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Foreign Resource Inflows, Saving, and Growth

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Abstract

This paper surveys aspects of the empirical and theoretical debate over the effects of foreign resource inflows on the national saving, investment, and growth of developing countries. The paper suggests a methodology for systematically studying the effects of resource inflows, based on standard optimal growth models modified for consistency with key empirical macro relations. A fairly robust normative implication even of representative-agent optimal consumption models is that much if not most of extra permanent resources should be consumed rather than invested.

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This chapter surveys aspects of of the empirical and theoretical debate over the effects of foreign resource inflows on national saving, investment, and growth.[1] The debate originated in the early 1960s in attempts to assess the role of capital inflows in development. But elements of the debate go back much further. Indeed, the classical controversy over the international transfer mechanism, initiated by Keynes and Ohlin in the 1920s, revolves implicitly around the related question: does a transfer raise the recipient's saving more or less than its investment, and by what amount? For it is the resulting incipient imbalance in the current account that drives the terms-of-trade effect of the transfer (Mundell 1968, pp. 17-21).

A salient problem in the existing literature is a failure to define clearly the question being asked. Generally researchers have sought to discover, through cross-sectional multi-country regressions, the statistical relationship between additional foreign resource availability and saving, investment, consumption, and/or the growth rate of GDP. But the resulting numerical estimates of correlation need not correspond to the effects of any well-defined economic policy. The impact of outright aid differs from that of a loan at market interest rates. Furthermore, market borrowing, an important source of developing-country finance,[2] responds endogenously to factors that simultaneously shift other macroeconomic variables. Accordingly, a cross-sectional regression of saving, say, on capital inflows generally cannot disclose the causal impact of those inflows on saving.

The chapter suggests a methodology for systematically studying the effects of resource inflows on macroeconomic variables. The methodology,

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[1]For a particularly complete set of references to the literature, see the recent survey article by White (1992).

[2]See Montiel (1994) for a recent survey of developing-country access to world capital markets.

which builds on the standard optimal growth framework, constructs a medium-scale dynamic model of the economy under study, one that is quantitatively consistent with the behavior of the economy's key macro variables.[3] Within such a model, the effects of an exogenous aid inflow, or of an exogenous relaxation in borrowing restrictions or terms, can be evaluated. The general approach also leads to a structural regression strategy for evaluating the effects of aid flows.

An objection to the approach proposed below is its assumption of a particular economic model that might not be the true model underlying the structure of the economy under study. But the interpretation of *any* statistical results for policy purposes requires a stance on the economic mechanisms generating the observed associations among macro variables. This is the essence of econometric identification. An advantage of the approach I advocate is that it makes maintained assumptions explicit, hence refutable, and it does so within a framework sufficiently flexible to capture a wide variety of economic structures.

The chapter is organized as follows. Section 5.1 describes early approaches to evaluating resource inflows and surveys the ensuing empirical debate. Section 5.2 describes the predictions of the standard optimal growth model, showing the sensitivity of results to the aid versus borrowing distinction and to the permanence of an inflow, factors not usually considered in existing empirical studies. In section 5.3 I illustrate how a fairly generic optimal growth model modified to allow for the presence of financially constrained consumers can be used to study the impact of an

[3]For earlier applications of the optimal growth framework to development issues, see, for example, Bardhan (1967) and Bruno (1970).

exogenous aid inflow.[4] I also explore a model with endogenous growth and discuss more briefly other possible extensions. Section 5.4 concludes.

The theoretical models I explore below mainly assume a representative national consumer in the recipient country, and thus might be rightly regarded as being more normative than positive in nature. However, I view these models as stepping stones to more complete positive models incorporating the competition of powerful political claimants for common resources, a process likely to raise the positive effect of foreign resource inflows (especially aid) on consumption. Tornell and Lane (1995) and Svensson (1997) look at this type of model, and offer suggestive empirical support. As will become evident below, a fairly robust normative implication even of optimal consumption models is that much if not most of extra permanent foreign resources should be consumed rather than invested. Such a response, if found empirically, may be a much greater cause for concern when political pull rather than social welfare maximization determines the uses and distribution of inflows.[5]

5.1 Previous approaches

Starting in the 1960s, researchers began to model and to test empirically for the role of foreign resources inflows on developing-country capital accumulation and growth. In the theoretical realm, models by Chenery and a number of associates, all based on the Harrod-Domar growth model, were

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[4]Schmidt-Hebbel and Serven (1995) have explored a related but much more detailed model. I discuss its results at several points in this chapter.

[5]Boone (1996) empirically studies the welfare effects of aid inflows, showing that they tend to raise government size while leaving indicators of private welfare (such as child mortality) unaffected. His conclusion is that aid serves mainly to augment, not simply aggregate consumption, but the consumption of those who already are relatively well off.

especially influential.[6] These models, simulated on the basis of empirically plausible parameter values, seemed to imply that aid and capital inflows would speed the transition to a targeted self-sustaining growth path and current-account balance.

Skeptics of this optimistic view countered by arguing that resource inflows augment consumption and depress saving enough to reduce, possibly to zero, any favorable impact on investment and subsequent growth. Even funds tied to specific investment projects might not be "additional": they may finance investments that governments would have carried out anyway with resources now freed for consumption purposes. The contention that foreign resource availability either directly or indirectly raises consumption inspired a large body of empirical work, by both adherents of the optimistic view and by its critics.

This section critically reviews both the theoretical framework underlying the early models of resource inflows and growth and some of the leading attempts (spanning more than a quarter century) at empirical resolution of the debate those models inspired.

A simple growth model along Chenery lines

The model, which is adapted from Grinols and Bhagwati (1976), focuses on a small open economy that receives an exogenous net resource inflow n(t) from foreign sources. One can think of n(t) as the noninterest current account deficit. It is taken for granted that the economies under study here face limits to international capital market access that go strictly *beyond* the standard intertemporal budget restriction of the present value (at world

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[6]See, for example, Chenery and Bruno (1962), Adelman and Chenery (1966), Chenery and Strout (1966), and Chenery and Eckstein (1970).

prices) of absorption to the present value of income. The question is how an easing of the additional constraints will affect saving, investment, and growth.

If $y(t)$ denotes GDP, $c(t)$ consumption, and $i(t)$ investment, we have the identity

$$(1) \qquad y(t) + n(t) = c(t) + i(t).$$

Output depends on the capital stock, $k(t)$, alone, perhaps because of the presence of an unlimited supply of labor à la Arthur Lewis:

$$(2) \qquad y(t) = k(t)/\pi.$$

Above, π is the Harrod-Domar capital-output ratio. The capital accumulation identity is

$$\dot{k}(t) = i(t),$$

which, by virtue of (2), can be written

$$(3) \qquad \dot{y}(t) = i(t)/\pi.$$

The final ingredient of the model is a consumption function,

$$(4) \qquad c(t) = \gamma + (1 - \rho)y(t) + \lambda n(t),$$

which allows for a direct "leakage," $\lambda n(t)$, of foreign resources out of saving and into consumption. This leakage could arise because, for example, additional foreign resources depress domestic interest rates or spur government consumption. Models in the vein of Chenery and Strout (1966) simply assumed that $\lambda = 0$.

Combining equations (1), (3), and (4) leads to

$$y(t) + n(t) = \gamma + (1 - \rho)y(t) + \lambda n(t) + \pi\dot{y}(t),$$

which can be rewritten as an equation in the output growth rate, $g_y(t) = \dot{y}(t)/y(t)$:

$$(5) \qquad g_y(t) = \frac{\rho}{\pi} - \frac{\gamma}{\pi y(t)} + \frac{(1 - \lambda)n(t)/y(t)}{\pi}.$$

Equation (5) clarifies the potential role of foreign resources in development. In the absence of resource inflows from abroad ($n = 0$), $g_y(t)$ converges to Harrod's "warranted" growth rate, ρ/π, provided the initial capital stock, $k(0)$, is bigger than $\gamma/\rho\pi$. Positive resource flows $n > 0$ speed growth, however, and can hasten the transition to self-sustained balanced growth. Indeed, a constant ratio n/y of resource inflow to output induces a long-run growth rate above the warranted rate.

These growth-enhancing effects of foreign resources on growth presuppose that the leakage λ is incomplete: $\lambda < 1$. If, instead, *all* resource transfers are consumed, the economy's growth path is not altered. And, the positive growth effect is greater the lower is λ. Hence the importance of ascertaining the fraction of foreign resource inflows that is invested domestically.

The model also makes strong predictions concerning the dynamics of saving. Differential equation (5) implies an output level of

$$y(t) = y(0)e^{\rho t/\pi} + \frac{1}{\pi}\int_0^t e^{\rho(t-s)/\pi}[(1 - \lambda)n(s) - \gamma]ds.$$

The level of saving, s(t), therefore is[7]

$$(6) \qquad s(t) = \rho\left[y(0)e^{\rho t/\pi} + \frac{1}{\pi}\int_0^t e^{\rho(t-s)/\pi}[(1 - \lambda)n(s) - \gamma]ds\right] - \gamma - \lambda n(t).$$

Assume, for simplicity, that the level of resource inflow is constant at n. Then (6) becomes a relatively simple function of n:

$$s(t) = [\rho y(0)-\gamma]e^{\rho t/\pi} + \left[e^{\rho t/\pi}(1 - \lambda) - 1\right]n.$$

Notice that a sustained increase in n causes an initial ($t = 0$) drop in saving if $\lambda > 0$, but that saving rises monotonically thereafter, overtaking its prior path at time $t = -\pi ln(1 - \lambda)/\rho$. If $\lambda = 0$ (the case of no leakage), saving is always higher after n rises.[8]

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[7]The following notion of saving, as discussed further below, isn't the theoretically relevant one when n takes the form of unrequited aid, because, in that case, n becomes part of national income. In the balance of payments n would appear as a current-account credit (a transfer from abroad) with a counterpart debit equal to additional imports in the amount n. If resources are borrowed, however, the appropriate definition of saving must subtract from GDP interest payments due to foreign creditors. Chenery's models, as noted below, ignored the dynamics of foreign interest payments and did not clearly distinguish between foreign aid and lending.

[8]Chenery's models also considered the possibility that growth might be constrained by the availability of foreign exchange, independently of the

Consider the behavior of the saving *rate* as a fraction of GDP, given by

$$\frac{s(t)}{y(t)} = \rho - \frac{\gamma}{y(t)} - \frac{\lambda n}{y(t)}.$$

If n rises in a sustained fashion at t = 0, the saving rate initially falls because saving falls and y(0) is given. As GDP growth accelerates, however, the saving rate eventually overtakes and passes its initial path, ultimately converging to ρ (as it would at the initial level of n). Figure 1 shows an example of how the saving rate with a foreign resource inflow overtakes its initial path, despite the rather large leakage parameter ($\lambda = 2/3$) assumed in the simulation.

The preceding model warrants several comments. Obviously, the welfare significance of the initial fall in saving that accompanies a foreign resource inflow is unclear a priori. In the model, the inflow augments aggregate consumption possibilities (and consumption) at every point in time, hence welfare is increasing in the standard sense.

A precise assessment of the welfare gain, however, requires a satisfactory account of individual or social preferences with regard to the level and timing of consumption. Such an account would, in general, predict a consumption function quite different from the naive Keynesian consumption function (4).

Another weakness of the model is the assumption of unlimited labor

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domestic savings constraint. Thus, despite domestic savings themselves being adequate for satisfactory growth, growth could be impeded by lack of enough foreign exchange to buy necessary imported inputs. While some older empirical studies support the relevance of this "two-gap" approach (e.g., Weisskopf 1972), it seems of secondary importance today. I therefore omit further discussion. For an exposition, see Cardoso and Dornbusch (1989).

supplies, or at least of no fixed factors in production. While the "new growth theory" has revived theoretical interest in such models, their empirical relevance has been increasingly questioned in recent years. (Even in a more traditional neoclassical growth model along Solow lines, however, higher investment due to a foreign resource inflow increases the economy's growth rate while the economy is in transit to its steady state.)

Finally, the model gives no adequate account of the dynamics of foreign debt when foreign resources must (at least in part) be borrowed. Such debt would affect consumption behavior; in particular, the need to service foreign obligations has strong consequences for long-run consumption possibilities. The implied interest payments to foreigners would drive a wedge between national output and national income. This last distinction is critical for assessing the long-run welfare impact of the resource inflow, since higher GDP growth may yield little domestic benefit if most of it goes to service external debts.

After a review of some useful accounting identities and of the existing empirical evidence, section 5.2 below will take up models that remedy these deficiencies.

A digression on accounting

The implication of Chenery-style models, that foreign assistance would invariably promote investment and growth, and eventually raise saving, was disputed by critics who viewed development assistance programs as motivated ultimately by an alleged desire of donor countries to exercise political and economic dominance in the developing world. The ensuing empirical debate generated many studies on the links between foreign resource inflows and various aspects of macroeconomic performance by the recipients.

A preliminary digression to recall some accounting identities highlights several basic issues in the empirical assessment of the macroeconomic impact of foreign resource inflows.

Let ca denote the (per capita) current account surplus, *a* aid (as before), ℓ *gross* foreign lending, b *gross* foreign borrowing at market interest rates, and *int* interest and dividend payments to foreigners. Then then the national income identity is:

$$
\begin{aligned}
y + a - int &= c + i + g + ca \\
&= c + i + g + \ell - b.
\end{aligned}
$$

On the assumption that *int* is determined by the past, and, thus, is unresponsive to current changes, the preceding identity gives the following responses of national saving s = i + ca to exogenous changes in *a* and b, respectively:

$$
\frac{ds}{da} = 1 + \frac{dy}{da} - \left(\frac{dc}{da} + \frac{dg}{da}\right), \qquad \frac{ds}{db} = \frac{dy}{db} - \left(\frac{dc}{db} + \frac{dg}{db}\right).
$$

Aid directly increases national income, hence national saving, and it may have an effect dy/d*a* on output, for example, through income effects on labor supply. To the extent that private or government consumption rises, however, national saving falls. Borrowing operates through similar channels, except that the sum borrowed, unlike a sum granted outright, does not enter national income. *Domestic* saving (in contrast to national saving) could be defined as s – *a*, i.e., as national saving net of unrequited transfers. Aid affects domestic saving only through its effects on y, c, and g. But national rather than domestic saving is the theoretically relevant concept from the standpoint of tracking net asset accumulation and intertemporal welfare.

The associated investment effects are:

$$\frac{di}{da} = \frac{ds}{da} + \frac{db}{da} - \frac{d\ell}{da}, \qquad \frac{di}{db} = \frac{ds}{db} + 1 - \frac{d\ell}{db}.$$

Aid affects investment by changing saving and the net inflow of borrowed foreign resources. For example, if aid raises saving, but the saving escapes abroad (capital flight), investment will not change. Gross foreign borrowing that is channeled into flight capital leaves investment unchanged, but borrowing can raise investment even if saving declines.[9]

These relations suggest that, to understand how particular foreign resource inflows affect saving and investment (and growth), there are a few key questions to ask. How are government and private consumption affected, how does output respond, and, importantly, what are the induced effects on other (endogenous) gross resource inflows and outflows? (Of course, the linkage from investment and consumption to growth will depend on the specific mechanisms generating output and technical change in the economy.)[10]

Evidence

The empirical debate initially focused on the first of these issues, the impact on saving of foreign resource inflows. Later researchers have

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[9]One could distinguish further between the legal and illegal components of ℓ. Illegal capital movements accomplished through deceptive invoicing of trade flows, for example, could lead to distortions in reported saving and current account figures.

[10]My discussion assumes that aid is fungible, which seems accurate for moderately-sized inflows; see Pack and Pack (1993).

looked directly at effects on investment and growth.

Griffin (1970) pointed out that if present consumption is a normal good, additional foreign resources must in general lead to an immediate rise in consumption. This is something that the Chenery-Strout (1966) model does not allow (although it may occur in the modified model developed earlier in this section if $\lambda > 0$ is allowed). Griffin (1970) and Griffin and Enos (1970) went further, however, arguing that foreign resources do not promote saving or growth at all--in effect, that λ is 1 *or even above* 1 in the model above. They argued that, through the 1960s, foreign assistance had been negatively correlated with growth and that foreign assistance largely had supplanted domestic savings.

To support the latter contention, Griffin (1970) reported the following ordinary least squares regression (based on 1962-64 average data for a sample of 32 developing countries)

$$\frac{s}{y} = 11.2 - \underset{(0.11)}{0.73}\,\frac{\Delta d}{y}, \qquad R^2 = 0.54,$$

where $\Delta d = b - \ell$ is the current account deficit (the change in foreign debt, d). While acknowledging the lack of a clear structural interpretation of this correlation, Griffin viewed it as implying a nearly complete crowding-out of domestic saving by foreign borrowing. A time-series regression on 1950-63 data from Colombia led Griffin to a similar conclusion.[11]

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[11] Earlier, Rahman (1968) had reported a cross-sectional "crowding-out" coefficient of only -0.25 using Chenery and Strout's (1966) 1964 data for 31 countries.

Studies regressing saving on the current account deficit implicitly give the correlation between investment and net foreign borrowing, of course. The identity $s = i - \Delta d$ implies that the coefficient of the regression of s/y on $\Delta d/y$ is that of the regression of i/y on $\Delta d/y$, less 1. Thus, for example, if 1 percent of GNP more foreign borrowing is estimated to reduce saving by 0.5 per cent of GNP, it would be estimated to raise investment by 0.5 percent of GNP.

Weisskopf (1972) presented further times-series results along the lines of Griffin's for 17 countries, but the Weisskopf results showed weaker saving effects. In a pooled sample, he found a coefficient of -0.227 (with a *t*-statistic of -5.3) in a regression of saving on the foreign resource inflow and other variables.

Papanek (1972) leveled a number of criticisms at these and similar studies. National saving, he noted, typically had been calculated as investment less total net foreign inflows. However, inflows with a grant component, for example, concessional loans, are in part gifts that should augment national income. Correspondingly, even when these gifts are entirely consumed, national saving does not decline. Papanek also noted that prior analyses erred in another way when aggregating all foreign inflows, whether pure aid, borrowing on market terms, official reserve depletion, direct foreign investment, project assistance, etc. In principle, such inflows could have very different effects on saving and growth. The discussion of accounting above suggests that the use of net flows itself could be misleading. If gross inflows partially finance capital flight rather than domestic investment, regressions of saving or growth on net inflows could seriously overstate the impact of a dollar of foreign borrowing.

Papanek (1973) focused on the effects of foreign inflows on growth, using cross-section regressions that control for saving and break inflows down into aid, direct foreign investment, and other foreign inflows. He found some evidence that inflows, especially aid inflows, promoted growth in Asian and Mediterranean countries in the 1950s and 1960s. Less favorable results are reported for a different sample by Mosley et. al (1987), who find no convincing cross-sectional evidence that, conditional on saving and other variables, aid promotes growth.

Papanek's (1972) weightiest criticism of previous literature flowed from the observation that the correlations between saving or growth and inflows found in the data do not establish *causality* running from the latter variable to the former ones. For example, countries experiencing economic difficulties might receive more aid or borrow more heavily abroad. Recipient governments might even behave strategically, consuming rather than investing aid inflows in the belief that economic stagnation will elicit more future donor largesse than robust growth (Pedersen 1996; Svensson 1996).

One might add that, to the extent that resource inflows are elastic, an exogenous fall in domestic saving can lead to additional foreign borrowing to finance investment: measured statistical relationships may, in large part, reflect this mechanism rather than an effect of resource inflows on saving. Similarly, an exogenous rise in the profitability of domestic investment leads to extra foreign borrowing and helps induce a negative statistical relation between investment and the current account, one that has been extensively documented. (See, for example, Baxter and Crucini 1993 on industrial countries and Reinhart and Talvi 1997 on East Asia and Latin America.) But it does not follow that capital inflows "cause" investment; if anything, the reverse is closer to the truth in the last example.

Papanek (1972) concluded (p. 948) that "For a number of countries it is plausible to conclude that exogenous factors caused both high inflows and low savings rates and generally low growth rates as well." The key point is that inflows are *endogenous*, in a way most likely to be quite important when a country has some discretion over the amount it borrows from abroad, but also potentially important even when it does not. Earlier researchers had failed to grapple directly with this problem.

Gupta (1975) was probably the first to account for endogeneity through an explicit simultaneous-equations, deriving the effects of exogenous shifts in foreign inflows from a seven-equation, life-cycle-based empirical model of the saving rate, the output growth rate, per capita income, the dependency rate, the birth rate, the female labor-force participation rate, and the infant mortality rate. Gupta found that the "role of foreign resource inflows [in reducing the saving rate] is quite small" (at most a coefficient of -0.13) (Gupta 1975, p. 372). Gupta also found that foreign private investment has the largest growth-enhancing effect of the types of foreign inflow considered. Unfortunately, Gupta reports no standard errors on reduced-form coefficients, and offers no rationale for the appearance of foreign saving in the domestic saving function. A general drawback of multi-equation approaches, of course, is that misspecification of any single equation generally will contaminate all of the multipliers derived from the estimated model.

Subsequent work by Fry (1978, 1980) and Giovannini (1983, 1985), despite some ambiguity, tends to support the negative correlation between aid inflows and saving. Chenery himself (see Chenery and Syrquin 1975, p. 125) suggested, on the basis of a cross-sectional regression with 41 observations, that on average only 45 percent of external resources would translate into additional investment.

Halevi (1976) regresses investment, private consumption, and public consumption on the import surplus and individual components of the capital account, finding strong evidence of a positive correlation of inflows with investment (conditional on GNP) and weaker evidence of positive correlation with private and public consumption. Halevi's direct focus on investment and consumption, rather than saving, is quite appropriate, since these variables are directly relevant to welfare and growth. Furthermore, saving , which is calculated as a residual, is probably subject to greater measurement error than are investment and consumption. Finally, as noted above, the definition of saving has differed from study to study--some fail to include aid or foreign interest bills in income, for example. Thus, future empirical work should add consumption and investment to the list of variables to be explained.

In two studies, Levy (1987, 1988a) regresses investment rates on saving rates and the ratio of official development assistance (ODA) to GDP. He finds that, conditional on saving, ODA feeds through virtually one-for-one to investment.[12] Since this regression procedure is silent on the response of saving itself to ODA, it cannot disclose the *reduced-form* or total response

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[12]Feldstein (1994) adopts a similar cross-sectional regression methodology to study the effect on aggregate domestic investment of foreign direct investment (FDI) outflows and inflows. For a sample of industrial countries, he regresses the investment rate on the national saving rate plus FDI outflows and inflows, with both of the latter two variables expressed as a fraction of output. The outflows variable attracts a coefficient near -1; so does the inflows variable, in some regressions, but the evidence on inflows is much more mixed. Feldstein concludes that FDI outflows are extremely effective in lowering domestic investment, given saving. It is hard to reconcile this conclusion with a picture of perfectly integrated world capital markets, except by positing that some of the same factors (perhaps country-specific technology shocks) that lower aggregate domestic investment profitability also make foreign investment more attractive. Feldstein attempts to allow for this possibility by adding control variables to his regression equations, but reports that his initial conclusions are not substantially modified.

of investment to ODA. Levy (1987) recognizes the potential dependence of saving on ODA in devising instrumental-variable estimates of his basic ODA equation, but he unfortunately does not report the result of his first-stage regression of the saving rate on instrumental variables including ODA. Thus, his results give no obvious answer to he question: How does aid affect investment?

Levy (1988b) observes that aid inflows are in part predictable, and that systematic, anticipated aid should have different effects from unexpected, temporary aid, such as emergency famine relief. Levy tests this hypothesis by first estimating a forecasting model in which transfers of aid resulting from previous aid commitments depend on a distributed lag of past commitments. He then regresses consumption (for a panel data set) on "permanent income" (defined as a weighted average of past income), the forecast model's prediction of the expected aid inflow based on past commitments, and unexpected aid inflows. He finds that much or all of the unexpected aid inflow feeds into consumption (with a coefficient equal to or higher than that of permanent income). Expected inflows, however, have a much smaller effect on consumption. (An alternative estimation approach yields similar results.) Levy argues that these results support the idea that systematic aid is not targeted for consumption and is less fungible than emergency aid, which often is targeted for consumption. This is not entirely convincing, since even aid targeted for investment may release resources to consumption that might have been invested in the absence of the targeted aid. Thus, Levy's results become difficult to reconcile with a consumption smoothing model in which transitory, unexpected aid should be largely saved and systematic aid consumed. Levy (p. 456) recognizes this, arguing that recipients of systematic aid must, somewhat irrationally, perceive it as transitory. A partial rationale for Levy's results may come from the observation that emergency aid tends to be given when consumption urgency is especially high. Despite these ambiguities, however, the study by Levy (1988b) is important in focusing attention both on permanent-income theories of consumption and on the distinctions between expected and unexpected, and permanent and transitory, aid.

The foregoing considerations bring out the need for dynamic studies of resource inflows that go beyond the prevalent pure cross-section methodology. Schmidt-Hebbel et al. (1992) provide a recent study along these lines. Using panel data from 10 countries, they regress the *household* saving rate on a number of postulated determinants of aggregate saving, including trend income, the deviation of income from trend, the real interest rate, and the current account deficit (which they label foreign saving). They find that foreign saving has a significantly negative coefficient (equal to around -0.15) in their regressions. Since their result applies to household rather than total private saving (which includes corporate saving), it is difficult to know what the implications are for the correlation between foreign saving and investment.

While Schmidt-Hebbel et al. motivate their saving function by standard life-cycle theories, their lack of a general equilibrium framework leads to some ambiguities in interpretation. For example, they find that interest-rate effects on household saving are insignificant, and attribute this to the well-known tension among income, wealth, and substitution effects. However, foreign inflows will affect saving in part through their interest rate-effects, which tend to drive domestic and world interest rates into line. Thus, some of the effect of changes in domestic real interest rates could be captured by the resource-inflow variable. The effects of foreign resource inflows depend on the share going to the government and the precise mode by which the balance is allocated to the private sector.

Most recently, Boone (1994, 1996) has carried out cross-sectional regressions on a large sample of countries, 1971-1990, to study the effects of aid. To address the simultaneity issue raised by Papanek (1972), he uses as instrumental variables dummies capturing donors' political interests rather than recipients' economic conditions. He also uses population as an instrument, and runs regressions that control for variables that might endogenously influence aid flows (such as GNP per capita). He finds that aid has virtually no investment effect (except in countries where aid is a very large share of GNP), and no growth effect. The hypothesis that all aid goes into consumption cannot be rejected.

Interestingly, the simultaneity bias hypothesized by Papanek appears to be abundantly present in Boone's data. Ordinary least squares gives much higher estimates of the proportion of aid that is consumed. Boone argues that, because poorer countries have higher consumption-income ratios, this finding merely reflects the simultaneous positive effect of low per capita income on both the consumption-income and aid-income ratios.

Boone's 1994 study is unique in basing its estimation strategy on an explicit intertemporal model of consumption and growth. Boone's specification assumes that every country is in the *steady-state* equilibrium of a Ramsey-Cass-Koopmans exogenous long-run growth model of the type explored in sections 5.2 and 5.3 below. Countries have identical rates of long-run technological efficiency gain and population growth, but investment (and, hence, consumption) as a fraction of GDP differs across countries due to different levels of distortion imposed by the domestic government or political system.

A difficulty in drawing inferences from Boone's (1994) methodology is related to the interpretation of his results. While the results may be informative about economies in steady state, they say nothing about the effects of aid on countries that are still in transition. The models in sections 5.2 and 5.3 below will make clear that, in a Ramsey-Cass-Koopmans model, aid will generate additional saving and investment *only* when the recipient economy hasn't yet reached its balanced growth path. Boone (1994, p. 13) also points this out. Thus, Boone's estimates potentially throw little or no light on the effects of aid on developing countries, which presumably are considered to be developing in part because they have not yet attained balanced-growth paths. Plainly a measure of the economy's distance from the steady state could be essential for getting an estimate of the *actual* effects of aid on consumption, saving, and investment.

Boone's (1994) attempt to interpret the evidence on aid in terms of forward-looking dynamic models is, however, a very important step, and completely consistent with the perspective I adopt in this chapter.

Recent empirical work by Burnside and Dollar (1997) makes use of the instrumenta; variables suggested by Boone to correct for simultaneity. The work also adopts a specification in which aid flows are interacted with an index of policy quality in an empirical growth equation. Burnside and Dollar find that the effect of aid on growth depends on the quality of economic policies. Contrary to Boone's findings, countries following bad policies seem to experience a growth slowdown as a result of aid, whereas countries following sufficiently good policies can reap a significant growth-rate gain. The authors also try to explain policy quality, but find that aid does not make policies any better or worse.

Assessment

The weight of the accumulated empirical evidence suggests that net foreign resource inflows (especially borrowed resources) are negatively related to national saving and positively related to domestic investment. Thus, in credit-constrained economies, higher resource inflows that reach the private sector may well promote higher consumption and higher investment (at least for a time), as a market-clearing, competitive, intertemporal model would suggest. But the *magnitudes* of these consumption and investment effects are quite uncertain--the existing empirical work, none of which is tightly linked to a structural theoretical framework, yields a wide range of results that depend on the details of specification, time period, and country sample. Unfortunately, in the absence of such a theoretical framework it is hard to know how to interpret these findings. In particular, it is hard to know if they represent a causal relationship linking resource inflows to economic performance, or merely a statistical regularity devoid of a unidirectional causal interpretation.

The lack of any consistent statistical relationship between resource inflows and economic growth reinforces these doubts. As noted by Cassen and associates (1994, p. 29) in their discussion of aid:

> Inter-country statistical analyses do not show anything conclusive--positive or negative--about the impact of aid on growth. Given the enormous variety of countries and types of aid, this is not surprising. If appropriate aid is put to good use in a satisfactory policy context, and if all the other components of growth are present, the statistical relationship between aid and growth will be positive. If such a relationship does not emerge overall, it only shows the unexciting conclusion that aid may or may not be strongly related to growth, depending on circumstances.

What research strategy should one adopt, then, in seeking to understand the effects of resource inflows on saving, investment, and growth? One approach would be to pursue the cross-sectional strategy followed in much of the literature reviewed above, refining the estimating equations to encompass the additional variables to which Cassen and associates (1994) allude. These could include political and macroeconomic stability, quality of the educational system, central bank independence, the honesty of government officials, conditionality of foreign resource flows, etc. Such analyses (for example, Edwards 1995 and Burnside and Dollar 1997) can be useful in revealing stylized facts, but typically yield no structural information--notably, no account of causal mechanisms. Boone's (1994) work, discussed earlier, is unique in deriving its estimating equations from a well-specified intertemporal model, thus admitting the potential for structural interpretation.

The underlying data used in such exercises, and the statistical correlations that emerge, can also play a role in informing an alternative research strategy. That strategy is to develop medium-scale general-equilibrium intertemporal models that capture the behavior of key macro aggregates when modified to reflect institutional features of the economy under study. Schmidt-Hebbel and Serven (1995) have built a model based on just this idea. The strategy, somewhat reminiscent of Chenery's basic approach, would allow one to simulate the dynamic effects of resource inflows, but within a model that is empirically plausible and that allows for forward looking consumption and investment behavior in a manner that Chenery and his co-authors did not. A lesson of the existing econometric work is that applications must explicitly distinguish between different forms of resource inflow, taking account of permanence and predictability as well.

The next section presents an illustrative analytical model, basic to either research strategy, within which pertinent thought experiments can be performed and the key parameters determining dynamic responses ascertained.

5.2 An illustrative theoretical model

The fundamental effects of foreign resource inflows on saving, consumption, and growth are well illustrated by a stripped-down model of capital accumulation over time. The model is much too simple to capture all of the complex institutional factors governing intertemporal allocation in industrial (not to mention developing) economies. Yet the model highlights forces that will be at work in more realistic settings, and serves as a springboard for more detailed exercises.

For simplicity, the model involves two factors of production only, physical capital and raw labor. Much recent research on economic growth emphasizes the role of human capital, and an impact of resource inflows on the educational system could be a crucial conduit for growth effects. The model sketched below could easily be expanded to incorporate human capital accumulation, possibly with borrowing restrictions. Section 5.3 studies an endogenous growth model with human capital.

Foreign aid

Let us begin by considering the case of a permanent unrequited foreign aid inflow at level a (in terms of consumption) per period. There is a representative individual in the economy who maximizes

$$(7) \qquad \int_0^{\infty} u[c(t)]e^{-\delta t}dt$$

H u(c)

subject to the constraint

(8) $\dot{k}(t) = a + f[k(t)] - c(t).$

As usual, we can think of the objective function (7) as the social welfare function of a benevolent economic planner in an economy with heterogeneous individuals, in which case the model's results have a normative interpretation. Positive conclusions concerning economies with finite lifetimes require a more detailed treatment of aggregation, as discussed below.[13] The production function f(k) implicitly assumes a constant labor force, although the model can accommodate exogenous labor-force growth with k reinterpreted as the capital-labor ratio in production, f(k) as output per capita net of the decline in capital intensity due to labor-force growth, and c as consumption per labor unit.

The equations necessary for an optimum plan are the capital-accumulation constraint and the intertemporal Euler condition

(9) $\dot{c} = -[u'(c)/u''(c)][f'(k) - \delta].$

Two specific assumptions simplify the model further so as to allow a relatively transparent analysis of the model's dynamics. These assumptions are that u(c) belongs to the isoelastic class,

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[13]Eaton (1989) contains a very interesting discussion of several alternatives along these lines. His treatment of the present model, however, is restricted to consideration of a resource transfer that occurs when the economy is in a steady state (in which case only consumption, and not investment, changes). The steady state assumption is probably not appropriate for developing economies. Below, I therefore consider economies with capital stocks strictly below steady-state levels.

$$u(c) = \frac{c^{1-(1/\sigma)} - 1}{1 - (1/\sigma)},$$

where $\sigma > 0$ is the intertemporal substitution elasticity; and that the production function f(k) is Cobb-Douglas,

$$f(k) = Ak^{\alpha},$$

with $\alpha < 1$. Under these assumptions the dynamic system describing the economy is given by the specialized forms of (9) and (8):

$$\dot{c} = \sigma c(\alpha A k^{\alpha-1} - \delta),$$

$$\dot{k} = a + Ak^{\alpha} - c.$$

The steady state of this system consists of $\bar{c}$ and $\bar{k}$ such that

$$\bar{c} = a + A^{1/(1-\alpha)}(\alpha/\delta)^{\alpha/(1-\alpha)}, \qquad \bar{k} = (\alpha A/\delta)^{1/(1-\alpha)}.$$

The second equation here is the fundamental condition determining the long-run capital stock in this model, $f'(\bar{k}) = \delta$, i.e., the long-run marginal product of capital must equal the rate of time preference. Figure 2 shows the dynamic behavior the equations imply. The steady state is a saddle point, and, in the present case (a expected to remain at a constant level forever), the relevant adjustment path is the stable saddle path labeled SS.

A simple way of exploring how the economy's preferences and technology interact to determine the impact of aid is to take a linear approximation to the two-equation system in a neighborhood of the steady state. The result is

$$\begin{bmatrix} \dot{c} \\ \dot{k} \end{bmatrix} = \begin{bmatrix} \sigma(\alpha A\bar{k}^{\alpha-1} - \delta) & \sigma\bar{c}\alpha(\alpha - 1)A\bar{k}^{\alpha-2} \\ -1 & \alpha A\bar{k}^{\alpha-1} \end{bmatrix} \begin{bmatrix} c - \bar{c} \\ k - \bar{k} \end{bmatrix}$$

$$= \begin{bmatrix} 0 & -\sigma(1 - \alpha)\delta(\delta + a/\bar{k}) \\ -1 & \delta \end{bmatrix} \begin{bmatrix} c - \bar{c} \\ k - \bar{k} \end{bmatrix}.$$

The characteristic roots of the matrix above are real and of opposite sign, equal to

$$(10) \quad \lambda^{+}, \lambda^{-} = \{\delta \pm [\delta^2 + 4\sigma(1 - \alpha)\delta(\delta + a/\bar{k})]^{1/2}\}/2.$$

It is the negative, stable root λ^- alone that governs the economy's motion along SS in figure 2.

It can be shown that, along SS, consumption and the capital stock are given (as a function of the initial capital stock, $k(0)$) by:

$$c(t) - \bar{c} = (\delta - \lambda^-)[k(0) - \bar{k}]\exp(\lambda^- t),$$

$$k(t) - \bar{k} = [k(0) - \bar{k}]\exp(\lambda^- t).$$

Notice a key point: the greater the absolute value of λ^-, the faster the capital stock's convergence rate to the steady state, i.e., the faster the initial discrepancy $k(0) - \bar{k}$ is eliminated. A critical determinant of $|\lambda^-|$ is σ, the elasticity of intertemporal substitution, which, loosely speaking, measures consumers' willingness to tolerate a tilted consumption path. When σ is large, $u'(c)$ doesn't vary much as consumption changes, and, so, people find it optimal to arrange for rapidly growing consumption when the marginal product of capital is high compared with δ. This, in turn, implies a relatively low level of consumption in the early phases of the development process, and, correspondingly, a more rapid convergence to the steady state.

Dividing the first of the two last equations by the second shows that, near the steady state, SS is approximated by the linear equation

$$(11) \quad c(t) = \bar{c} + (\delta - \lambda^{-})[k(t) - \bar{k}].$$

This equation makes clear that changes in a affect consumption and investment through two channels: changing long-run consumption per capita, $\bar{c}$, and changing the negative root λ^{-} and, hence, the slope of SS and the economy's rate of convergence. (Recall that here, $\bar{k}$ is independent of a.)

The local (near the steady state) consumption effect of a change in a [given the current capital stock $k(t)$, which is predetermined by history] can be calculated as the sum of these two effects:

$$\frac{dc(t)}{da} = 1 - \frac{d\lambda^{-}}{da}[k(t) - \bar{k}],$$

where

$$\frac{d\lambda^{-}}{da} = -\sigma(1 - \alpha)\delta/\bar{k}(\delta - 2\lambda^{-}) < 0.$$

[These derivatives follow from differentiating (11) and (10), respectively.] If the economy is initially at its steady-state [$k(0) = \bar{k}$], all of a permanent increase in aid is consumed ($dc/da = 1$).[14] For an initial capital stock *below* the steady state [$k(0) < \bar{k}$], however, $dc/da < 1$. Figure 3 illustrates this effect when *a* rises from 0 to a positive level; the effect basically follows from the fact that, even with zero capital, aid makes possible positive levels of consumption and saving. Consumption rises by less the greater is the difference between $\bar{k}$ and the current capital stock. Furthermore, it can be shown that a higher value of σ lowers dc/da. Thus, for an economy below its steady state, a permanent increase in aid raises both consumption and investment in the short run, and raises the rate of convergence toward the steady state.

Figure 4 shows the effects of a temporary aid inflow *a*, which lasts from dates 0 to T.[15] The path indicated is determined by the implication of smooth consumption, that consumption not take an anticipated discrete jump on date T. Consumption jumps initially, as does investment, but the consumption growth rate subsequently declines and investment accelerates. On date T, the economy is again on the original saddle path SS; but the date T capital stock, k(T), is higher than it would have been in the absence of temporary aid. Obviously, both permanent and temporary aid inflows entail higher economic welfare for the recipient country.

Constrained foreign borrowing

A more intricate analysis applies to the case of an exogenous easing in

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[14] This is the application of the present model emphasized by Eaton (1989).

[16] Schmidt-Hebbel and Serven also consider this experiment in their simulation model.

[16] Schmidt-Hebbel and Serven (1995) have explored a related but much more detailed model. I discuss its results at several points in this chapter.

a country's foreign borrowing constraint. (Of course, the borrowing of a country whose capital-market access is constrained only by its intertemporal budget constraint is endogenous, so any additional gross capital inflow would merely generate an equal gross outflow in equilibrium.) Suppose that, at time 0, a country previously excluded from the international capital market gains the opportunity to borrow a fixed amount n per period at an interest rate $r \leq \delta$. Suppose that the government auctions these resources to the private sector at the going rate of interest.

Since $f'(k) > \delta \geq r$ as long as the capital stock is below $\bar{k}$, it will pay for the economy to borrow the full available amount n each period. The gains from fully investing n are obvious, but, in general, the economy can better satisfy its social welfare objective by consuming part of what it borrows. At the time T when k first reaches $\bar{k}$, $f'(\bar{k}) = \delta$ and foreign borrowing stops provided we make the extra assumption that $r = \delta$. Steady-state consumption is determined by the obligation to service the debt nT incurred between dates 0 and T:

$$(12) \quad \bar{c} = f(\bar{k}) - \delta nT.$$

Figure 5 shows the economy's path once the borrowing opportunity appears at time 0. Prior to date 0, the economy is on the saddle path SS associated with financial autarky. Once borrowing is available in the amount n, all of which is used, the equation of motion for capital is given by equation (8), with a set equal to n. Correspondingly, the phase diagram for the system's motion after time 0 corresponds to the *cum*-aid case in figure 3, with $a = n$.

The economy's path is given by AB, the divergent path of the latter phase diagram that terminates at $\bar{c}$ in (12) exactly at time T. An initial consumption level above c(0) would slow capital accumulation and lengthen T, thus necessitating a sharp anticipated downward jump in c(T) to $\bar{c}$ when k reached $\bar{k}$. An initial consumption level below c(0) would shorten T, and, by similar logic, imply an expected upward jump of c(T) when $k(T) = \bar{k}$. Thus, the problem has a determinate solution. Analytically, the precise path can be determined by solving for the unknowns c(0) and T:

$$\bar{c} = f(\bar{k}) - \delta nT = c(0)\exp\left[\int_0^T \sigma\{f'[k(s)] - \delta\}ds\right],$$

$$\bar{k} = k(0) + \int_0^T \{f[k(s)] - c(s)\}ds + nT,$$

when c and k follow (9) and (8) (the latter with $a = n$) for $0 \leq s \leq T$.

More interesting than these computational questions are the qualitative properties of the path AB in figure 5. Consumption rises in the short run, as does investment, but the need to service debts in the long run makes long-run consumption lower. Nonetheless, the economy is better off than under financial autarky, because it can arrange for a more nearly level consumption path over the course of its development. Furthermore, the economy's convergence to the steady state is hastened by an ability to borrow even a limited amount. Notice that c(0) rises by less, and investment by more, than in the case where the foreign resource inflow is outright aid rather than a loan. This result points, once again, to the importance of distinguishing the effects of the grant and loan components of aid inflows.

As noted above, the preceding model can be viewed as one with an intergenerational structure, but in which a planning authority allocates consumption so as to maximize a social welfare function.[17] For positive purposes, it might be more appropriate to proceed with an overlapping generations structure similar, for example, to those proposed by Blanchard (1985) or Weil (1989). The principles governing the effects of resource inflows in those models are quite similar to those sketched above. A major complication is that, with an overlapping-generations structure, permanent aid inflows or any past borrowing can affect the steady-state stock of capital. Furthermore, government tax/subsidy policies associated with the disbursement of aid or the servicing of foreign debts will affect the economy's saving behavior, as stressed by Eaton (1989).[18]

Any attempt to use models such as these for predictive purposes must contend, not only with demographic complexity, but with a host of structural issues such as imperfect domestic credit markets, distorting taxes, the conditionality (or lack thereof) of foreign resource inflows, the agendas of the agents who make up the government, etc. The role of relative prices, also ignored up until now, can be critical as well. In the next section I sketch a basic empirical analytical framework that can be adapted to account for such issues.

5.3 A basic framework for investigation

This section sketches a bare-bones empirical framework suitable for

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[17]See Calvo and Obstfeld (1988) for a formal justification.

[18]The economy's steady-state capital stock can be affected by permanent aid, even in the absence of overlapping generations, if some relative prices are endogenously determined, including the case in which there is an endogenous domestic labor supply. An endogenous rate of private time-preference would also lead to variable steady-state capital intensity. So would any effect of aid on the long-run rate of capital taxation.

examining the impact of foreign resource inflows under more realistic assumptions. Two models are examined, one a standard optimal-growth model with a set of liquidity constrained consumers, the other an endogenous growth model. One approach to applying the general framework of this section is to construct a medium-scale macroeconomic model capturing the major determinants of consumption and investment behavior in a dynamic setting. The basic models can be tailored to the particular economy under study by modifying parameter values and institutional features to fit known empirical regularities. The approach thus can, at least potentially, answer more detailed questions than the prevalent cross-sectional regression methodology, and it has the definite advantage of laying bare the structural, causal mechanisms through which resource inflows operate on the economy. As mentioned earlier, the work of Schmidt-Hebbel and Serven (1995) exemplifies this use of a related but more detailed model. The basic model can also be applied to *normative* questions: for a given social welfare function, what fraction of resource inflows *should* an economy be investing domestically?

The drawback of this "calibration" approach is that, while models can be tailored to fit the most salient empirical regularities, they can never match the data perfectly nor can we be certain that some other model doesn't underlie the empirical data generating process. The interpretation of *any* econometric work, however, requires *some* maintained identifying assumptions, some stance on the underlying economic model. The approach I sketch here has the advantage of making the identifying assumptions explicit, hence, in principle, refutable.

A second approach to applying the framework sketched in this section is to use it as a guide to econometric specification. This is the promising tack taken by Boone (1994, 1996), whose approach could be extended in several ways, including the explicit estimation of nonbalanced-growth models.

I have deliberately kept the models described below simple--indeed, simple enough to understand intuitively and to solve without extensive computation. I examine one experiment, a permanent and unanticipated increase in aid inflow to an economy that is shut off from world capital markets. One could modify the basic model to look at more subtle capital-market imperfections.

One important message of this section's analysis is that the saving and growth dynamics induced by resource inflows are likely to be quite intricate. Cross-sectional econometric studies that ignore temporal factors can throw no light on these dynamics.

A basic model

Per capita output is produced according to the technology

$$y_t = Ak_t^{\alpha},$$

and, if a is the permanent level of aid inflow and θ the depreciation rate of capital, capital evolves according to

$$k_{t+1} = (1 - \theta)k_t + y_t + a - c_t. \tag{13}$$

In actual applications, it would be important to allow for secular per capita growth in the form of a trend increase in the technology parameter A.

There are two classes of consumers. Class 1 consumers are intertemporal maximizers with access to perfect capital markets. Each class 1 consumer maximizes

$$\sum_{t=0}^{\infty}\beta^{t}u(c_{1t}) \qquad (0 < \beta < 1),$$

subject to a standard present-value budget constraint. As usual, a condition for intertemporal optimality is the consumption Euler equation

$$(14) \quad u'(c_{1t}) = \beta(1 + r_{t+1})u'(c_{1t+1}),$$

where $r_{t+1} = \alpha Ak_{t+1}^{\alpha-1} - \theta$ is the domestic real rate of interest between periods t and t + 1. A class 2 consumer owns no assets and consumes all of labor income. On the assumption that aid is rebated to the population in an egalitarian fashion, the consumption of a representative class 2 consumer is

$$(15) \quad c_{2t} = a + (1 - \alpha)Ak_{t}^{\alpha}$$

(recall that $1 - \alpha$ is labor's share of GDP under a Cobb-Douglas production function).

Aggregate consumption per capita is a weighted average of c_{1t} and c_{2t}:

$$(16) \quad c_{t} = \psi c_{1t} + (1 - \psi)c_{2t}.$$

Assuming the earlier isoelastic form for u(c), (14) takes the form:

(17) $$c_{1t+1} = \beta^{\sigma}\left[1 + \alpha A k_{t+1}^{\alpha-1} - \theta\right]^{\sigma} c_{1t}.$$

Using (15) and (16), one can rewrite (13) in terms of c_{1t} as

(18) $$k_{t+1} = [1 - (1 - \psi)(1 - \alpha)]Ak_t^{\alpha} + \psi a + (1 - \theta)k_t - \psi c_{1t}.$$

The steady state for this system in c_1 and k is:

$$\bar{c}_1 = a + (1/\psi)\{[1 - (1 - \psi)(1 - \alpha)]A\bar{k}^{\alpha} - \theta\bar{k}\},$$

$$\bar{k} = \left(\frac{\alpha A\beta}{1 - \beta + \beta\theta}\right)^{1/(1-\alpha)}.$$

Linearization of (17) and (18) near the steady state[19] yields the difference-equation system

$$\begin{bmatrix} c_{1t+1} - \bar{c}_1 \\ k_{t+1} - \bar{k} \end{bmatrix} = \begin{bmatrix} 1 - \psi\xi_{ck} & \xi_{ck}(1 + \xi_{kk}) \\ -\psi & 1 + \xi_{kk} \end{bmatrix} \begin{bmatrix} c_{1t} - \bar{c}_1 \\ k_t - \bar{k} \end{bmatrix},$$

where $\xi_{ck} = \beta\sigma\bar{c}_1\alpha(\alpha - 1)A\bar{k}^{\alpha-2}$ and $\xi_{kk} = [1 - (1 - \psi)(1 - \alpha)]\alpha A\bar{k}^{\alpha-1} - \theta$. The stable characteristic root of this system is

$$\lambda^{-} = \{2 + \xi_{kk} - \psi\xi_{ck} - [(2 + \xi_{kk} - \psi\xi_{ck})^2 - 4(1 + \xi_{kk})]^{1/2}\}/2.$$

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[19]An alternative approach would be to log-linearize, as in Campbell (1994).

In a neighborhood of the steady state, the consumption of class 1 consumers is related to the aggregate capital stock by

$$(19) \qquad c_{1t} = \bar{c}_1 + \left(\frac{1 + \xi_{kk} - \lambda^-}{\psi}\right)(k_t - \bar{k}).$$

Using (16), (18), and (19), one can investigate the effects of changes in a for alternative parameter values. I assume below that $\alpha = 0.4$, $\psi = 0.6$, $\theta = 0.1$, $\beta = 0.97$, and $\sigma = 0.4$ (a value in line with Ostry and Reinhart's 1992 estimates for developing countries). I also assume an initial capital-output ratio of 1 and that initial per capita output is 1000 real 1994 dollars per year. The last assumptions imply A = 63.1, given that α = 0.4. The long-run capital-output ratio is 3.06.

Dynamic effects of aid

The experiments look at the effects of a permanent, unexpected increase in a from 0 to 10 (which equals 1 percent of initial GDP). The variables of primary interest are consumption, net investment, and the growth rate of net output, $y - \theta k$. Because there is no opportunity to lend or borrow abroad, the net saving rate equals the net investment rate, Δk, and the current account is identically zero. Notice that, in calculating net saving, I therefore include a as a component of national income:

$$(20) \qquad s_t = a + y_t - \theta k_t - c_t.$$

Figure 6 shows the effect on (net) saving (and, by implication, on net investment) of an unexpected permanent rise in a from 0 to 10. Saving rises slightly initially, eventually falling below its initial level. Figure 7 shows the difference that the aid makes to saving. Slightly more than a tenth of the aid translates initially into higher saving and investment, the balance going into consumption. Over time, however, output and savings both rise above their initial levels. After seven years, saving is about 1.6 dollars higher than in the baseline simulation. Then it falls sharply to, and below, the baseline level.

Saving ultimately must fall because the long-run capital stock is independent of aid. Thus, because aid accelerates investment, it also accelerates the rate at which the real rate of return falls over time. Ultimately, this leads to saving below the baseline ($a = 0$) level. Asymptotically, saving converges to zero with or without aid.

The aggregate consumption effects underlying these saving results are shown in figure 8. Initially, each class 1 consumer raises her consumption by about $8.22 while each class 2 consumer raises his by the full $10 of higher disposable income. Thus, the initial rise in aggregate consumption per capita is $(0.6) \times (\$8.22) + (0.4) \times (\$10) = \$8.93$. Figure 9 shows that aid has a greater impact on consumption in early years than later on (where the positive effect on consumption asymptotes to $10). This "bulge" simply reflects the higher level of output in the short run, which temporarily depresses domestic real interest rates relative to their baseline path.

In their model, which is based on the preceding optimal-growth paradigm but allows for several of the extensions listed at the end of this section, Schmidt-Hebbel and Serven (1995) also find that most of a permanent aid inflow is consumed. Investment rises in the short run because an endogenous terms-of-trade improvement raises the long-run capital stock. Replacement investment in the steady state also is higher.

Figure 10 shows the difference in the present model that aid makes for the growth rate of net output. The additional saving of class 1 consumers promotes growth initially, but, since the long-run output level is independent of aid, this temporary acceleration of growth must be repaid later in the form of growth below baseline. (However, positive growth today, when consumption is low, is worth more than the same amount of negative growth later when consumption is comparatively high.) All growth effects are quantitatively small, but the amount of the aid is also quite a small fraction of GDP. Very large amounts of aid (relative to GDP) naturally could have palpable growth effects in the short run.

Net growth effects over time would require a model in which growth is endogenous, or a "big push" model (à la Murphy, Shleifer, and Vishny 1989) with scale effects in which aid facilitates a larger market and a permanent rise in output. (An overlapping generations model could also generate net growth effects, but at a level less likely to be quantitatively important.) The incorporation of such features into the model is feasible--examples exist in the literature on "real business cycles"--and suggests an important line of future research.

While the present model is special, the small initial effect of aid on investment seems likely to be a robust feature of any plausible model in which aid is funneled through the private sector. One could increase this investment response by raising σ, as discussed in the last section, but few researchers believe σ to be significantly above 1. Aid funneled through the government could have a greater impact on investment if the crowding out effect on private investment were not too strong. But there is little evidence that, in practice, governments have a higher marginal propensity to invest than the private sector. The result that even intertemporally optimizing consumers save far less than half of an aid inflow renders extremely implausible any causal interpretation of reduced-form regression results showing big effects of aid on aggregate investment or growth. The result also raises the question of the desirability, on welfare grounds, of a large investment response. The next model has similar implications.

An endogenous growth model

An example using an endogenous growth model indicates how the effects of aid inflows can be evaluated in that setting. The model used is the physical/human capital model of Uzawa (1965), as exposited by Barro and Sala-i-Martin (1995, chapter 5.2). The particulars of the model applied would vary with the country case at hand, but the following account exposes economic forces likely to be at work in most endogenous-growth settings.

In this model the supply of raw labor is constant and normalized at 1. Raw labor can be viewed as a fixed factor in the production of output, y, which also depends on physical capital, k, and human capital, h, according to the production function

$$(21) \quad y = Ak^{\alpha}(uh)^{1-\alpha},$$

where $u \in [0,1]$ is the fraction of the economy's human capital stock allocated to production. The balance of the human capital, $1 - u$, is used in producing new human capital ("education"), so that the stock of human capital evolves according to

$$(22) \quad \dot{h} = B(1 - u)h - \theta h,$$

where B, like A, is a productivity coefficient and θ is the capital depreciation rate. (Continuous time simplifies the derivations now.) Both A and B are assumed constant. The stocks of physical and human capital, and therefore their ratio,

$$\omega \equiv k/h,$$

are predetermined state variables of the economy.

The representative individual again maximizes (7), subject to (21), (22), and

$$(23) \quad \dot{k} = y + ak - c - \theta k,$$

where a is the aid inflow, expressed as a fraction of the capital stock. In what follows I will take a to be a permanent constant (for the purpose of having a steady state with aid), but I will assume that the dependence of total aid on k is ignored by domestic investors in making their decisions; that is, the aid recipient takes the product ak as given. Under this assumption, consumption follows the Euler equation

$$(24) \quad \dot{c}/c = \sigma[\alpha A u^{1-\alpha}\omega^{-(1-\alpha)} - \theta - \delta]$$

when u(c) is isoelastic.

Following Barro and Sala-i-Martin (1995), define

$$\chi \equiv c/k.$$

Then (32) and (24) imply that

$$(25)\qquad \dot{\chi}/\chi = (\alpha\sigma - 1)z + \chi - [\theta(\sigma - 1) + \delta\sigma] - a,$$

while (since $\omega \equiv k/h$), (21), (22), and (23) imply that

$$(26)\qquad \dot{\omega}/\omega = Au^{1-\alpha}\omega^{-(1-\alpha)} - \chi - B(1 - u) + a.$$

Finally, the optimality condition for u is

$$(27)\qquad \dot{u}/u = - \chi + Bu + B\left(\frac{1 - \alpha}{\alpha}\right) + a,$$

as a simple modification of Barro and Sala-i-Martin's discussion shows. The model has a steady-state balanced growth path in the variables $\omega = k/h$, $\chi = c/k$, and u, such that the *absolute levels* of c, k, and h grow at equal constant rates given by (24). The critical simplification Barro and Sala-i-Martin suggest is to define the average product of capital (which also is constant in the steady state),

$$(28)\qquad z \equiv Au^{1-\alpha}\omega^{-(1-\alpha)},$$

and to notice that (26) and (27) imply

$$(29)\qquad \dot{z}/z = (1 - \alpha)(B/\alpha - z).$$

This step is useful because the system consisting of (29), (25), and (27) is relatively easy to analyze.

To do so, solve for the steady-state values

$$(30) \qquad \bar{z} = B/\alpha, \quad \bar{\chi} = a + [\theta(\sigma-1) + \delta\sigma] + \frac{(1-\sigma\alpha)B}{\alpha}, \quad \bar{u} = 1 - \sigma + \frac{[\theta(\sigma-1) + \delta\sigma]}{B}.$$

As in the standard optimal growth model, aid affects steady-state consumption one-for-one, but has no other steady-state affect on the economy. Thus, one must look at the transition path to find effects of aid on investment. The model's linearization around the steady state is:

$$\begin{bmatrix} \dot{z} \\ \dot{\chi} \\ \dot{u} \end{bmatrix} = \begin{bmatrix} -(1-\alpha)\bar{z} & 0 & 0 \\ (\alpha\sigma - 1)\bar{\chi} & \bar{\chi} & 0 \\ 0 & -\bar{u} & B\bar{u} \end{bmatrix} \begin{bmatrix} z - \bar{z} \\ \chi - \bar{\chi} \\ u - \bar{u} \end{bmatrix}.$$

The characteristic roots of this system are apparent from inspection: they are $-(1 - \alpha)\bar{z}$, $\bar{\chi}$, and $B\bar{u}$. The linearized model has a unique saddle path along which z, χ, and u evolve according to

$$(31) \qquad z(t) - \bar{z} = [z(0) - \bar{z}]\exp[-(1-\alpha)\bar{z}t],$$

$$(32) \qquad \chi(t) - \bar{\chi} = \left(\frac{(1-\alpha\sigma)\bar{\chi}}{\bar{\chi} + (1-\alpha)\bar{z}}\right)[z(0) - \bar{z}]\exp[-(1-\alpha)\bar{z}t],$$

$$(33) \qquad u(t) - \bar{u} = \left(\frac{(1-\alpha\sigma)\bar{\chi}}{\bar{\chi} + (1-\alpha)\bar{z}}\right)\left(\frac{\bar{u}}{B\bar{u} + (1-\alpha)\bar{z}}\right)[z(0) - \bar{z}]\exp[-(1-\alpha)\bar{z}t].$$

Provided $\alpha\sigma < 1$, as conventional estimates imply, z and χ rise or fall together along the saddle path, implying that c/k rises as k/h falls. The reason is that a high initial k/h (say) implies a low real interest rate and, through the income effect, a low initial consumption level relative to the capital stock.

In simulating an unexpected shock to the model, it is important to remember that z is *not* a state variable. However, ω is, so (33) can be used to eliminate u(0) from (28), allowing solution for z(0) in terms of $\omega(0)$, which is predetermined at $t = 0$, and the new steady state values of z, χ, and u.

Figure 11 shows the consumption effect of a permanent unexpected aid inflow equivalent to 1 percent of the capital stock. For this simulation, I set B, the steady-state marginal product of capital, at 0.18, $\alpha = 0.4$, $\sigma = 0.4$, $\theta = 0.1$, $\delta = 0.3$, and normalize $A = 1$. With an aid inflow of zero, the initial steady state is

$$\bar{z} = B/\alpha = 0.45,\ \bar{\omega} = 1.06,\ \bar{u} = 0.33,\ \bar{\chi} = \overline{c/k} = 0.33.$$

Steady-state growth, the hallmark of endogenous growth models, is at 2 percent per year. The long-run values of z, ω, and u are unaffected by the aid, as is the long-run growth rate, but $\bar{\chi}$ rises by 0.01. In the short-run, however, aid effects all the model's endogenous variables. I assume that, initially, $\omega(0)$ is given at $1.5 > \bar{\omega} = 1.06$. Thus the economy initially is rich in physical relative to human capital. (The endogenous growth model's impulse responses do not depend on the country's absolute wealth, just on the initial imbalance between the two types of capital.)

Figure 11 shows that c/k initially jumps, but by less than the full amount of the aid, 0.01. The initial jump is 0.00769: 76.9 percent of the aid is consumed initially. (The initial consumption jump would be even greater were some consumers liquidity constrained.) It is important to notice that if the economy were in a starting position with $\omega(0) < \bar{\omega}$, c/k would rise by *more than* a. Alternatively, with $\omega(0) > \bar{\omega}$ but $\alpha\sigma > 1$, c/k would jump initially by more than a. There thus is no presumption in this model that all aid will not be consumed, even in a country at a total wealth level that is low relative to developed-country total wealth levels.

Interestingly, aid that is not consumed does not go entirely into physical capital accumulation, although investment does rise slightly (see figure 12). When aid is received, u immediately falls. As human capital is shifted from the final-goods sector to producing human capital, output falls and human capital accumulation accelerates.

The initial reallocation of human capital from the output to the "educational" sector lowers the initial rate of return to physical capital. According to Euler equation (24), consumption growth dips temporarily.

This endogenous-growth model confirms the earlier growth model's prediction that, optimally, most aid will and should be consumed. An interesting finding is that, for the parameter constellation above, a country richly endowed with human relative to physical capital will consume more than its total marginal aid inflow. The model cautions that the effects of aid on investment may well show up in human rather than physical capital accumulation.

Extensions

This section has illustrated a basic methodology for exploring the impact of foreign resource inflows within dynamic models. The models were deliberately chosen to be rather generic. Applications to individual economies would require country-specific modeling of various technological and institutional features.

A number of modifications to the basic models might be necessary to match the features of specific economies. Stochastic elements could be introduced, allowing calibration of the model to observed moments of macro-variables or to impulse-response functions from identified vector autoregressions. Explicit recognition of the economy's stochastic structure would permit a more detailed treatment of the saving behavior of financially constrained consumers, possibly along the lines sketched by Deaton (1989).

The endogeneity of labor supply and labor-force participation should be modeled. A more detailed account of demographic structure would allow an examination of how the channeling of foreign resources to different generations influences its impact on the economy.

Relative prices, especially the relative price of nontradables, need to be considered. A body of research (for example, van Wijnbergen 1986) suggests that aid inflows have real exchange rate effects that help determine their impact on saving.[20] Empirically, the association between market-determined inflows and real appreciation is well established (see, for example, Calvo, Leiderman, and Reinhart 1993). The model of Schmidt-Hebbel and Serven (1995) incorporates endogenous terms-of-trade effects, the classical transfer mechanism.

The government sector requires more detailed attention. Distorting taxes, productive public expenditure, and the endogenous response of the budget to resource inflows all are important determinants of saving and growth. The budgetary response, in reality, will result from the interaction of different political constituencies that compete for additional foreign-supplied resources. Policy conditionality that accompanies foreign

[20]For a theoretical analysis, see Edwards (1989).

resources can be built into the model's structure. Schmidt-Hebbel and Serven (1995) consider a fairly detailed model of government activities, including government debt, money creation, consumption, and investment subsidies.

Resource leakages though capital flight probably are important in practice in determining the impact of gross inflows. An important, but little-discussed empirical question is the extent to which capital flight limits the effectiveness of gross aid inflows. In addition, the model should endogenize key elements--sovereign risk, moral hazards, and the like--that may limit access to world capital markets.

The model above applied to the medium term, but its applicability to the short-run analysis of some economies would be enhanced by the addition of nominal rigidities. In general, the incorporation of monetary factors would allow an analysis of the impact of foreign resource inflows on inflation and seigniorage revenue. Schmidt-Hebbel and Serven (1995) incorporate money, as noted above, and a rigid real wage.

Finally, the preceding models have relied on *linear* solution procedures even though they may be inaccurate if (as I assumed above!) the economy initially is far from steady state. Schmidt-Hebbel and Serven (1995) solve their model through a modified multiple-shooting algorithm.

5.4 Conclusion

This chapter has surveyed the literature on the consumption, investment, and growth effects of foreign resource inflows. Early empirical research on the subject suffered from pervasive endogeneity of regressors, preventing a clear structural interpretation of least squares results. After surveying the empirical literature, including more recent contributions, I explored the effects of exogenous foreign resource inflows, both permanent and transitory, in dynamic representative-agent growth models. That discussion led to a description of neoclassical and endogenous growth models that might be calibrated to investigate the impact of additional foreign resource inflows, or applied in econometric testing and estimation.

An interesting and seemingly robust implication of these models is that even under intertemporal optimization by a unitary planner, much of any small resource inflow is likely to be consumed, not saved, so that even short-run growth effects are small for moderately sized inflows. From a policy perspective, the fact that aid and other inflows raise consumption in the short run is not necessarily a bad thing. After all, if the purpose of resource transfers to developing countries is to raise long-run consumption, the principle of consumption smoothing dictates that consumption also should rise in the short run.

Unfortunately, the consumption rises observed in practice often seem to be concentrated among the political elites rather than among those most in need of more resources. This suggests that in thinking about the effects of resource inflows and in designing efficient aid and lending programs, the question of who ultimately benefits from resources is as important as the question of how the resources are used.

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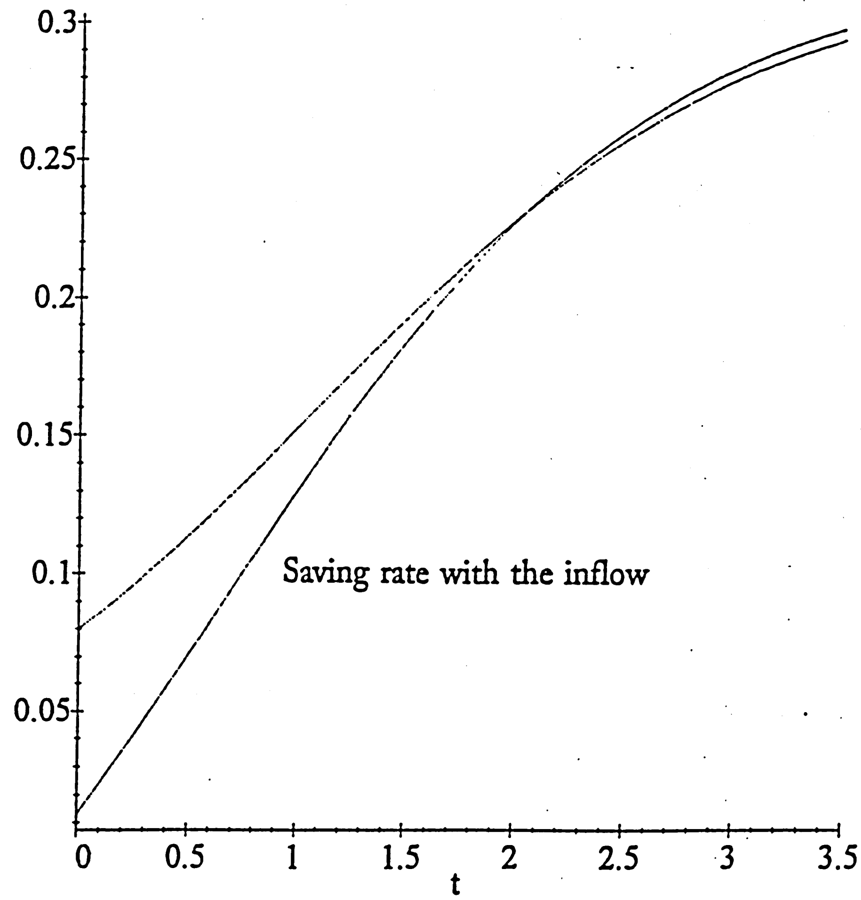


Figure 1: Dynamic effect of a resource inflow on the saving rate

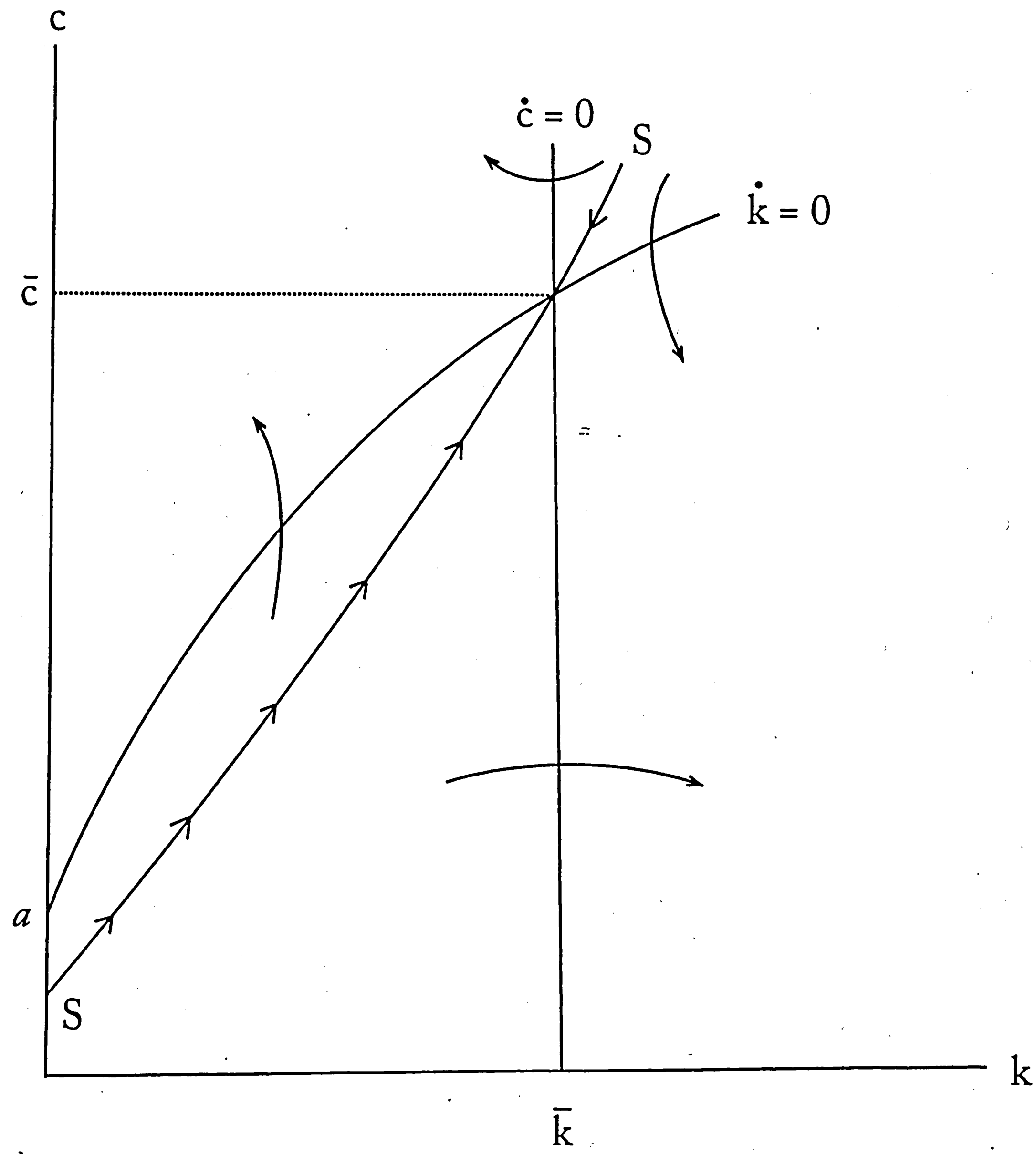


Figure 2: Adjustment to the steady state capital stock

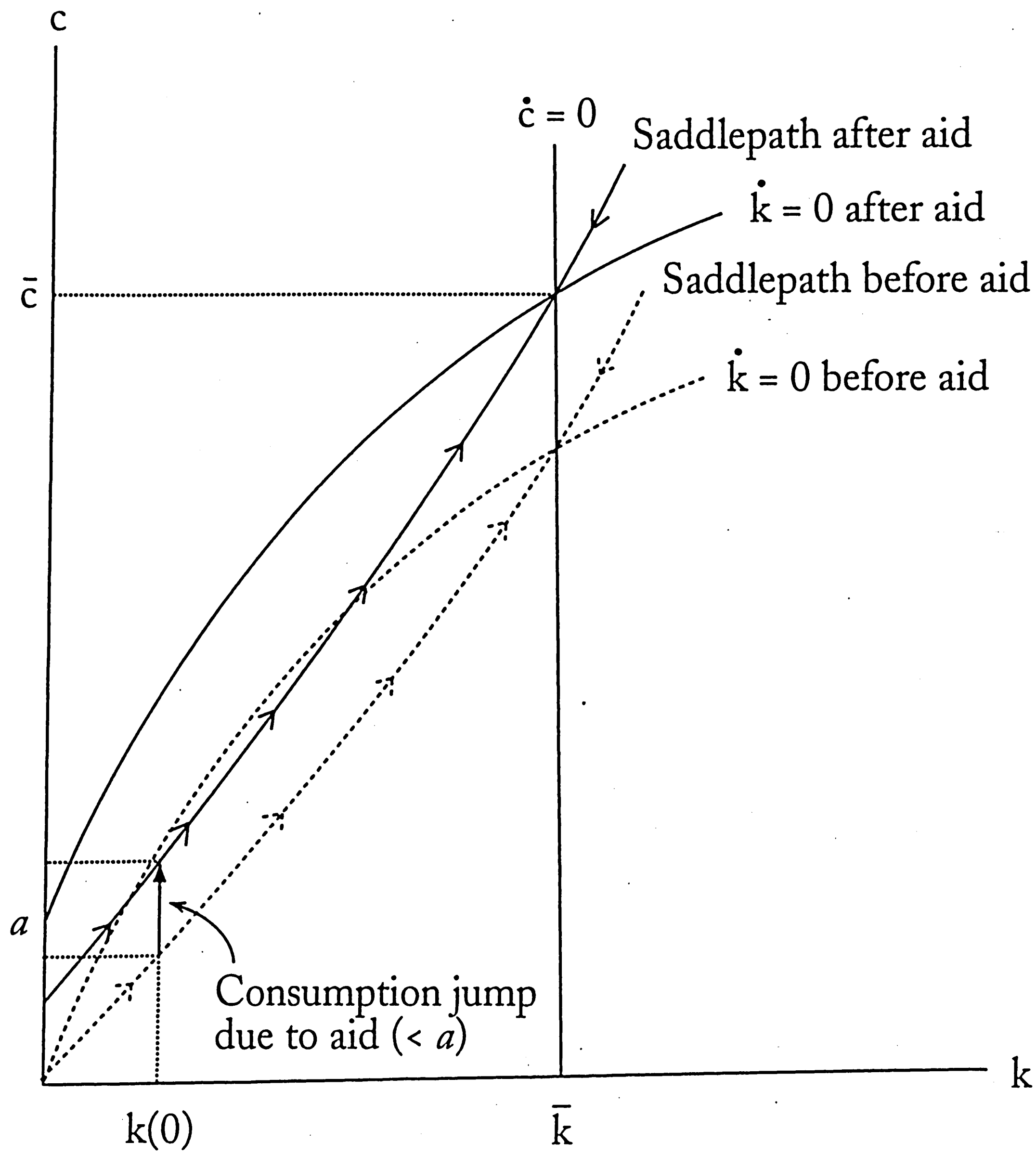


Figure 3: Permanent unexpected aid in the amount *a* causes consumption to jump initially by less than *a* if k(0) < $\bar{k}$

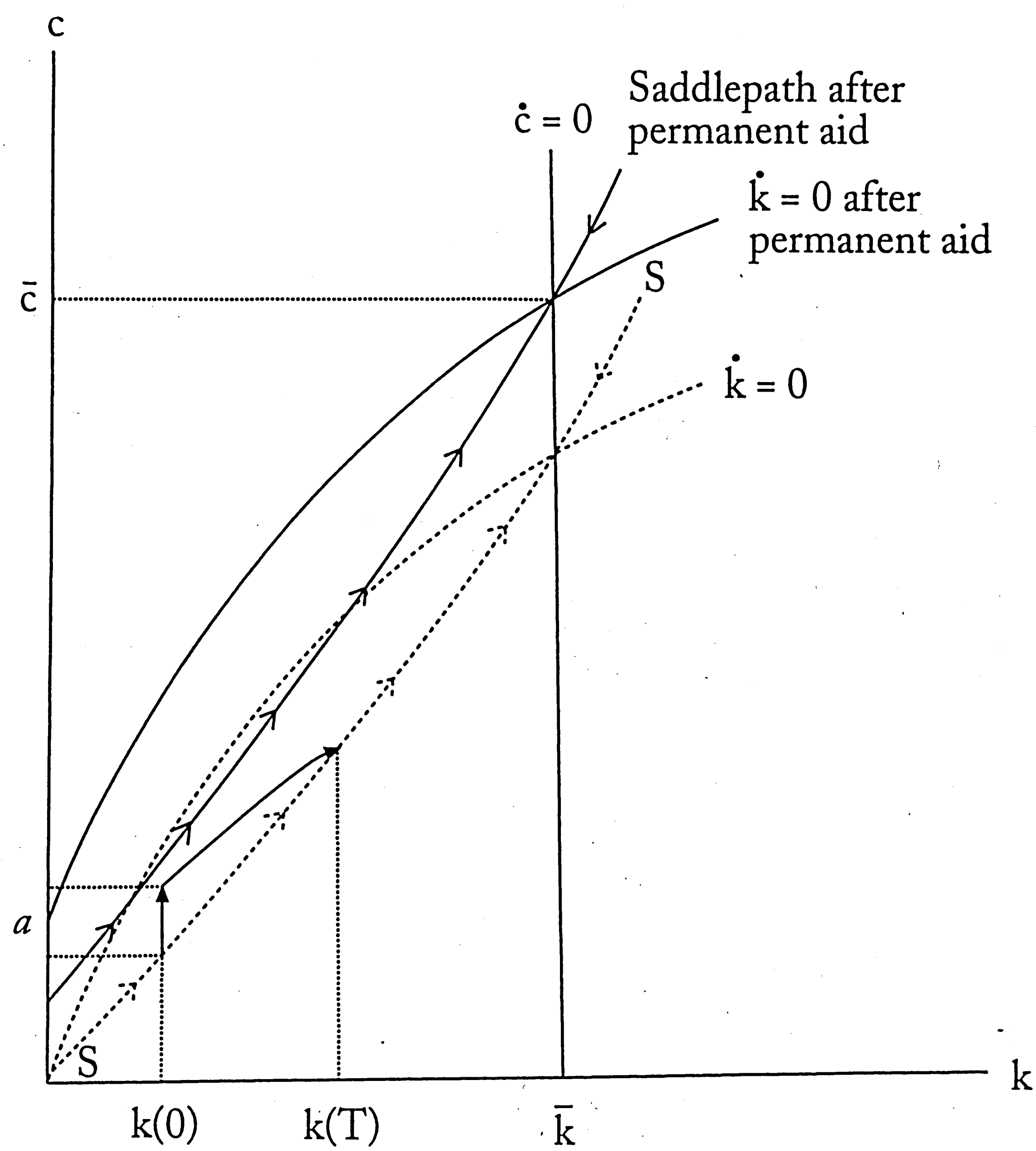


Figure 4: Unexpected temporary aid in the amount *a* causes a smaller consumption rise than equal permanent aid

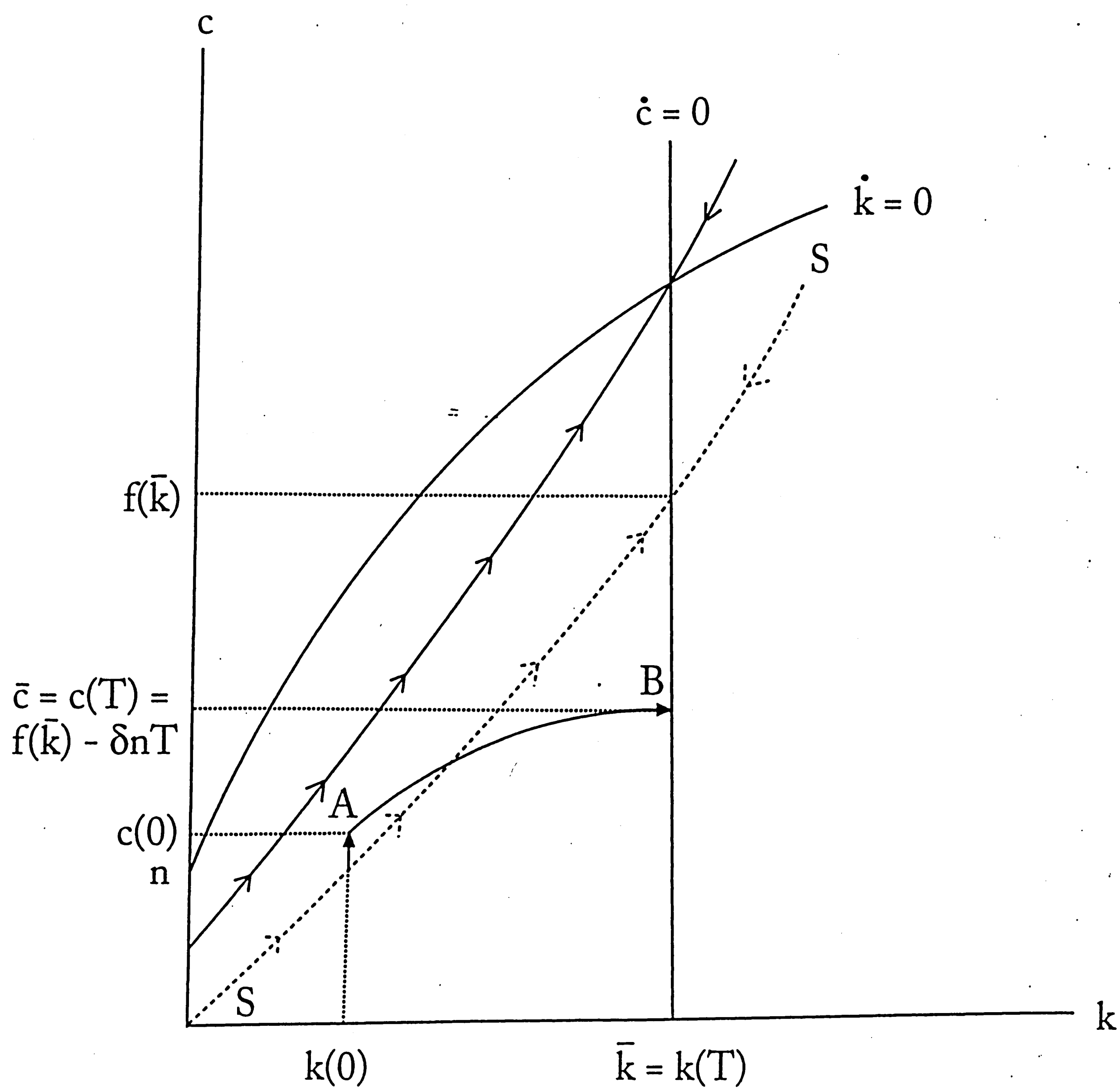
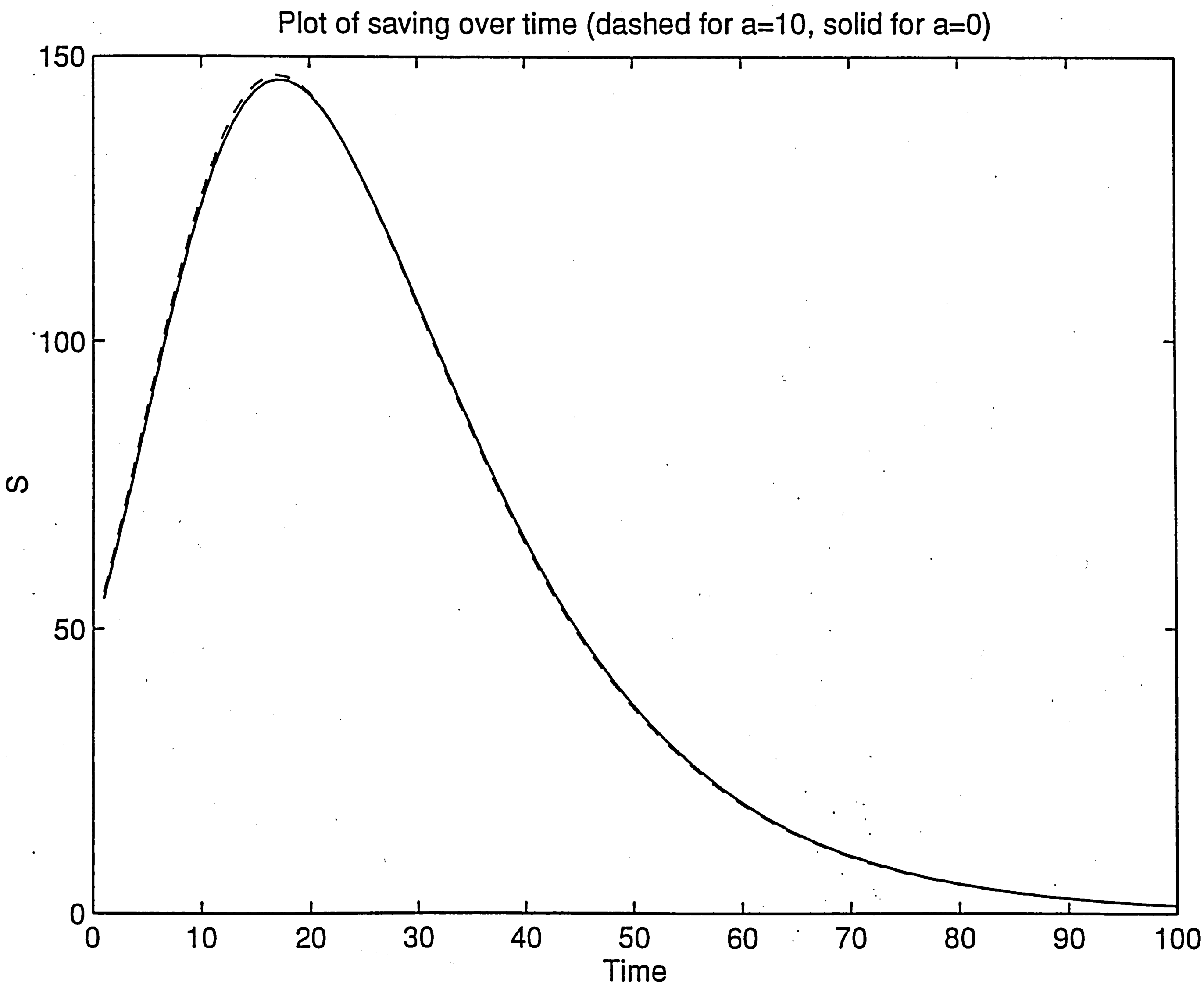


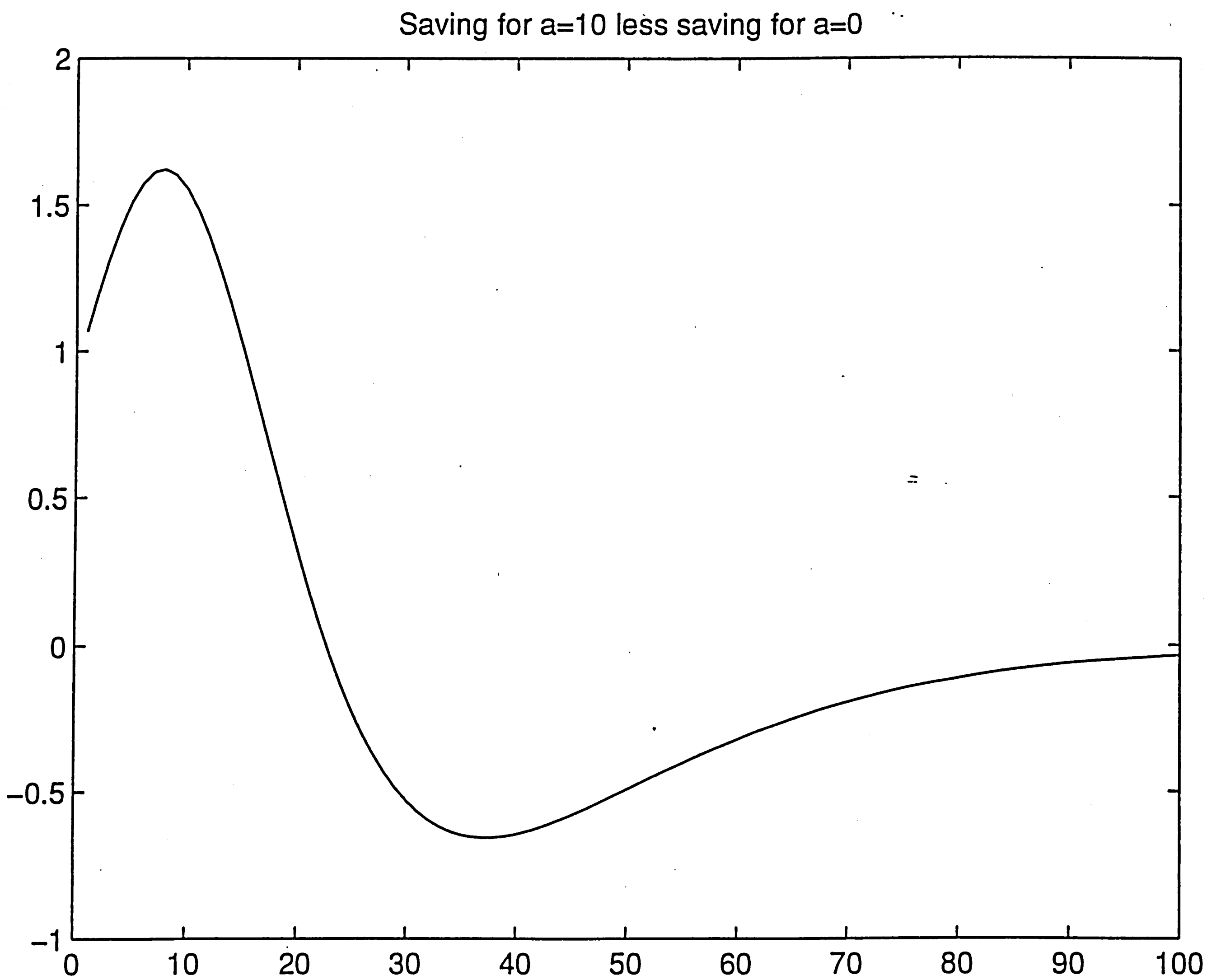
Figure 5: Adjustment to the steady state capital stock with a rationed foreign credit flow of n

Figure 6



Plot of saving over time (dashed for a=10, solid for a=0)
150
100
50
0
S
0
10
20
30
40
50
60
70
80
90
100
Time

Figure 7



Saving for a=10 less saving for a=0
2
1.5
1
0.5
0
−0.5
−1
0
10
20
30
40
50
60
70
80
90
100

Figure 8

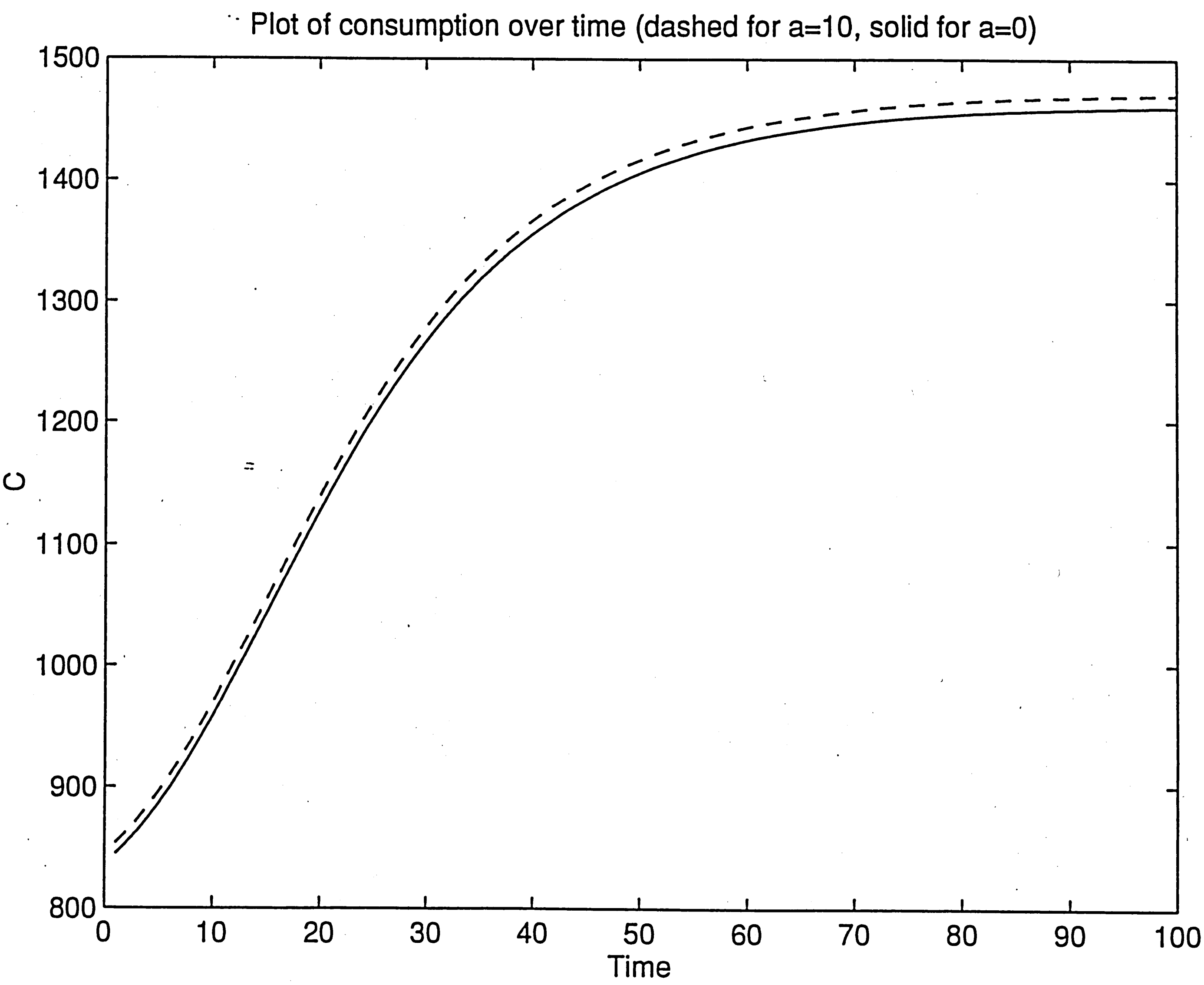
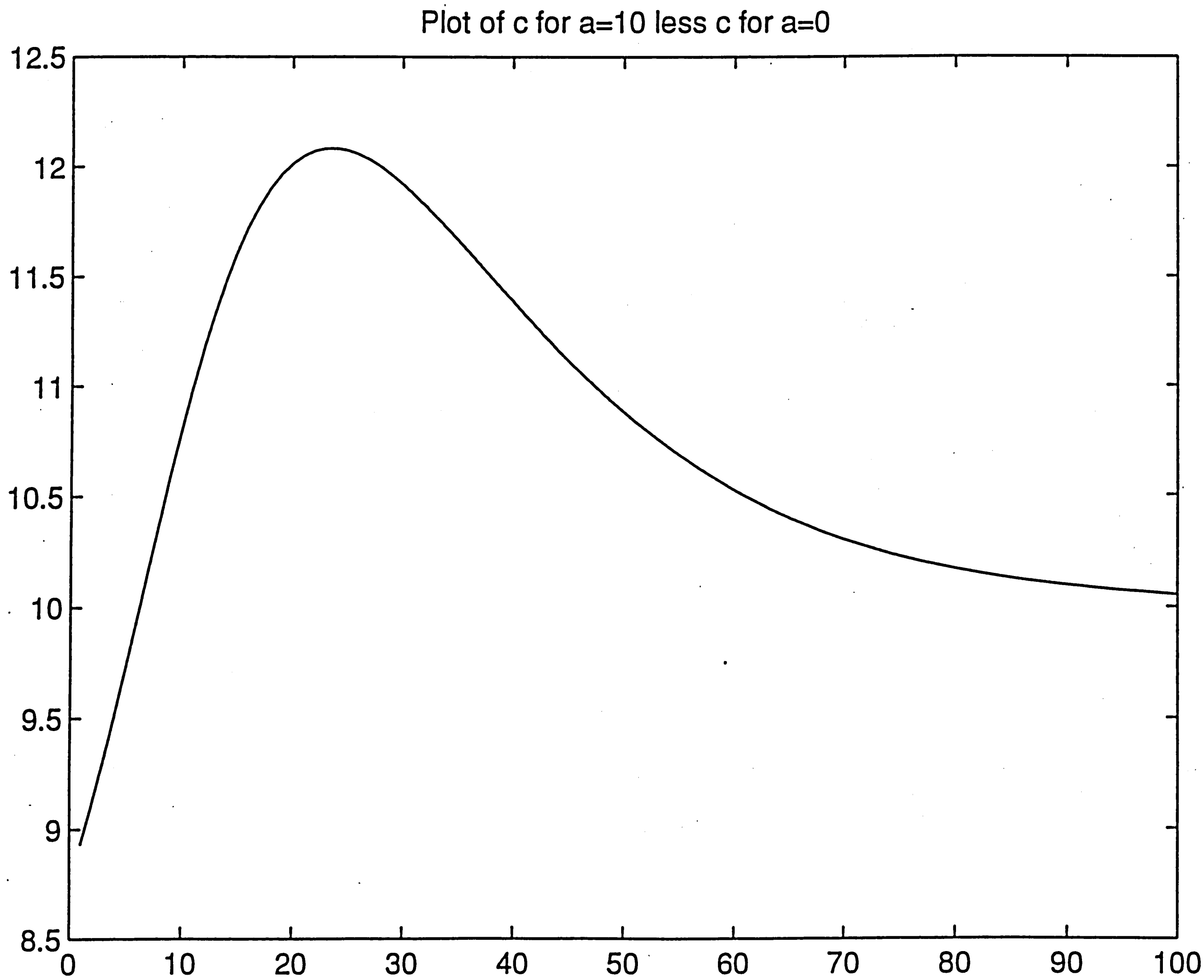
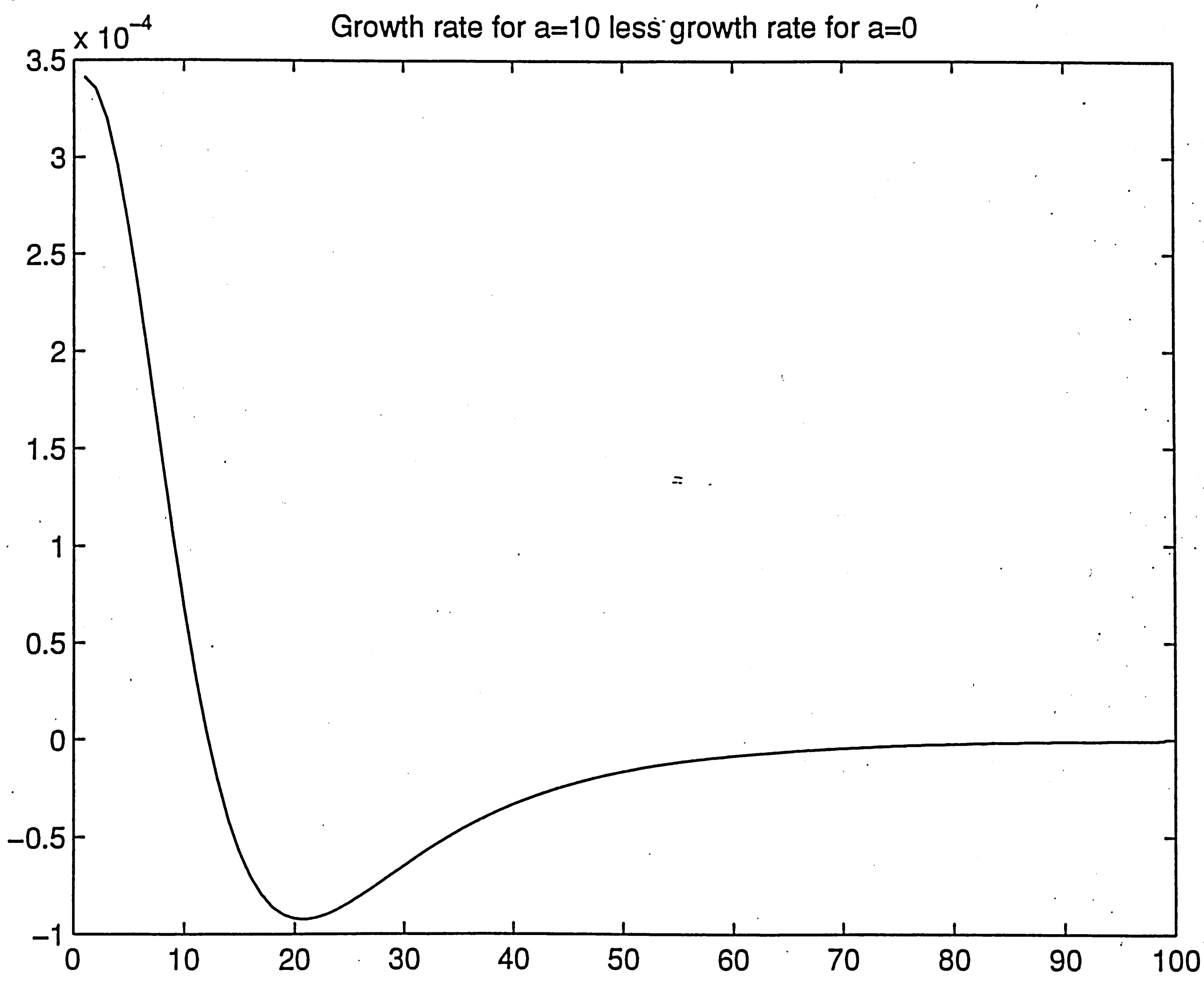

Plot of consumption over time (dashed for a=10, solid for a=0)
1500
1400
1300
1200
1100
1000
900
800
C
0
10
20
30
40
50
60
70
80
90
100
Time

Figure 9



Plot of c for a=10 less c for a=0
12.5
12
11.5
11
10.5
10
9.5
9
8.5
0
10
20
30
40
50
60
70
80
90
100

Figure 10


Growth rate for a=10 less growth rate for a=0
x 10^-4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
0
10
20
30
40
50
60
70
80
90
100

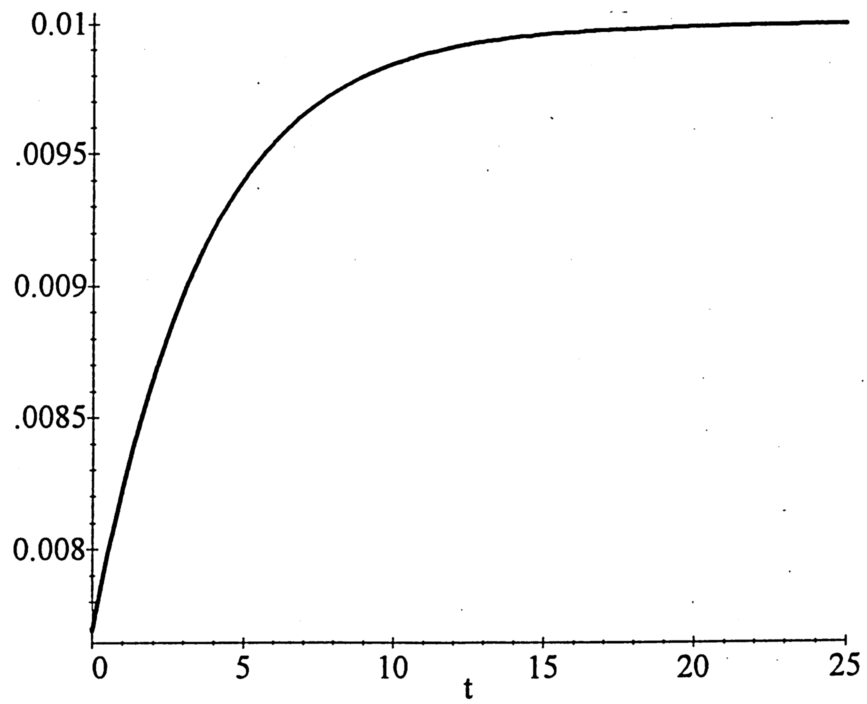


Figure 11: Effect of permanent aid equal to 1 percent of capital stock on c/k ratio

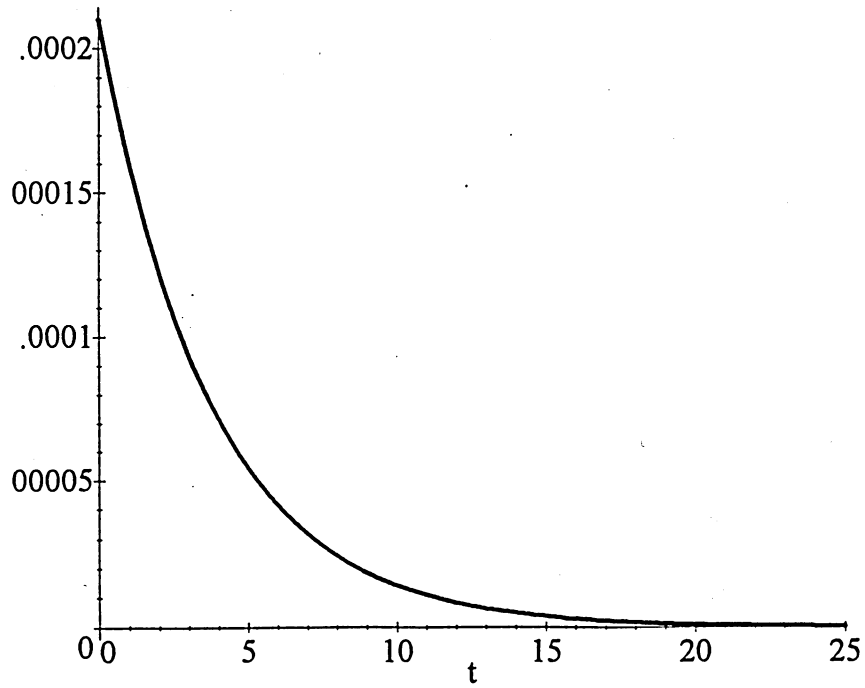


Figure 12: Effect of permanent aid equal to 1 percent of capital stock on capital-stock growth rate