash crops sector. As its profitability declines, capital—as well as labor—migrates out of this sector, pushing up its unit cost of production and hence its price.

We discussed earlier how shocks will change the rent earned by capital in different sectors when capital is not mobile. We can get an impression of this in Model I by calculating how the operating surplus relative to the capital stock changes by this infusion of export earnings. The operating surplus is defined as

$$\Pi_i = PN_iX_i - \Sigma\omega_{li}w_lL_{li}.$$

The result of this calculation is shown in Figure 3, where we see that the operating surplus actually increases in all sectors but the cash crops sector, where it declines. By far the largest increase (in percentage terms) comes in the capital goods and construction sectors. These sectors are more sheltered from foreign competition than the cash crops sector, and they produce the investment goods, demand for which increases following the infusion of export earnings. To the extent that these changes in operating surplus will generate investment incentives if we loosen up the sector-specificity of capital, we would expect capital primarily to flow out of the cash crops sector and into the capital goods and construction sectors, thus reinforcing the quantity effects as discussed in Section 2.

Returning to Table 2, we find that this is indeed the pattern that emerges. The cash crops sector takes a sharp nosedive, capital goods and construction increase their production, and the other sectors ex-

[4]The results in Table 2 represent percentage changes from the base case. In Models I and II the base cases are identical because the capital stocks are identical. In Model III, however, the capital stock is endogenous. Therefore, the base case is first recalculated in this model (using base year foreign savings levels) and the displayed results reflect deviations from this base.

Table 2: "Dutch Disease" (Percentage Changes from Base Run)

	Model I	Model II	Model III
Domestic prices			
Food crops	8.00	5.00	2.00
Cash crops	5.00	10.00	5.00
Forestry	9.00	6.00	4.00
Food processing	8.00	5.00	3.00
Consumer goods	8.00	5.00	3.00
Intermediate goods	9.00	7.00	4.00
Base metals	8.00	6.00	4.00
Capital goods	7.00	5.00	3.00
Construction	10.00	5.00	3.00
Private services	10.00	7.00	5.00
Public services	10.00	6.00	4.00
Output			
Food crops	0.75	0.73	0.80
Cash crops	−2.47	−10.73	−6.87
Forestry	−0.66	−1.33	−0.36
Food processing	−0.57	−1.08	−0.38
Consumer goods	−0.14	−0.46	0.07
Intermediate goods	−0.27	−1.03	−0.17
Base metals	−0.61	1.12	2.88
Capital goods	7.32	7.80	12.52
Construction	7.67	8.18	6.02
Private services	−0.01	−0.81	0.01
Public services	0.07	0.07	0.07
Exports			
Food crops	−8.51	17.02	−2.00
Cash crops	−3.60	−12.61	−7.99
Forestry	−3.05	−3.05	−1.43
Food processing	−7.08	−5.31	−2.50
Consumer goods	−7.23	−4.82	−3.37
Intermediate goods	−3.27	−3.32	−1.56
Base metals	−3.81	−1.38	0.64
Capital goods	4.29	5.71	9.30
Private services	−2.92	−2.92	−1.34
Imports			
Food crops	13.64	6.82	7.14
Cash crops	3.05	0.76	0.74
Food processing	9.12	5.74	3.78
Consumer goods	10.16	6.37	4.04
Intermediate goods	5.19	3.17	2.47
Base metals	6.59	6.47	6.61
Capital goods	10.54	9.85	14.05
Private services	3.92	2.20	1.89

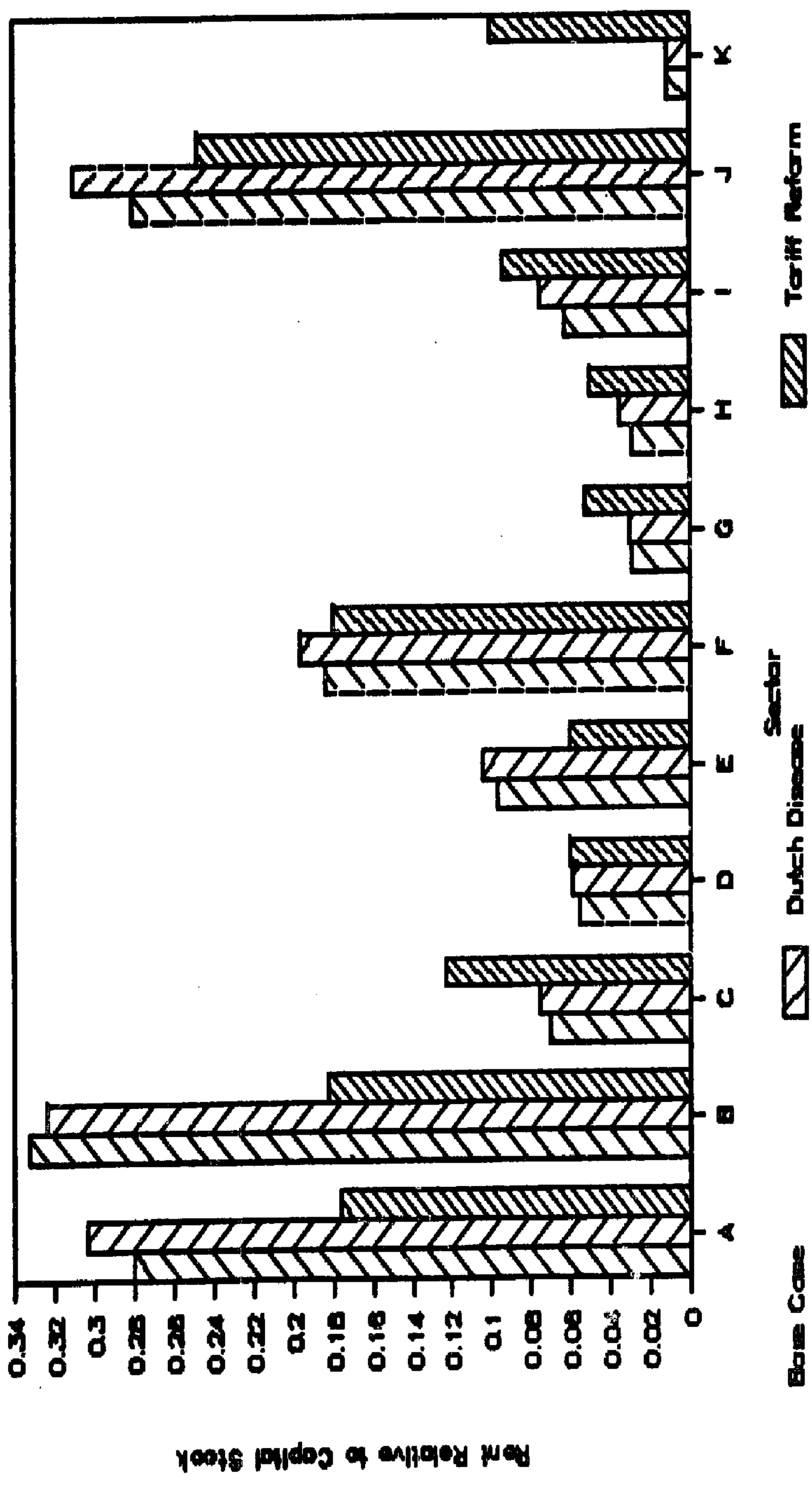

Figure 3. Operating surplus. A, food crops; B, cash crops; C, forestry; D, food processing; E, consumer goods; F, intermediate goods; G, base metals; H, capital goods; I, construction; J, private services; K, public services.

perience only minor changes.[5] An interesting difference can be observed between Models II and III. In the former the decrease in capital in the cash crop sector is almost twice as high. More generally, we see that in all sectors where production decreases, the decrease is larger in absolute value in Model II than in Model III because of the differences in the way the capital market works in the two models. Since in Model III firms can only disinvest by wearing down equipment, rather than by selling off the stock, a reduction in the capital stock will necessarily be less dramatic. The higher accumulation in the capital goods sector is thus an absorption of this "surplus" capital.

Table 2 also reveals the trade balance picture, familiar from the Dutch disease literature, of increased imports and depressed exports. The short- vs. long-run patterns follow their counterparts in domestic prices. In the short run, prices rise sharply, reducing the competitive position of exports and making imports more attractive. As domestic prices start declining toward the long-run equilibrium, exports will gradually regain some of their competitiveness and imports will become less attractive in the domestic market.

Despite this general pattern, some noteworthy anomalies surface on the export side. In the capital goods sector, exports increase in all three models. This is the result of our specification of the export supply function, where the *share* of exports in output is a function of the ratio of the world to the domestic price. Thus, when the price ratio declines, this share will too. However, the level of output in this sector has grown so much (for reasons explained above) that the level of exports can also grow, although the export-to-output ratio falls.

Similarly, in the food crops sector, we observe a sign reversal between Models I and III on the one hand, where exports decline, and Model II on the other hand, where exports increase quite dramatically. Exports are less than one percent of output in this sector. Thus, these large percentage swings represent small absolute changes.

3B. The Impact of a Tariff Reduction

We now report on a simulation experiment in which we removed all tariffs on imports in all three models. In Section 2 we identified two factors that drive the outcome of this experiment: the decline in

[5]Another reason why the cash crops sector contracts by so much in Model II is that it has the highest value for ρ_i, the ratio of the sector-specific interest rate to the economy-wide interest rate. The infusion of foreign savings raises the shadow price of capacity in the economy bidding up the interest rate. How this raises each sector's cost of capital, however, depends on ρ_i.

demand for import-competing goods and the reduction in production costs brought about by the lower prices in the economy. In the 11-sector model, two additional factors need to be taken into account. First, tariffs are highly differentiated in Cameroon. They range from none for forestry, construction, and private and public Services, 17 percent for intermediate goods, 22 percent for food crops, cash crops, and base metals, 36–37 percent for food processing and consumer goods, and 52 percent for capital goods. Second, to isolate the allocative effects of removing tariffs, we let the government recover the lost tariff revenue by imposing a lump-sum tax on consumers so that the government budget remains unchanged.

The impressions gained from the "Dutch disease" simulation are reinforced in the tariff experiment (Table 3). When the model is modified to incorporate capital mobility, the impact of a given shock is generally accented on outputs and damped on prices. The differences between the short and long runs are, however, generally small. As for the direction of change, this can be explained by the factors mentioned above. Domestic production decreases in the three sectors with high nominal rates of protection—food crops, food processing, and consumer goods. Production also decreases in private services in the long run, because of the extreme sensitivity of the cost of capital in this sector to variations in the interest rate. In the exportable sectors—cash crops, base metals, forestry, and intermediate goods—production increases. All of this reasoning is confirmed by a glance at the trade picture: imports of food processing and consumer goods increase; exports increase across the board, but especially for cash crops and base metals.

As for input costs, wages fall quite sharply, between 20 and 12 percent depending on the skill category, in Model I but only between 1 and 9 percent in Model II. This is because some of the "shock" is absorbed by capital in Model II. At the same time the interest rate increases by 1.4 percentage points in Model II.

Overall, there is a general higher growth and greater price declines in Model III compared with Model II. This is intuitive. In Model III, the capital stock in the economy is allowed to grow by the level of savings generated. Hence, each sector's supply curve shifts out leading to higher output and lower prices. Nevertheless, the *relative* growth rates of both prices and quantities between Models II and III are maintained, since these depend in both cases on rates of return across sectors.

The picture that emerges is one in which the removal of tariffs yields an economy that becomes more specialized in its production pattern.

Table 3: Tariff Reduction (Percentage Changes from Base Run)

	Model I	Model II	Model III
Domestic prices			
Food crops	−12.40	−6.90	−9.43
Cash crops	−9.30	−15.40	−21.75
Forestry	−12.70	−7.30	−10.74
Food processing	−14.30	−11.50	−14.27
Consumer goods	−13.70	−11.10	−14.00
Intermediate goods	−11.80	−10.70	−16.58
Base metals	−18.20	−18.40	−21.54
Capital goods	−17.10	−13.70	−15.91
Construction	−11.70	−9.20	−12.28
Private services	−12.50	−1.70	−6.14
Public services	−11.20	−7.30	−8.90
Output			
Food crops	−2.08	−5.03	−5.30
Cash crops	3.96	17.08	36.88
Forestry	0.93	1.50	8.27
Food processing	−1.24	−2.19	2.51
Consumer goods	−2.34	−2.75	2.13
Intermediate goods	0.45	1.51	8.25
Base metals	7.46	7.31	13.84
Capital goods	2.00	0.98	19.92
Construction	3.12	3.09	−5.53
Private services	−0.47	−5.96	−1.16
Public services	−0.12	−0.20	0.05
Exports			
Food crops	13.83	4.04	6.84
Cash crops	6.73	21.56	43.14
Forestry	5.27	3.82	11.61
Food processing	13.45	9.38	17.04
Consumer goods	12.05	8.67	16.82
Intermediate goods	4.76	5.32	14.16
Base metals	16.78	16.71	24.90
Capital goods	8.86	6.57	25.12
Private services	3.98	−4.94	0.99
Imports			
Food crops	7.05	13.86	9.93
Cash crops	9.62	13.28	20.65
Food processing	17.53	21.55	22.01
Consumer goods	21.33	25.66	26.13
Intermediate goods	0.64	2.55	4.85
Base metals	3.21	2.91	5.13
Capital goods	11.28	12.06	31.94
Private services	−6.25	−6.79	−3.92

How it will specialize will be different from the short to the long run. In the short run, labor will be reallocated from food crops and consumer goods into base metals, and to some extent cash crops. In the long run, both production and exports of base metals and cash crops increase substantially, at the expense of food crops and private services. The major difference between the short and long runs is that cash crops emerge as an area of specialization only in the long run.

It is important to note that the economy does not *completely* specialize even in the case of perfect capital mobility. The textbook small open economy with mobile capital and labor should specialize to producing just two traded goods in the absence of tariffs. However, in our case, the assumption of imperfect substitutability between imports and domestic goods permits the production of many more goods. Nevertheless, the results of this section show that for developing country CGE models, it is this Armington assumption, rather than the assumption of fixed, sector-specific capital, that prevents complete specialization.

4. CONCLUSION

In this paper we set out to compare the behavior of the same CGE model under varying assumptions about the mobility of capital. For at least three reasons, this is an interesting comparison. First, there is a marked difference between models of developed and developing countries with respect to their assumptions about capital mobility. Is this assumption crucial in determining the outcome of experiments with CGE models? Second, capital may be fixed in the short run but mobile in the long run. A comparison indicates how the economy would evolve from the short to the long run. Third, if capital immobility is due to entry and exit barriers, then the mobile capital case may describe the effect of removing these barriers.

We performed two generic experiments—an increase in foreign savings and tariff reform—with a CGE model of Cameroon under different specifications of the capital market. In broad terms, capital mobility does not affect the qualitative nature of the results of these experiments. For example, the shift in resources from tradables to nontradables associated with an increase in foreign savings occurs with and without capital mobility. With capital mobility, however, the magnitude of the changes is amplified. This is intuitive. As a sector becomes more profitable, not only does labor migrate to it, but so does capital. The result is that output grows by more in that sector than it would if only labor were mobile. Similarly, in the case of tariff reform, the tendency to specialize to the exportable sector (cash crops in the case of Cameroon) is accented when capital mobility is introduced.

In contrast with output changes, price changes are damped by capital mobility. Again, this is intuitive. With the introduction of capital mobility, the supply curve becomes more elastic. However, in some cases, the price changes are sharper. This is because, for a given positive demand shock, the supply curve can shift back by *more* with capital mobility. If labor were the only mobile factor, the demand shock bids up the wage rate causing the supply curve to shift back. With both factors mobile, both the wage and the interest rate rise, making the backward shift in the supply curve possibly greater. In the case of the foreign savings experiment, therefore, the price changes were generally damped with mobile capital, except in the case of cash crops, where the rising wage and interest rate caused costs to rise so high that the price was higher than in the case of immobile capital.

Our overall impression is that capital mobility is a subtle and complex phenomenon whose effect on model behavior cannot be anticipated beforehand. While we can interpret its effects in terms of the model's assumptions, the direction of these effects depends on the confluence of several, often conflicting, forces. The purpose of the general equilibrium model is to show the net effect of these forces. That model results do not differ qualitatively with and without capital mobility is not an argument for including or excluding capital mobility from the specification of CGE models. Such a decision should be based on the question being asked and the country being modeled.

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