The Nexus between Growth, Debt Sustainability and Public Investment in the ECCU[1]

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Abstract[3]

The main objective of the paper is to assess the link between public investment, economic growth and debt sustainability in the Eastern Caribbean Currency Union. A model similar to Buffie et at (2012) is calibrated to analyse the macroeconomic effects of public investment surges in the countries of the Eastern Caribbean Currency Union ECCU. The paper looks at the, i) the investment-growth linkages; (ii) public external and domestic debt accumulation; (iii) the fiscal policy reactions necessary to ensure debt-sustainability; and (iv) the macroeconomic adjustment required to ensure internal and external balance. The results from the model demonstrate that well-executed high-yielding public investment programs can have a concomitant increase on the level of economic output, boost private investment and consumption and most importantly not erode or lead to unfavourable debt dynamics in the long run. However, in situations where the program has poor execution, sluggish fiscal policy reactions, weak structural conditions in the domestic economy such a strategy can easily lead to unsustainable public debt dynamics. Front-loaded investment programs and weak structural conditions (such as low returns to public capital and poor execution of investments) make the fiscal adjustment more challenging and the risks greater.

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I. Introduction

The global recession has had a negative impact on economic activity in the Eastern Caribbean Currency Union ECCU region through the decline in tourism related activity and FDI-financed construction, the two pillars of economic growth in recent years. Growth has contracted for at least three consecutive years at the currency union level. At the same time the overall fiscal deficit has widened largely as a result of a plummet in revenues attributable to the contraction in economic activity. At the same time capital spending has fallen in most member states as they sought to maintain their current level of expenditure. Faced with budgetary pressures and political constraints, the room to manure is very narrow and limited and cuts to public investment have been seen as the easy way out.

The countries of the ECCU face a unique problem in that they are highly indebted countries with a narrow economic and tax base. However they have development agenda to which the Government has to provide the necessary infrastructure for the countries to develop. Public investment has a high profile in the small islands of the Eastern Caribbean Currency Union (ECCU), in common with many small states, it accounts for a large share of GDP. In part this not only reflects the limits of economies of scale in the provision of public goods, but also the regional perception that public investment is one of the main catalysts for economic growth and development. The recent economic crisis has seen numerous studies demonstrating the effectiveness of Government expenditure during an economic downturn. In particular the literature has shown that the multiplier for Government capital expenditure is quite large and under certain circumstances can exceed one. Armed with the knowledge some countries in the Currency Union have expressed that they need a stimulus package to reinvigorate growth in the countries. They expect to do so through an increase in public investment however the conundrum is how to do so without aggravating already very high debt positions.

The IMF-World Bank Debt Sustainability Framework has become the workhorse when investigating a country's probability debt distress; however, the model is not drawbacks and has faced criticism from some economist. Accordingly the tool has been criticised on the grounds that it does not present a consistent analytic framework for creating projections. For the purposes of this paper the criticism that stands most is the fact that IMF-WB DSF tool do not take sufficiently into account the relationship between public investment and growth. That is, the projections generally do not make an explicit linkage between the public investment that the proposed borrowing/debt is meant to finance and the resulting growth that should make the operation self-financing. This inflates debt indicators, such as debt-to GDP ratios, creates a bias toward conservative borrowing limits, and can amount "t*o sacrificing growth to imprecisely known debt sustainability risks*" (Wyplosz, 2007).

II. Objective

This paper investigates the link between public investment, economic growth and debt sustainability in the ECCU. Clearly the high debt to GDP ratios in the region presents a clear case for fiscal adjustment but the approach must be nuanced to the extent that the baby is not thrown out with the bath water. The cut in public investment has had a negative impact on economic growth; economic growth is a necessary but not sufficient condition to help address some of the economic issues confronting the countries. Therefore solid fiscal performance and economic recovery are not mutually elusive, they are mutually reinforcing. The discussion regarding fiscal policy in this adjustment phase focuses on three main questions: the timing of the process (*when*), the size of the required fiscal adjustment (*how much*), and its composition both in terms of revenues/expenditure, but also by type of taxes and expenditure items (*what to adjust*). A general agreement seems to be emerging with respect to at least two desirable conditions of the fiscal adjustment. First, it should be "*growth-friendly*" in the short run, which directs attention to the *timing* of the consolidation. Second, it should be "*development-friendly*" in the medium and long run, where more attention is devoted to its *composition.* The main objective of the paper is to assess ECCU public debt risks, considering the link between public investment and growth.

A model is developed a la Buffie et al (2012) to explore the macroeconomic effects of public investment stimulus package, making explicit: (i) the investment-growth linkages; (ii) public external and domestic debt accumulation; (iii) the fiscal policy reactions necessary to ensure debt-sustainability; and (iv) the macroeconomic adjustment required to ensure internal and external balance. Given that ECCU are countries with a pegged exchange rate regime and the government is committed to containing domestic financing to maintain the regime, it would be more realistic to allow a combination of domestic borrowing and external commercial borrowing. The model is therefore modified so that it supports a combination of different funding sources, concessional loans, domestic financing, and external commercial borrowing.

The model is essentially a standard two-sector model of a small open economy with a fixed exchange rate embellished with multiple types of public sector debt (concessional loans, domestic financing, and external commercial borrowing) and multiple tax and spending variables. The country produces a traded good and a non-traded good from private capital, labour, and government-supplied infrastructure. Besides these domestically produced goods, agents can import a traded good for consumption and machines to produce factories or whatever (private capital) and infrastructure (public capital). All quantity variables except labour are detrended, the exogenous long-run growth rate of real GDP. A composite good produced abroad is the numeraire, with the associated consumer price index (CPI) denoted by which is assumed to be equal to one for simplicity. The model is also reconfigured to account for nominal ridgities a departure from the model of Buffie et al.

The key findings from the model are that a well-executed high-yielding public investment program can substantially raise output/GDP growth and consumption and be self-financing in the long run. Notwithstanding the encouraging results caution has to be taken when undertaking such program because even if the long run looks encouraging, transition problems can be formidable when concessional financing does not cover the full cost of the investment program. Covering the resulting financing gap induced through tax increases or spending cuts requires sharp macroeconomic adjustments with a likely crowding out effect on private investment and consumption and delaying the growth benefits of public investment.

Additionally poor execution, sluggish fiscal policy reactions, or persistent negative weak structural conditions, this strategy can easily lead to unsustainable public debt dynamics especially in the case where interest rates are high. Front-loaded investment programs and weak structural conditions (such as low returns to public capital, tight absorptive capacity of the country and poor execution of investments) make the fiscal adjustment more challenging and the risks greater. It is not sufficient to simply analyse whether the return of public investment projects is higher than their costs of financing. A coherent analysis needs to be employed to look into a set of factors: the efficiency of public investment, the absorptive capacity of the country, the response of the private sector, and the authorities' ability to adjust expenditure and taxes.

III. Previous Literature

The macroeconomic literature has long acknowledged that fiscal adjustment episodes tend to include disproportionate cuts in public investment. In the case of developing countries, independent evaluation of a large set of IMF-sponsored fiscal programs concluded that, in most cases, the restrictive fiscal measures led to a public investment contraction that proved excessive ex post (IMF 2003). The experience of Latin America is particularly revealing in this sense. Over the last two decades, most of the countries in the region adopted fiscal adjustment measures that led to significant increases in the primary surplus. In most countries, the adjustment included a drastic contraction of public infrastructure investment.

The recent drive toward fiscal discipline has been associated, more often than not, with a persistent infrastructure investment crunch. This, of course, is not necessarily a cause for concern if the reduction in public investment reflects efficiency enhancements, improved public procurement, or reduced corruption, allowing the same services to be provided at a lower investment cost. If private and public capital are close substitutes, (*which is hardly ever the case*), the public sector retrenchment may have been fully offset by private sector entry, without any adverse impact on service provision. Lastly a public investment contraction might be a perfectly sensible strategy in a context in which the stock of public capital already has reached its target level, or following a shift in priorities toward other productive expenditures such as education or health not viewed as investment in the national accounts.

For example, in Latin America, the decline in public infrastructure investment was accompanied by the opening of most infrastructure sectors to private initiative. But the results were uneven: total investment (public plus private) fell in all infrastructure sectors except telecommunications (see Easterly and Servén 2003, chapter 2; Calderón and Servén 2004a). In fact, the countries that managed to attract higher private investment into such sectors were those that had maintained higher levels of public investment, which suggests that private and public investment may complement rather than substitute each other, contrary to the previous argument.

Moreover, the fall in total investment reflecting the decline in public investment and the limited response of private investment was in many cases so large that it is hard to explain in terms of efficiency gains and reductions in investment costs. In some Latin American countries, infrastructure investment had fallen to 1.0 to 2.0 per cent of GDP, a level that can barely cover the depreciation of existing assets and this in spite of the fact that in most cases infrastructure asset stocks remain wholly inadequate. In some EU countries, public investment has likewise fallen to levels that, according to some estimates, probably imply asset decumulation.

The seeming anti-investment bias of fiscal discipline likely reflects several factors. Among them, political economy considerations are surely key: it is politically much harder to cut pensions or public sector wages at times of fiscal stringency than to cancel infrastructure projects. However, public deficit and debt rules also play a major role. Such rules aim to protect the solvency of the public sector, but they often do so at the cost of distorting the composition of public expenditures.

The impact of public investment, and particularly infrastructure investment, on aggregate growth has once again moved to the fore in light of the current economic woes facing many countries. A plethora of empirical literature, beginning with the seminal work of Aschauer (1989), has sought to quantify the contribution of public capital to growth; see Calderón and Servén (2007) and Romp and de Haan (2005) for recent overviews. These studies are typically based on the estimation of aggregate production functions augmented with infrastructure stocks (for example, Calderón and Servén 2003, 2007; Canning 1999; Demetriades and Mamuneas 2000; Röller and Waverman 2001), or on empirical growth equations, including measures of public infrastructure or public investment among the explanatory variables (Aschauer 1998; Calderón and Servén 2004b; Easterly and Rebelo 1993; Esfahani and Ramirez 2003).

More recent research into the subject area has made use of the popular vector autoregression (VARs) models, a field comprehensively surveyed by Kamps (2004). Notable contributions include Pereira (2000), which focusing on the United States, uses data on aggregate and five specific types of public investment, output, private investment, and private employment. The estimated long-run effect on output of a one per cent, one-time random shock to aggregate public investment was 0.04, with variation according to the type of capital. This paper is in sharp contrast to the results shown by Aschauser (1989) who showed “core" infrastructure of streets, highways, sewers, and water systems‒has more explanatory power for productivity than does the stock of equipment that, whereby Pereira (2000) shows that the stock of equipment also has a positive impact of growth rate of GDP though the estimated magnitude is small. This is a very important dichotomy here since it raises the question is all public capital created equally?

Pereira and Fatima-Pinho (2006) used a similar VAR framework for the twelve euro-area countries. The same long-run effects on output were estimated to average 0.06 and ranged from 0.20 in the Netherlands to 0.20 in Italy.

Kamps (2004) assesses public investment in 22 OECD countries. Using vector error correction models and recursive identification procedures, impulse responses showed that the effect of public capital on output is positive in the long-term, but with very large standard errors. The average long-run elasticity of output to a public investment shock is 0.12, although this varies widely across countries.

While far from unanimous, a majority of studies especially those using physical asset stocks to measure infrastructure find significantly positive effects of public capital on aggregate output and its growth rate, although the findings are less robust among those studies that use public investment flows (or their cumulative value) as regressors. The likely reason is that investment spending may be a poor proxy for the accumulation of productive assets; see Pritchett (2000) and Keefer and Knack (2006).

In his paper entitled Public ***Investment and Growth in the Eastern Caribbean*** Roache S (2007) showed, based on the results conducted from a panel vector auto-regression model, that that public investment has a positive but short-run impact on growth. The model by definition implies that public investment cannot permanently affect the growth rate, but can permanently affect the level of GDP. The effect of a one-time random one-standard deviation shock on growth effectively dies out after 4 years. This suggests that public investment generates a weak investment response from the private sector, given the likely lags involved in private sector decisions. In contrast, the major effect of public investment on growth is direct (in the sense that it boosts domestic demand), with relatively weak multipliers. He also calculated the rate of return on capital investment which he showed to be negative. The paper did not seek to explain why public investment is relatively inefficient. The methods used only help to make inferences regarding its impact on growth. It also did not address the differential effects of various types of public investment. Attempting to explain why the rate of return is low and what types of public investment are most productive in the ECCU remains a fertile area for future research. In his influential paper Aschauer (1989) actually brought this point to the for by showing that the public stock of structures‒especially a "core" infrastructure of streets, highways, sewers, and water systems‒has more explanatory power for productivity than does the stock of equipment. As we know in the ECCU the purchase of capital equipment forms a major part of capital investment and we theorise that part of the problem why capital investment in the ECCU has such a weak impact as well as negative returns to investment is part due to the fact that capital investment does not have a large an impact on growth outcomes when compared to things like highways and so forth.

IV. Theoretical Underpinnings of Public Investment Fiscal Sustainability and Economic Growth

In this section a theoretical model explaining the link between public investment, economic growth and fiscal variables is developed. The theoretical model basically shows that under certain assumptions a surge in public investment can improve the debt ratio conditional on the financial rate of return on capital being greater than the user cost of capital. If this condition holds, the debt-to-GDP ratio will decline below its initial level. The financial rate of return is likely to vary greatly across investment types therefore, the type of public investment matters. Nevertheless, public investment projects may generate indirect financial returns to the government, to the extent that they affect aggregate income growth and hence the expansion of tax bases and public income. One important implication of this analysis is that evaluation of alternative fiscal strategies has to take into account their respective growth consequences, not just to gauge the economy's future aggregate performance, but also to assess the full effects of the different fiscal policy paths on public finances themselves.

The concept of fiscal solvency follows from the inter-temporal budget constraint of the public sector, which in essence prevents the government from running a Ponzi scheme in which interest payments on outstanding debt are financed by issuing more debt. Ultimately, interest payments must be financed, at least in part, through primary surpluses. The starting point for the arithmetic of solvency is the identity defining the trajectory of the public debt stock:

$\dot{B}(t) = r(t)B(t) - [T(t) - C(t) - I(t)]$…………(1)

where *B* is the stock of public debt, *r* is the short-term real interest rate, *T* is public revenue, and *C* and *I* respectively represent the current and (gross) investment expenditures of the public sector. It can be seen that the distinction between current and investment expenditure is of little consequence for the contemporaneous rate of debt accumulation (*i.e., the overall deficit*). From this expression, we can compute the debt stock at time t+u (*future date*) as follows:

$B(t+\mu) = e^{\int_t^{t+\mu} r(v)dv} B(t) - \int_t^{t+\mu} e^{\int_x^{t+\mu} r(v)dv} [T(s) - C(s) - I(s)]ds$……… (2)

As noted, the intertemporal budget constraint prevents the government from forever financing interest payments on its debt through additional debt issue. This amounts to saying that debt cannot indefinitely grow at a rate in excess of the real interest rate, that is, $\lim_{\mu \to \infty} e^{\int_t^{t+\mu} r(v)dv} B(t+u) \leq 0$.

Using equation (2), this is equivalent to the requirement

$\int_t^{\infty} e^{\int_t^{x} r(v)dv} [T(s) - C(s) - I(s)]ds - B(t) \geq 0$………….. (3)

Thus, the present value of the stream of current and future primary surpluses must be no less than the initial public debt stock. In practice, the intertemporal budget constraint in equation (3) will always be met through appropriate adjustment of some residual fiscal variable that is, taxes or public spending. Here we shall focus on the case in which the trajectories of these variables are given arbitrarily and the government has some initial debt (***B)***. Then the adjustment has to take the form of a suitable change in the initial debt stock that the government will honor.

Formally, we can write analogously (3):

$\int_t^{\infty} e^{\int_t^{x} r(v)dv} [T(s) - C(s) - I(s)]ds - DB(t) = 0$ … …. (3a)

Here D is a "*debt default discount factor*," endogenously determined so that the expression holds with strict equality. A value of *D* smaller than one corresponds to the case in which the present value of future primary surpluses falls short of the outstanding debt stock, and hence implies a debt write-down; conversely, a value above unity reflects a "*super-solvency premium*" on public debt and implies a "*debt write-up*" (see Buiter 2002).

For concreteness, we shall refer to the left-hand side of equation (3) $\int_t^{\infty} e^{\int_t^x r(v)dv}[T(s) - C(s) - I(s)]ds - B(t) \geq 0$ as the public sector net worth (denoted NW), keeping in mind that the term is shorthand for the debt write-down (or up) required for the government's budget constraint to hold with equality when the time paths of taxes and primary expenditures are exogenously given. Hence, the government's net worth *NW* is positive (negative) if and only if *D* is greater (smaller) than one (1). Equivalently, *NW* can be viewed, after a sign change, as the present value of the fiscal correction necessary to ensure long-run balance of the government budget (Bruce and Turnovsky 1999).

In a growing economy, it is often more convenient to restate the solvency condition in terms of the debt-to-GDP ratio b (t). Letting g denote the growth rate of real GDP, the trajectory of *b* is given by

$$\dot{b}(t) = [r(t) - g(t)]b(t) - [\tau(t) - c(t) - \iota(t)] \ldots\ldots\ldots \quad (4)$$

where the lowercase letters in the second square brackets denote the ratios to GDP of the corresponding uppercase variables. In this notation, the solvency condition prevents debt as a per cent age of GDP from indefinitely growing at a rate exceeding the difference between the real interest rate and the GDP growth rate, so that

$$\lim_{\mu \to \infty} e^{\int_t^{t+\mu}[r(v)-g(v)]dx}\, b(t+\mu) \leq 0$$

Hence, the counterpart to equation (3) is

$$\int_t^{\infty} e^{\int_t^x [r(v)-g(v)]dv}[\tau(s) - c(s) - i(s)]ds - b(t) \geq 0 \ldots\ldots\ldots\ldots \text{(3b)}$$

As before, we let $nw(t)$ denote the left-hand side of equation (3b). To highlight the role of public investment and public capital (or, more broadly, of public expenditure that generates future revenue), it is convenient to break up total revenues into two components: one that captures the direct financial return on the public capital stock, and another that includes all other income. Therefore, $T = \tilde{T} + \theta K$, where K is the public capital stock, θ is the gross financial rate of return captured by the government on each unit of public capital for example, public service user fees minus operating costs and $\tilde{T}$ includes all other public revenues. Then we can rewrite (3b) as follows:

$$nw(t) = \int_t^{\infty} e^{\int_t^x [r(v)-g(v)]dv} \left[\tilde{\tau}(s) + \theta(k)(s) - c(s) - i(s)\right]ds - b(t) \qquad \text{.......... (3b)}$$

Here, k denotes the public capital-to-GDP ratio, whose time path is given by

$$\dot{k}(s) = \frac{i(s)}{p} - [g(s) + \delta]k(s) \qquad \text{................ (5)}$$

Where δ is the depreciation rate of public capital and p denotes its replacement cost. In general, p will reflect not only the market price of investment goods, but also other factors such as the efficiency of public procurement or the effects of corruption on the actual cost of new public capital (Keefer and Knack 2006; Pritchett 2000). Inefficient procurement, bribes and kickbacks will result, other things equal, in higher values of p.

It is easy to illustrate the effect of public investment on government net worth. Assume for the moment that the real interest rate and the growth rate are exogenously given (with $r > g$); we shall return to this assumption later. Assume further that the current expenditure, investment, and tax revenue ratios are also constant. Solving equation (5) for $k(s)$ and replacing the result in equation (4), net worth at time 0 is given by:

$$nw = \left[\frac{\theta}{r+\delta} k_0 - b_0\right] - \frac{1}{r-g}\left[\tilde{\tau} - c + i\left(\frac{\theta}{p(r+\delta)} - 1\right)\right] \qquad \text{................ (4a)}$$

where the zero subscript denotes the initial values of debt and public capital. The first term of this expression captures the government's initial net assets. Their replacement cost is $pk_0 - b_0$, but that of the capital stock pk_0 needs to be adjusted multiplying by the return on capital relative to its user cost $\theta/p(r+\delta)$. In turn, the second term of the expression captures the contribution to net worth of income and expenditure flows. Public investment appears multiplied by the ratio of the direct financial yield on public capital θ to the user cost of capital $p/(r+\delta)$. From this expression, the impact of a permanent, deficit-financed change in the public investment ratio $\boldsymbol{i}$ is just:

$\frac{dnw}{di} = \frac{1}{r-g}\left[\frac{\theta}{p(r+\delta)} - 1\right]$………….. (6)

Thus, an increase in public investment raises or reduces the government's net worth depending on ***whether the financial rate of return on public capital θ is greater or smaller than the user cost of capital $(r+\delta)p$.***

An equivalent way to illustrate the same point is to express the net worth of the government in terms of its net liabilities, $b - pk$. The expression equivalent to equation (4), for the case of constant r and g, is as follows:

$nw(t) = \int_t^\infty e^{\int_t^x -r-g(s-t)]} \{[\tilde{\tau}(s) + [\theta - (r+\delta)v]k(s) - c(s)\}]ds - [b(t) - pk(t)]$…………..(4b)

In this formulation, solvency requires the present value of the government's primary surplus on current account, net of the user cost of public capital, to be no less than the face value of net public liabilities—*that is, debt minus capital*. From equation (4b), it is clear that an increase in the public capital stock matched by an equal increase in public debt at time t (so that net liabilities $b - pk$ remain unchanged) raises or lowers the net worth of the public sector depending on the sign of the return differential $\theta - (r+\delta)p$[4].

Irrespective of the net worth effect of an investment increase, its impact on the primary surplus must be negative in the short run, while that on the debt-to-GDP ratio must be positive. Over time, as the extra capital is put in place and returns accrue at the rate, the primary surplus will rise and provided that $\theta > (r+\delta)p$ (*ie is the financial rate of return on capital is greater than the user cost of capital*) the debt-to-GDP ratio will decline below its initial level. This contrast between the short- and long-run effects on the primary surplus and debt is a reminder that cash flow can be a poor guide to solvency.

[4] A fall in *pk* matched by an equal reduction in *b* could be interpreted as a privatization whose proceeds are used to retire public debt. Such transaction strengthens public finances only if $\theta > p(r+\delta)$. This amounts to requiring that the government sell the capital assets at a price greater than the present value of the future financial returns that would have accrued from holding them. This might occur if the government smartly manages to overbill the private purchaser or, more realistically, if the returns that the purchaser can accrue (and hence the purchase price s/he is willing to pay) exceed those that the government would have obtained if it had retained the asset.

These expressions illustrate the net worth effects of a debt-financed investment change. The effects of an investment expansion financed instead by cutting public consumption are much more straightforward: short-run cash flow is unchanged, but government net worth must rise if the net financial rate of return on public capital θ is greater than zero. Obviously, the composition of spending matters for net worth as long as financial rates of return differ across expenditure types—as is the case in this framework, which assumes that public consumption yields zero return.

The effects on **net worth of a public investment expansion depend on the direct financial return on public capital** θ. However, the value of θ is likely to vary greatly across investment types. User fees may cover the user cost of capital of government-owned utilities, but not that of un-tolled roads or sanitation projects, which often yield no direct financial return (that is, $\theta \leq 0$). Nevertheless, public investment projects may generate indirect financial returns to the government, to the extent that they affect aggregate income growth and hence the expansion of tax bases and public income[5].

One important implication of this analysis is that evaluation of alternative fiscal strategies has to take into account their respective growth consequences, not just to gauge the economy's future aggregate performance, but also to assess the full effects of the different fiscal policy paths on public finances themselves. Analytically, a simple illustration can be provided as follows. Assume that the economy's aggregate production technology is of the form

$$Y(s) = AK(s)^{\alpha}[L(s)e^{\gamma s}]^{1-\alpha} \ldots..(7)$$

Where L is labour, 1 >α > 0, and γ ≥ 0 denotes the rate of exogenous labour-augmenting technical progress. For simplicity, we ignore private capital and assume continuous full employment of the given labour supply **L**, which for convenience will be set equal to one and ignored in what follows. **Hence, $\boldsymbol{\gamma(1-\alpha)}$ captures the growth of output due to exogenous factors affecting the productivity of public capital (which *are the exogenous factors which affect the productivity of public capital*). Note that the marginal product of public capital is just $\frac{\partial Y}{\partial K} = \frac{\alpha}{k}$. In this framework, the growth impact of a given change in the public**

[5] This is well known to budgetary authorities in many countries, who often turn to overoptimistic growth projections as a last resort to balance public finances, even if only on paper.

investment ratio is smaller the higher the prevailing public capital-to-output ratio k. Furthermore, investment only affects the economy's transitional dynamics; with a constant investment-to-output ratio, the growth rate of the economy converges to γ in the long run.

Assuming a constant real interest rate r (with $r > \gamma$), as well as constant public consumption, investment, and tax ratios to GDP, it can be shown that net worth is given by

$$nw = \left[\frac{\theta}{r+\delta}k_0 - b_0\right] + \frac{1}{r-\gamma}\left[\tilde{\tau} - c + i\left(\frac{\theta}{p(r+\delta)} - 1\right)\right] H\left(\frac{i}{pk_0(\gamma+\delta)}\right) \ldots .(8)$$

The two terms in square brackets are identical to equation (4a) above, with the long-run growth rate γ replacing g. But here the second term is multiplied by a factor H (.) that captures the effect of net investment on output growth. It is straightforward to verify that H is monotonically increasing in its argument, with $(0) = \frac{r-\gamma}{r-\gamma+\alpha(\gamma+\delta)} < 1$ $H(1) = 1$. Hence when investment is just sufficient to keep the public capital-output ratio constant, the growth rate is equal to, and net worth (8) reduces to the simpler version (4a). Aside from that particular situation, $H(.) > 1$ if $i > pk_0(\gamma+\delta)0$, so that the capital output ratio is rising, and $H(.) < 1$ in the opposite case.

Using equation (2), it is straightforward to compute the change in net worth arising from a change in the public investment ratio. To simplify the algebra, it will be convenient to assume that we start from a situation with $i = pk_0(\gamma+\delta)$, so that initially the capital-to-output ratio is not changing. Holding the public consumption and tax collection ratios constant, we get:

$$\frac{dnw}{di}/_{k=0} = \frac{1}{p(r+\delta(1-\alpha)-\alpha\gamma)(r-\gamma)}\left\{(\tilde{\tau} - c)\left(\frac{\partial Y}{\partial K}\right) + \theta - p(r+\delta)\right\} \ldots\ldots\ldots (9)$$

Where $(\partial Y/\partial K)_0 = \alpha/k$ (*ie marginal product of capital*). If $r > \gamma$, as assumed, the denominator of this expression is positive. The expression boils down to equation (4a) when $\alpha = 0$, in which case the marginal product of public capital is also zero: the net worth effect of investment changes depends only on the (direct) rate of return on capital relative to its user cost. When $\alpha \neq 0$, capital accumulation generates additional output and net government revenue, provided the net tax collection ratio $(\tilde{\tau} - c)$ is positive. Hence, in this case, a rise in the public investment ratio increases net worth if the total financial return on the additional public capital given by the sum of user fees plus the indirect tax revenue effect, the first two terms inside the curly brackets in equation (9) exceeds its user cost. This is more likely to be the case the higher the marginal product of public capital and the net tax ratio, and the lower the user cost of capital. Furthermore, under the plausible assumption that the total financial return captured by the government on public capital cannot exceed its marginal product, equation (9) implies that a necessary condition for net worth to rise with an increase in the public investment ratio is that public capital be initially underprovided—that is, $(\partial Y/\partial K) > p(r+\delta)$ (*ie the marginal product of capital is greater than the user cost of capital*).

If the initial situation is such that net worth equals zero, equation (9) becomes

$$\frac{dnw}{di}/_{k=0,nw=0} = \frac{1}{p(r+\delta(1-\alpha)-\alpha\gamma)(r-\gamma)}\left\{\left(\frac{1-\alpha}{r-\gamma}\right)\left[\frac{\theta}{p}-(r+\delta)\right]+\alpha\left(\frac{b_0}{pk_0}-1\right)\right\} \ldots\ldots\ldots\ldots (10)$$

Thus, a deficit-financed investment expansion is more likely to raise government net worth the higher the initial ratio of public debt to public capital. Indeed, if the direct financial return on public capital fails to cover its user cost (*that is, when* $\theta < (r+\delta)p$), a necessary condition for net worth to rise with public investment is $b_0 > pk_0$, so that the government's initial debt exceeds its capital stock[6] . The intuitive reason for this is that under such conditions the additional growth associated with capital accumulation contributes to erode the government's net liabilities, thereby enhancing its patrimonial position; this has been stressed by Easterly (1999) and Easterly and Servén (2003). As before, in the short run the public debt-to-output ratio is likely to rise following a deficit financed public investment expansion. Starting from a position of zero net worth, the debt ratio will rise initially provided 1/ 0 (∂*Y* ∂*K*) 0 ≤ *b*, which is likely to hold unless indebtedness is very high or the public capital stock is very low but if expressions (9) or (9a) are positive, the initial rise will be followed by a decline in the public debt ratio, which will eventually fall below its initial level.

So far we have assumed that the investment expansion is deficit-financed and the net tax collection ratio $(\tilde{\tau}-c)$ remains constant relative to GDP. This amount to assuming that the tax system is sufficiently elastic so that tax revenue rises in proportion with aggregate output[7]. What if the investment expansion were financed instead by an offsetting change in net tax collection? In such scenario $i = d(\tilde{\tau}-c)$, so that for given k the primary surplus ratio remains constant. In

[6] This is also the case if the government's net worth is initially positive

[7] Public capital operating costs and maintenance spending may rise along with investment, but they are already included in. Regarding other current spending c, as well as revenue collection $\tilde{\tau}$, rather than assuming them fixed, we could let them vary with the long-run growth rate g. Empirically, however, the evidence seems consistent with the constancy assumption; see Calderón, Easterly, and Servén (2003).

this simple framework, which abstracts from the distorting effects of taxation, net worth must unambiguously rise[8].

Stylized Facts

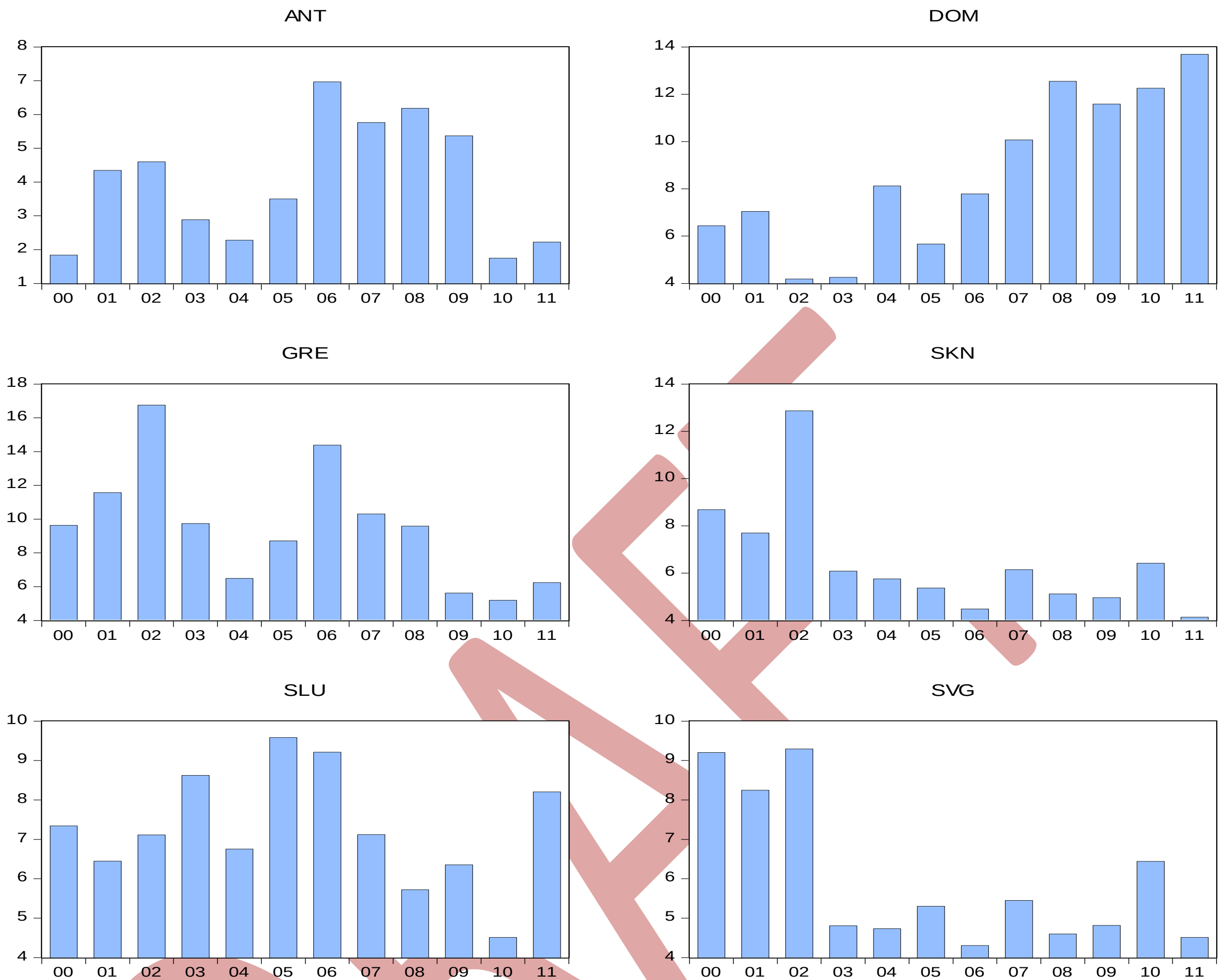
In the ECCU the level of public debt as a percentage of GDP is very high; the average debt to GDP ratio across the ECCU is 108.0 per cent of GDP over the period 2002 to 2012. Current expenditure as per cent age of GDP is 22.8 per cent of GDP and current expenditure as a proportion of revenue is 87.0 per cent. The high level of current expenditure as a per cent of total revenue invariably means that countries have to borrow in order to finance capital expenditure. However under weak structural conditions the additional borrowing to finance capital expenditure if it does not generate economic growth will lead to unsustainable debt positions. The problem remains with the level of current expenditure at these very high levels consuming 0.87 cent of every dollar of revenue and grants earned this only leaves back 0.13 cent for public investment hence the burden of public investment falls heavily on borrowing. While there is nothing wrong per se with borrowing to undertake public investment the problem arises when this investment does not generate sufficient economic growth to increase revenue to retire the debt that has been incurred.

Capital investment in the ECCU has averaged roughly 6.5 per cent of GDP for the period 2000 to 2012. The graph below shows the divergence in capital expenditure by the six larger territories. From the graph below it can be observed that in general Antigua and Barbuda has had the lowest level of capital investment.

[8] For example, equation (9a) would become

$$\frac{d\,nw}{d\,i}/_{k=0,nw=0,di=-dc} = \frac{1}{r+\delta(1-\alpha)-\alpha}\left\{\left(\frac{1-\alpha}{r-\gamma}\right)\frac{\theta}{p}+\alpha\frac{b_0}{pk_0}\right\} \geq 0$$

Capital Expenditure as % of GDP



While the level of capital expenditure has generally been high what has been the impact on economic performance? Gonzalez-Garcia, J, Lemus, A, and Mrkaic, M (2013) and Roache, S (2007) have demonstrated that public investment has a positive but short-run impact on growth, both papers suggest that the impact of public investment dissipates after four years with the largest impact. What both papers have shown is that while public investment has positive effect on growth its impact is minimal and short lived. Estimates of the marginal productivity suggest that marginal productivity of public investment is in the range from 0.50 to 0.66 while the rate of return is negative. In the end the low impact of impact of public investment of GDP growth may be due to the composition of public investment, perhaps too little is spent on infrastructure that will increase productivity. The second hypothesis is that perhaps too much money is being spent on replacing capital rather than augmenting the capital stock. Therefore any boost to capital expenditure through additional borrowing has to be carefully calibrated that it does not lead to unsustainable debt.

Public investment plays an important role in raising and sustaining economic growth in the region. However, public investment must be efficient if it is to have the desired effect on economic growth and reduce the risks that it will add to public sector indebtedness. The evidence from the ECCU over the last 30 years suggests that public investment has had only a temporary and limited growth effect. To the extent that investment is financed by borrowing, this suggests that public investment has had a larger impact on the debt stock than on GDP.

CONSTRUCTION OF THE MODEL AND CALIBRATION TO THE CASE OF ECCU

This section customizes the Buffie and others model (2012) for the ECCU. The model applied to the ECCU in this paper is a two-sector open economy dynamic general equilibrium model with three types of public sector debt (external concessional, external commercial and domestic debt) that attempts to capture some of the main features of these economies which have a feature of low and middle income countries. This model is intended for long-run analysis and therefore does not include money or nominal rigidities.

A. Model Construction for ECCU[3]

The model has the following three key features for ECCU: (i) imports account for a high share of public investment inputs; (ii) the government has ability to obtain external financing; and (iii) the country has the ability to sustain a credible pegged exchange rate regime.

The Firms

ECCU is a small open economy with two productive sectors: Non-tradable goods (q_n) and tradable goods (q_x). The Cobb-Douglas production function is outlined as.

$$\boldsymbol{q_{it} = A_{i,t}(z^{e}_{t-1})(k_{i,t-1})^{a}(L_{i,t})}$$

Where $q_{i,t}$ is output, z^{e}_{t-1} is productive infrastructure, $k_{i,t-1}$ is private capital, $L_{i,t}$ is labor, and i (with $i = n$, x) denotes each sector (non-traded and traded sectors).

The Consumers

The model has two types of consumer's savers and non-savers; nominal consumption is subject to a tax. The tax rate is h is a summary of the indirect tax burden. Remittances and transfers are assumed to be proportionate to the consumers share in aggregate employment.

Non-savers consume all of their income in each period, which allows for non-Ricardian Effects. Non-savers have the following utility function.

$$Max \sum_{t=0}^{n} \beta^{t} \frac{(c_t^S)^{1-1/\tau}}{1-1/\tau}$$

Where τ denotes the inter-temporal elasticity of substitution (and $1/\tau$ is the coefficient of relative risk aversion), and β denotes the discount factor.

The nonsavers are subject to the following budget constraint:Nonsavers are su

$$\boldsymbol{(1+h_t)P_t c_t^H = w_t L^H \frac{a}{1+a}(R_t+T_t)}$$

Where a denotes labor ratio of nonsavers to savers, R is remittances; $T$is transfers, which are defined as current expenditure less direct taxes; and P is the consumer price index. P is derived from a constant elasticity of substitution basket that includes a domestic traded good, a foreign traded good, and a domestic non-traded good such that

$$P_t = [\rho_x \rho_{x,t}^{1-\varepsilon} + \rho_m \rho_{m,t}^{1-\varepsilon} + \rho_n \rho_{n,t}^{1-\varepsilon}]$$

The model assumes that savers can invest in private capital in both the traded and non-traded sectors ($I_{i,t}^S$) in Equation 5 denotes investment in each of the sectors). They also pay user fees for infrastructure services (μz^e), can buy domestic bonds (b_t^S), and can contract foreign debt (b_t^{S*}). Savers solve the same utility function as the non-savers, but subject to three constraints (5). The model is rescaled by a permanent component of sector-wide total factor productivity, growing at a rate (g).

$$Max \sum_{t=0}^{\infty} \beta^{t} \frac{(c_t^S)^{1-1/\tau}}{1-1/\tau}$$

Subject to

$$P_t b_t^{S*} - b_t^{S*} = r_{x,t} k_{x,t-1}^{S} + r_{n,t} k_{n,t-1}^{S} + w_t L_t^{S} + \frac{R_t}{1+a} + \frac{T_t}{1+a} + \frac{1+r_{t-1}^{*}}{1+g} b_{t-1}^{S*} +$$

$$\frac{1+r_{t-1}}{1+g} P_t b_{t-1}^{S} + P_{k,t}\left(I_{x,t}^{S} + I_{n,t}^{S} + AC_{x,t}^{S} + AC_{n,t}^{S}\right) - P_t c_t^{s}(1+h_t) - \mu z_{t-1}^{e} - \Upsilon_t^{S} - \Phi_t^{S},$$

And

$$(1+g)k_{x,t}^{S} = I_{x,t}^{S} + (-\delta)k_{x,t-1}^{S},$$

$$(1+g)k_{n,t}^{S} = I_{n,t}^{S} + (-\delta)k_{n,t-1}^{S}$$

Where r is the real interest rate on domestic bonds, r^* is the interest rate on foreign debt, □ is the depreciation rate, Φ_t^{S} is profits for domestic firms, g is the trend growth rate of GDP per capita, $AC_{i,t}^{S}$ terms are capital adjustment costs in each of the sectors, and Υ_t^{S} is portfolio adjustment costs linked to foreign liabilities, capturing the degree of financial account openness.

The Government

The Equation below captures the inefficiencies in public capital creation.

$$\boldsymbol{(1+g)z_t^{e} = (1+\delta)z_{t-1}^{e} + s\left(I_{z,t} - \bar{I}\right) + s\bar{I}_z}$$

Where $I_z$public investment at the initial steady is state; s is a value between zero and one, denoting the efficiency of public investment; I_z is public investment; and z^e is additional public capital or infrastructure produced by public investment. This equation implies that one dollar of additional public investment (the second term on the right-hand side of Equation (6) does not necessarily translate into one dollar of productive public capital.

Equation below defines the government budget constraint.

$$\boldsymbol{P_t\Delta b_t + \Delta d_{c,t} + \Delta d_t = \frac{r_{t-1}-g}{1+g} p_t b_{t-1} + \frac{r_{d,t-1}}{1+g} d_{t-1} + \frac{r_{d,t-1}-g}{1+g} d_{c,t-1} + P_{s,t} I_{z,t} + T_t - h_t P_t c_t + G_t - \mu z^e_{t-1}}$$

The left-hand side of the Equation is financing ("*below the line*") and the right-hand side is the government expenditure and revenue ("*above the line*"). The first positive terms on the right-hand side of the equation refer to expenditure on debt service (domestic debt, external commercial debt, and concessional debt), infrastructure investment, and government transfers, respectively. The negative terms are "*revenue*" items, namely tax revenue on consumption, grants (exogenous, obtained from donors), and revenue from user fees on infrastructure. When revenue falls short of expenditure, the deficit is financed by borrowing domestically or abroad (on commercial and/or concessional terms).

Infrastructure is built by combining one imported machine/equipment with a_z units of a non-traded input. The supply price of infrastructure is determined by Equation below.

$$\boldsymbol{P_{z,t} = P_{m,t} + \alpha_z + P_{n,t}}$$

Where $P_{n,t}$ the relative is price of the non-traded good, and $P_{m,t}$ denotes the relative price of the imported good (machine/equipment).

The key feature of the model is to capture the dynamic interactions of public investment, growth, recurrent costs, and fiscal policy. The government collects revenue from the indirect tax (consumption tax) and from the user fees for infrastructure services. This user fee is expressed as a fixed fraction/multiple (*f*) of recurrent costs of maintaining infrastructure, that is, $\mu = f * \delta * P_{z0}$. The government spends on infrastructure investment, transfers, and debt service.

Equation below is the policy adjustment function.

$$\boldsymbol{GAP = \frac{1+r_d}{1+g} d_{t-1} - d_t + \frac{r_{dc,t-1}-g}{1+g} d_{c,t-1} + \frac{r_{,t-1}-g}{1+g} P_t b_{t-1} + P_{s,t} I_{z,t} + T_t - h_t P_t c_t + G_t - \mu z^e_{t-1}}$$

$$\boldsymbol{Gap = P_t \Delta b_t + \Delta d_{c,t} + \Delta d_t + (h_t t - h_0) P_t c_t\, t - P_{z,t} I_{z,t} - (T_t - T_0)}$$

The term $\boldsymbol{P_{z,t} I_{z,t}}$ in Equation above corresponds to public investment outlays including costs overruns associated with absorptive capacity constraints. It is defined by the Equation below

$$\boldsymbol{P_{z,t} I_{z,t} = HH(I_{z,t} - \bar{I}_z)\bar{I}_z} \,,$$

Because skilled administrators are in rare supply in small lower middle income countries and low-income countries, ambitious public investment programs are often undermined by poor planning, weak oversight, and poor coordination problems, all of which contribute to large cost overruns during the implementation phase. To capture this, we multiply new investment $\boldsymbol{(I_{z,t} - \bar{I}_z)}$ by Ht which is defined below.

$$H_t = \left(1 + i_{z,\frac{t}{z_{t-1}}} - \delta - g\right)^{\phi}$$

Where $\phi \geq 0$ determines the severity of the absorptive capacity–or "bottleneck"–constraint in the public sector.

With the path for public investment and concessional loans taken as given (exogenous to the model), the government uses all concessional resources available, and the fiscal gap before policy adjustment.

The tax path is assumed to be exogenous. When revenue falls short of expenditure, the adjustment will be done through external commercial borrowing and/or the cutting of Transfers (expenditures).

Given the rigidity of the transfer adjustment, t a cap for the change of transfer as percentage of the GDP is established. Given the features of public consumption expenditure in the ECCU, we set the cap at 1.5 per cent of GDP.

Table 1: Assumptions for Calibration of Model

Parameters	Values
Value added in non-traded sector	65.0%
Initial public domestic debt-to-GDP ratio	41.0%
Initial public external concessional debt-to-GDP ratio	26.0%
Initial public external commercial debt-to-GDP ratio	10.0%
Initial private external debt-to-GDP ratio	0.0
Grants-to-GDP ratio	2.7%
Remittances-to-GDP ratio	4.0%
Trend growth rate (per cent)	2.0%
Imports (per cent of GDP)	80.0%
Initial ratio of infrastructure investment to GDP	6.7%
Initial consumption taxes	20.0%
Initial real interest rate on domestic debt	5-6%
Initial real interest rate on external public commercial loans	6%
Initial real interest rate on private external debt	0.0
Labor ratio of nonsavers to savers	1.2
Depreciation rate	6.0%
Real interest rate on concessional loans	0.0%
Capital's share in value added in the traded sector	60.0%
Capital's share in value added in the non-traded sector	60.0%
Cost share of non-traded inputs in the production of capital	65.0%
The portfolio adjustment costs parameter	1.0
user fee as a multiple/fraction of recurrent costs of infrastructure	40%
Initial return on infrastructure	30%
Efficiency of public investment	60%
Absorptive capacity parameter	1.5

Real risk-free foreign interest rate	2.0%
Intertemporal elasticity of substitution	
Capital adjustment cost parameter	
Intratemporal elasticity of substitution across goods	
Public debt risk premium parameter	3.0%
Fiscal reaction parameters (policy instrument terms)	0.26
Fiscal reaction parameters (debt terms)	0.21
Elasticities of sectoral output with respect to infrastructure	0.17

With the availability of a long series of historical data, the following parameters are calibrated based on averages of ECCU historical data (2000–11): imports as per cent of GDP (x), value added in non-traded sector (ρn), initial public external concessional debt-to-GDP ratio ($d0$), initial public external commercial debt-to-GDP ratio ($dc,0$), initial private external debt-to-GDP ratio ($b*$), remittances-to-GDP ratio ($R0$), trend growth rate (g), initial ratio of infrastructure investment to GDP ($iz,0/y0$), and initial transfer- to-GDP ratio.

The following parameters are calibrated based on the average of ECCU recent historical data (2009–11) or an anticipated normal level. *Grants-to-GDP ratio (G0).* The average of grants-to-GDP ratio (G0) is 2.75 per cent; however, there is a permanent drop of grants-to-GDP ratio to around 2.5 per cent in 2011. We set G0 = 2.5 per cent.

Initial public domestic debt-to-GDP ratio (b0). The average of public domestic debt-to-GDP ratio between 2000 and 2011 is about 39.0 per cent. During the past few years, the domestic debt as a per cent of GDP has increased by about 7.0 percentage points over its average between 2000 and 2008; this may be a result of limited external financing sources.

Initial public investment-to-GDP ratio (Iz,0/y0). The average public investment to GDP ratio over the period 2000-2011 was 6.4 per cent of GDP. Therefore, *Iz,0/y0 I* is set at 6.5.

Initial consumption taxes (indirect taxes h0, it includes taxes on domestic goods and services and taxes on international trade and transactions). The value added tax and other indirect tax revenue as a per cent of GDP are used to calibrate this parameter. It is set it at 15.0 per cent based on the average of the past five years.

The following parameters are calibrated based on the best estimate for ECCU.

Initial real interest rate on domestic debt (r0). It is set at 5.0 per cent because the average weighted interest of bonds and obligations was around 7.65 per cent, and average inflation rate was approximately 2.65 per cent over the past three years (2009–11).

Initial real interest rate on public commercial loans (rdc,0). It is set at 4.0 per cent, similar to the assumption in the DSA. *Initial real interest rate on private external debt (r*).* It is set at 6.5 per cent because the interest rate of the private external debt is approximately 9.0 per cent in 2011 minus the 2.5 per cent world inflation rate.

Capital's share in value added (αn, αz). The Global Trade Analysis Project (GTAP) assembled the social accounting matrices. The GTAP5 database for SSA suggests around 35–40 per cent for capital's share in value added in the tradable sector and 55.0–60.0 per cent in the non-tradable sector (Buffie and others, 2012). Given that there are no specific data available for ECCU, this pair of parameters are set αn = 0.55 and αz = 0.40.

Cost share of non-traded inputs in the production of capital (α). Given that imported goods account for a relatively higher share of public investment inputs than non-tradable goods, this parameter is set at a relatively low level of 0.0 per cent.

The portfolio adjustment costs parameter (η). This parameter controls the degree of openness of the capital account. Given that private sector has some, but limited, access to international Capital markets, this parameter is set at 0.8 in the base case.

Real interest rate on concessional loans (rd). Given that the world inflation rate is about

2.5 per cent and the average interest rate of concessional loans is also around 2.5 per cent , this parameter is set at 0. In addition, the labour ratio of no savers to savers (*a* = 1.2) for ECCU is based on best estimates in the context of ECCU.

The following parameters are estimated based on ECCU circumstances. As the model outcome is sensitive to these parameters, we will undertake sensitivity analysis and discuss it later in the paper.

Efficiency of public investment (s) and the absorptive capacity parameter (ϕ). Efficiency of public investment (s) is set at 0.6 as used in the Buffie and other (2012). The base case also assumes that scaling up does not strain the absorptive capacity (ϕ = 0). The paper also examines later a more pessimistic scenario (lower efficiency of public investment (*s* = 0.2) associated with tighter absorptive capacity (ϕ = 3)) and a more optimistic scenario (higher efficiency of public investment (*s* = 0.8) associated with a good absorptive capacity (ϕ = 0)).

Return on infrastructure (R0). Buffie and others (2012) did some research and concluded that 30.0 per cent could be norm for economies with good governance. Given that ECCU has good governance, the parameter is set at 30.0 per cent under the base case. It is also the same value as the one set in Buffie and others (2012). Alternative scenarios of lower return on infrastructure (*R0* = 0.10) and higher return on infrastructure (*R0* = 0.40). Return on infrastructure investment is the net marginal product of public capital (marginal product of public capital net of depreciation).There is considerable uncertainty about the average return on infrastructure investment in the ECCU

User fees for infrastructure services (μ). The user fee for infrastructure services is a multiple/fraction of recurrent costs of infrastructure, μ = fδPz, 0. According to Buffie and others (2012), f ranges from 0.2 to 1. The paper assumes *f* = 0.6 under the base case. Since *Pz,0* = 1/(1-αz) = 1.61 and *δ* = 0.04, then μ = 0.067. The paper also investigates alternative scenarios of a lower (*f* = 0.20) and higher (*f* = 1) user fee recoup rate

Depreciation rate (δ = 0.06). The paper set 0.6 for the base case.

Fiscal reaction parameters (policy instrument terms $\lambda 1$), fiscal reaction parameters (debt terms $\lambda 2$) are set according to (Leonce, 2011). public debt risk premium parameter (ηg), private debt risk premium (u), public debt risk premium (vg), capital adjustment cost parameter (v), elasticities of sectoral output with respect to infrastructure (Ψx, Ψn), intertemporal elasticity of substitution (τ), intratemporal elasticity of substitution across goods (ε), and real risk-free foreign interest rate (rf).

V. Results

Overall, the results of the base case (Figure 1) shows that the scaling-up contributes to growth; public debt remains manageable but with increased risks. Specifically:

- *Public debt.* Public debt is projected to remain self-containable. It is expected to peak in year 11 at around 80.0 per cent of GDP and then declines as the country repays its debt and GDP increases.

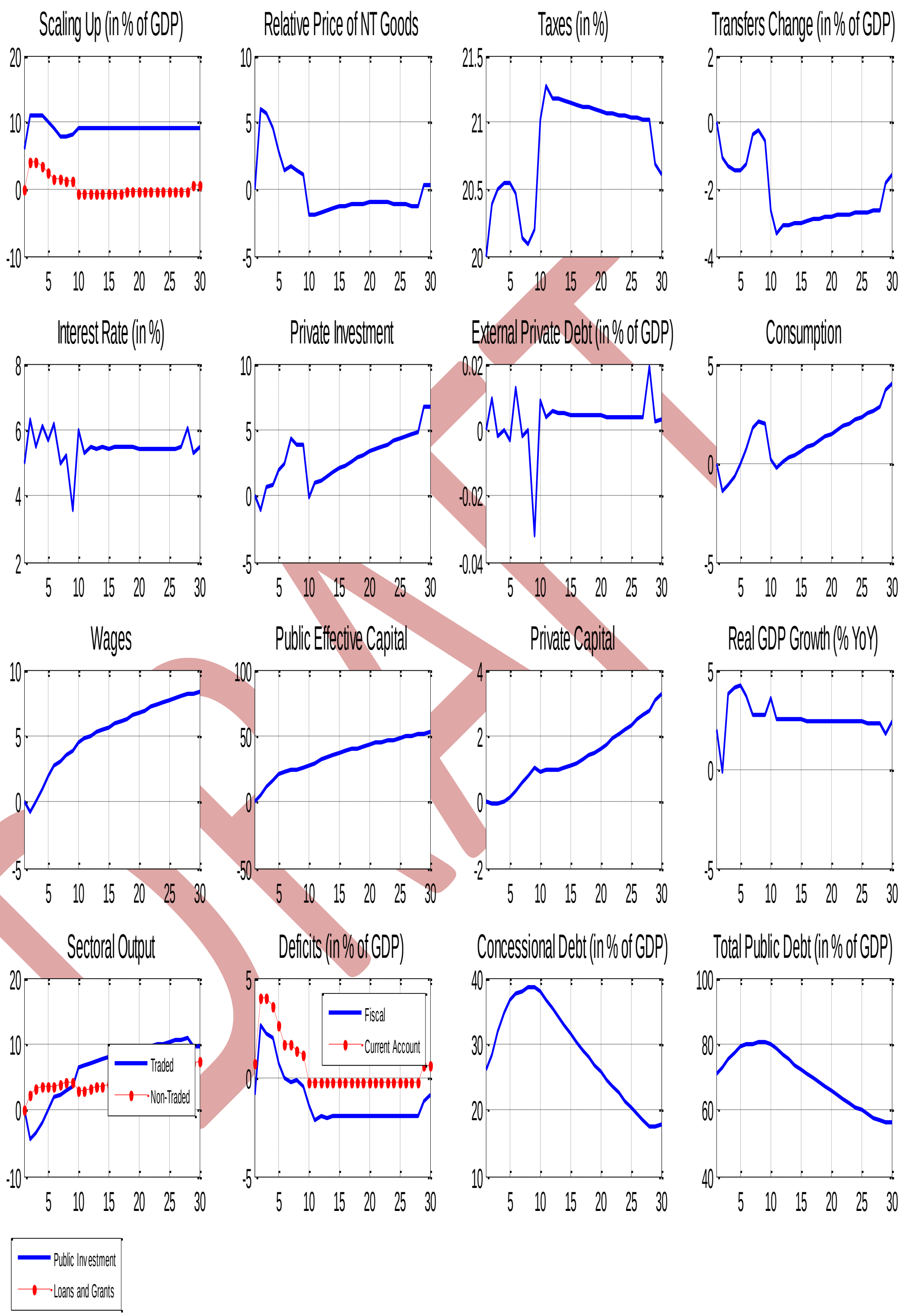
- *Growth.* The scaling-up is expected to contribute to higher real GDP growth for the first nine years. Then the GDP growth rate is projected to around 4.25 per cent, a level still higher than the normal real GDP growth rate (approximately 2.0 per cent) before the scaling-up.

- Fiscal response and external commercial borrowing needs the fiscal response to scaling up is that tax rates rise up 21.0 per cent of GDP as a result of the scaling up while transfers decline by almost 4.0 per cent of GDP. The rational for this rise is that as the country accumulates debt due to scaling up of public investment these debts have to be repaid. Therefore we assume the authorities respond by cutting expenditure which we call transfers and increase taxes. However in this analysis we assume that the bulk of the fiscal adjustment fall on taxes since expenditure cutting is more politically difficult.

- *Public and private capital*. Public effective capital increases as a result of scaling-up of public investment. After around the ninth year, public effective capital starts to decline but stabilizes at a level higher than the initial level. In early years, the private capital is projected to increase and stabilize at a level much higher than the initial steady state.

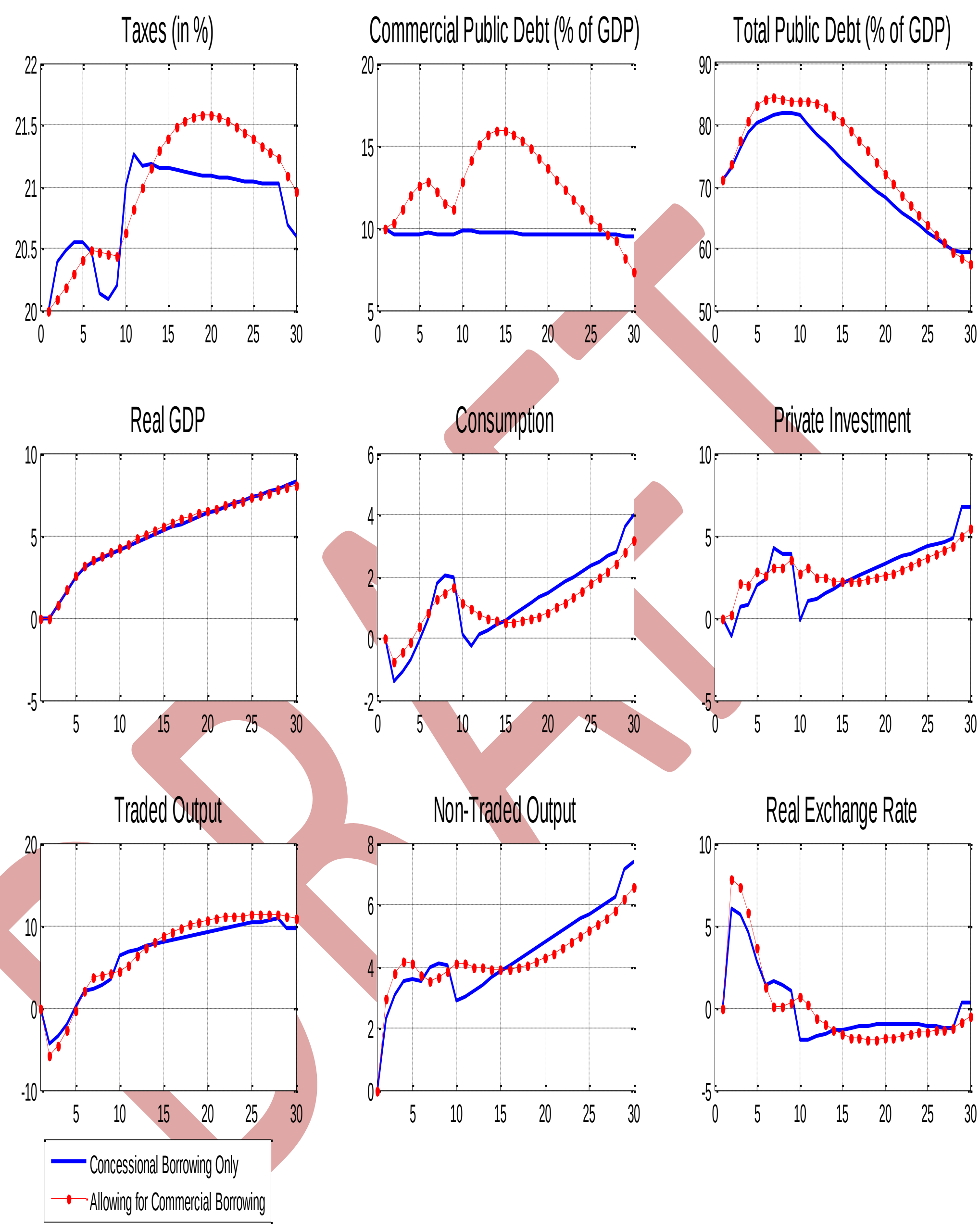
- The impact on consumption is also quite robust. The level of consumption rises to by almost 5.0 per cent of GDP.

Figure 1 Model 1 Baseline Run


Scaling Up (in % of GDP)
Relative Price of NT Goods
Taxes (in %)
Transfers Change (in % of GDP)
Interest Rate (in %)
Private Investment
External Private Debt (in % of GDP)
Consumption
Wages
Public Effective Capital
Private Capital
Real GDP Growth (% YoY)
Sectoral Output
Traded
Non-Traded
Deficits (in % of GDP)
Fiscal
Current Account
Concessional Debt (in % of GDP)
Total Public Debt (in % of GDP)
Public Investment
Loans and Grants

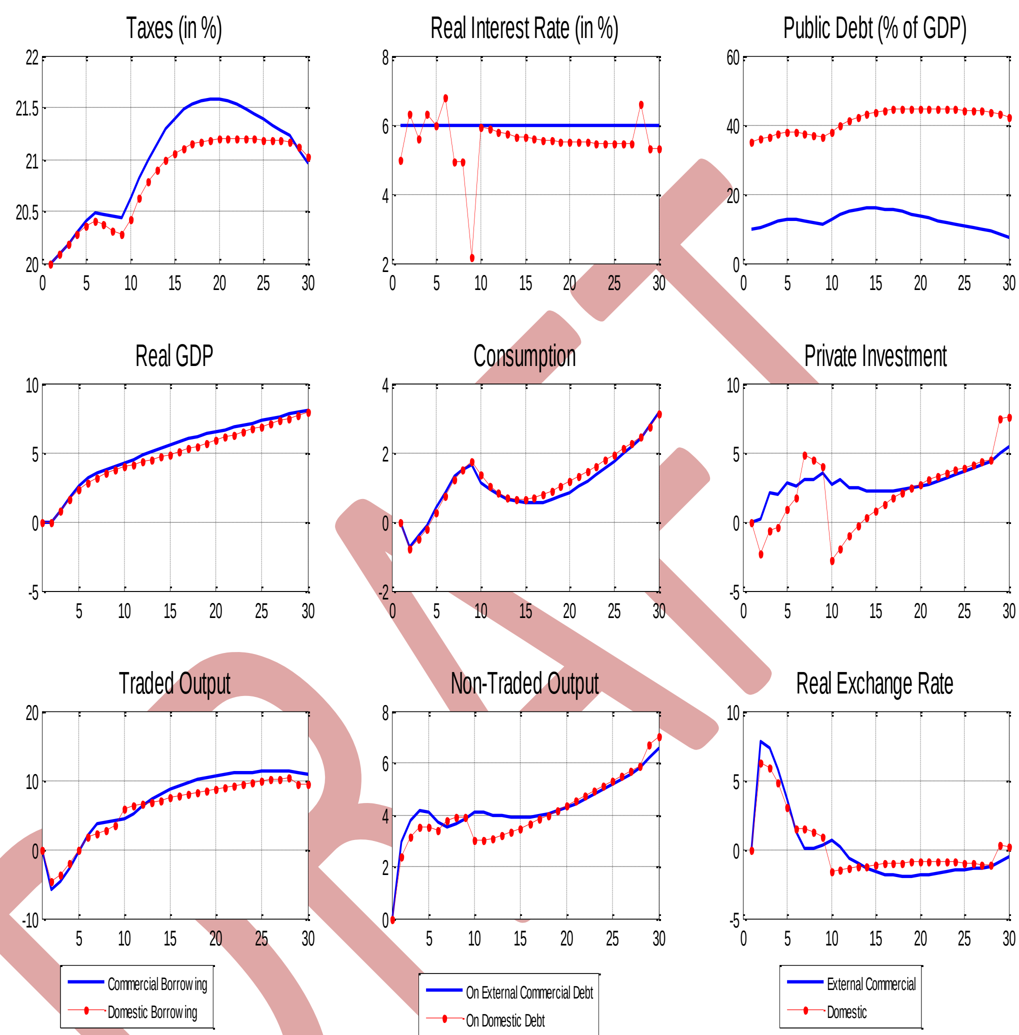
In figure 2 we show the results for the baseline when provision is made for external commercial borrowing. Under this situation we see that total public debt as a percentage of GDP exceed the baseline case, where by debt rises up 84.0 per cent of GDP as opposed to 80.0 per cent in the baseline. Taxes also rise more sharply than under the baseline; however they take a longer time to rise by almost 5 years. Commercial debt shoots up to 15.0 per cent of GDP by year 17 but decline thereafter even blew they baseline case as the countries generate enough growth and revenue to pay off the debt

Figure 2 Baseline allowing for commercial borrowing



In figure three we show the baseline calibration when we allow for domestic borrowing.

Figure 3 Baseline Allowing Domestic Borrowing



For the second simulation a much more optimistic case is presented than what occurred in the baseline. The key changes are the that user fees return 60.0 per cent of the initial expenditure in investment, the return on infrastructure investment is 50.0 per cent, and the efficiency on public investment is 60.0 per cent implying that for every one dollar on public investment 0.60c worth of capital is created.

The results are shown in ***figures 4 to 6***.

- In this case the growth outcome in the initial years is notably better than in the base case. Real GDP growth reaches 5.1 per cent in the five years of scaling up but then peters out to roughly 4.43 per cent per year after. In any case this is much better than the 2.0 per cent average growth that occurs currently.

- *Public debt.* Public debt performs even better than in the base case. In the first years of scaling up public debt reaches a maximum of 77.0 per cent of GDP. However over the longer run public debt actually declines to 50.0 per cent of GDP.

- Fiscal response and external commercial borrowing needs- the fiscal response to scaling up to taxes and expenditure are the same as in the baseline scenario.

- The response of both consumption and private investment are even more pronounced than in the baseline fuelling the higher levels of growth. In this case consumption and private investment shoot up to almost 10.0 per cent of GDP. This is a quite respectable response of the private sector to boost in public investment.

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Figure 4 Model 2 Optimistic Scenario

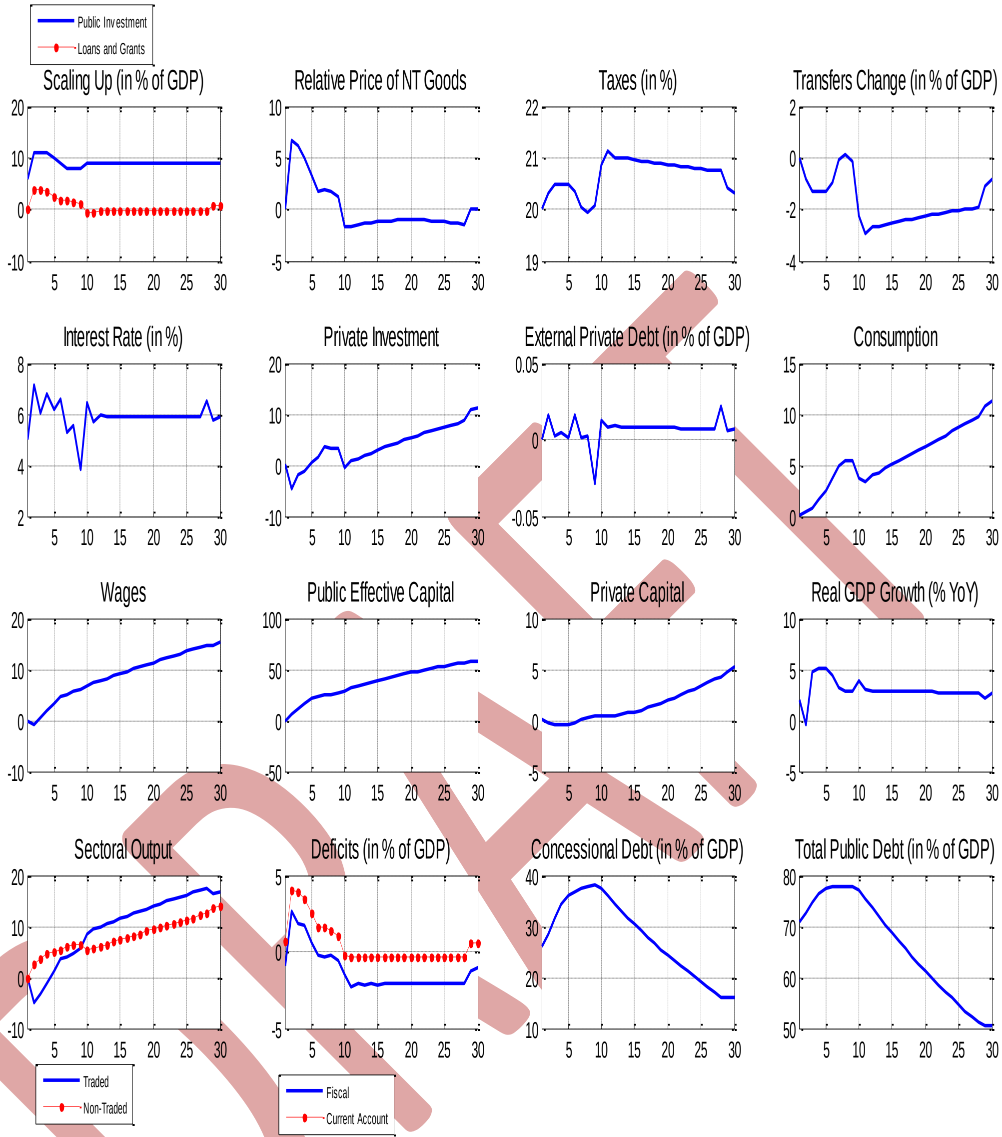


Figure 5 Optimistic Scenario allowing for commercial borrowing

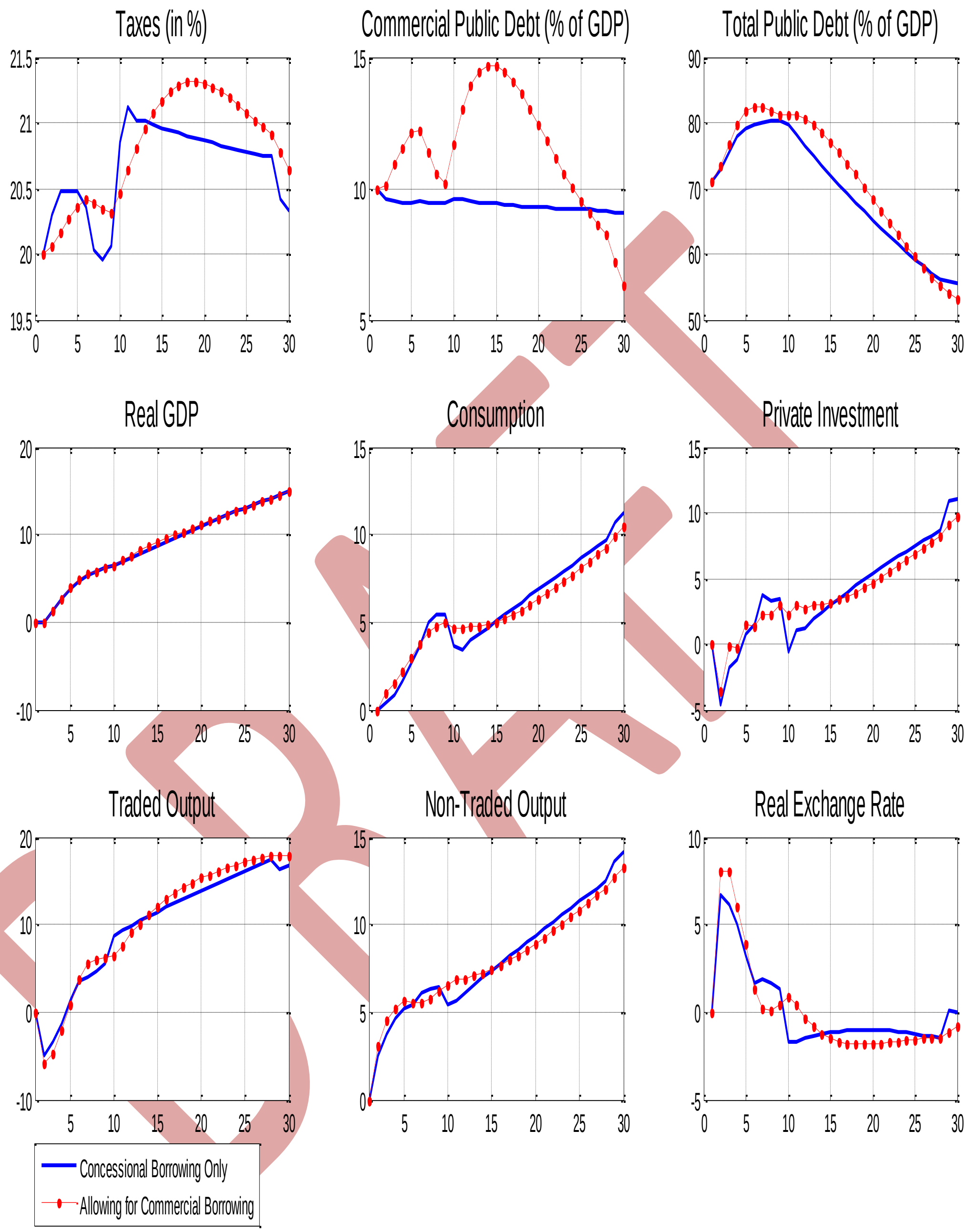
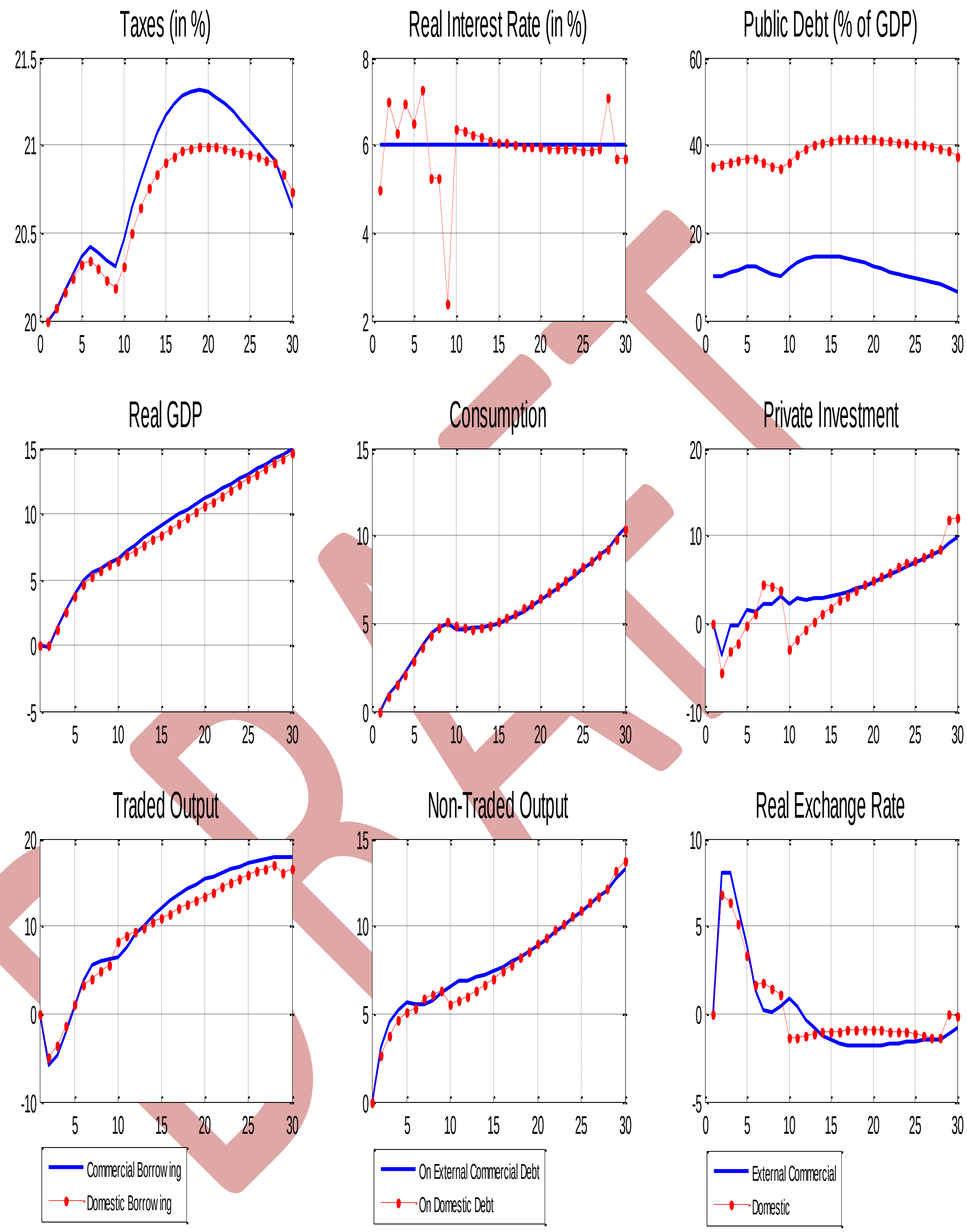


Figure 6 Optimistic Scenario allowing for domestic borrowing



For the third simulation a much more pessimistic case is presented than what occurred in the baseline. The key changes are that user fees return 20.0 per cent of the initial expenditure in investment, the return on infrastructure investment is 20.0 per cent, and the efficiency on public investment is 30.0 per cent implying that for every one dollar on public investment 0.30c worth of capital is created.

The results are shown in figures 7 to 9. In this case the growth outcome in the initial years is is worse than in the baseline. Real GDP growth does not even reach 4.0 per cent per annum and actually fall back to 2.0 per cent after 10 years. This result is especially discouraging.

Public debt. Public debt performs worse than in the base case. In the first years of scaling up public debt reaches a maximum of 83.0 per cent of GDP. In the longer run public debt actually declines but does not fall below 60.0 per cent as in the baseline case. Fiscal response, due to increase in public investment scaling as in the base case there is a rise in tax rates and fall in transfers. *Consumption.* The transfer cut is projected to contribute to a permanent drop of consumption as a per cent age of GDP. Even when we make provision that the authorities can delay tax hikes by borrowing external commercial loans or domestic loans. The results are still discouraging. While both commercial and domestic borrowing provide the authorities with ability to delay tax hikes by 5 years whereby tax rates actually increase to 20 per cent of GDP in 15 rather than 10 years the story still remains the same that adjustment must happen.

Figure 7 Model 3 Pessimistic Scenario baseline

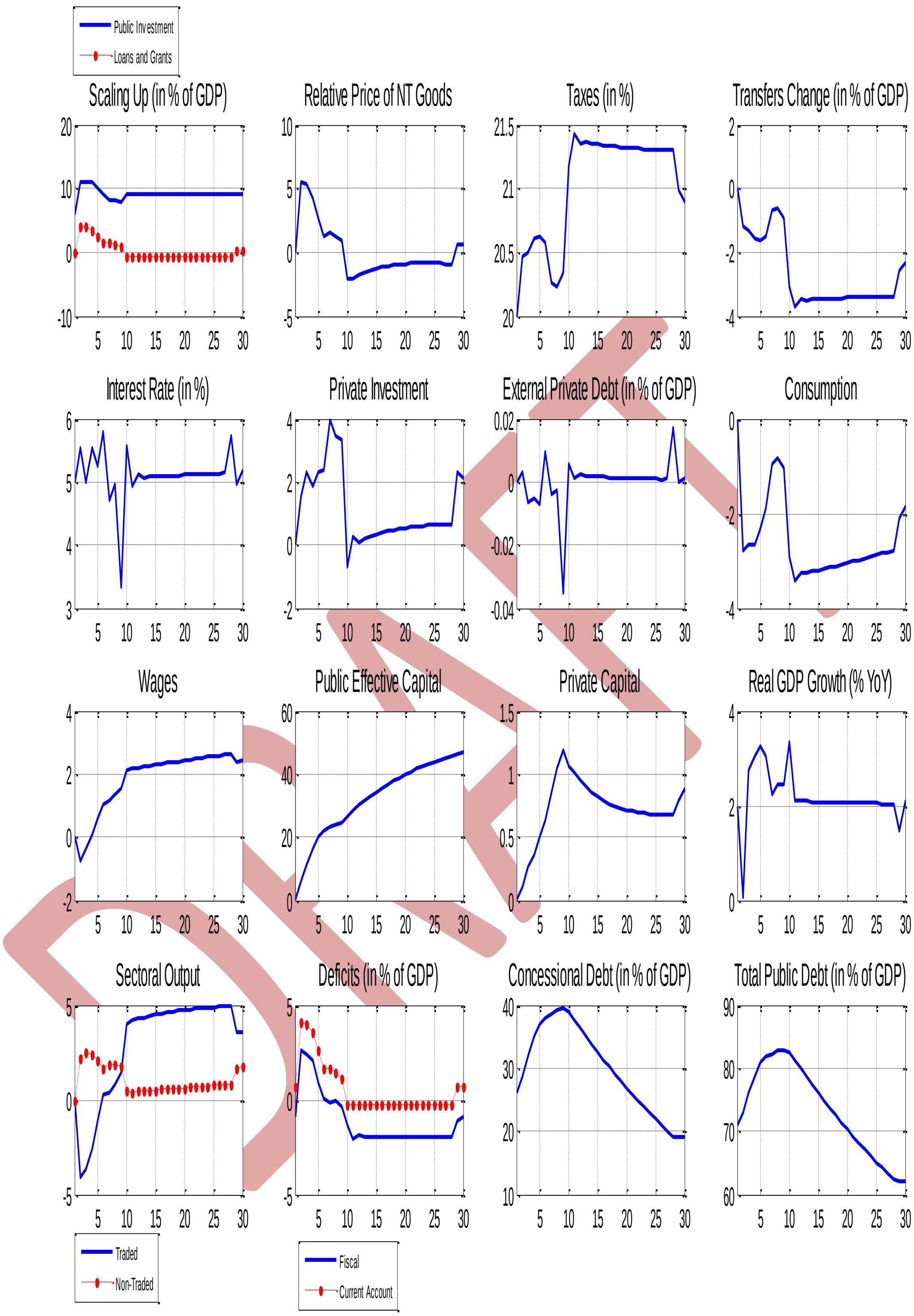


Figure 8 Pessimistic Scenario allowing for commercial borrowing

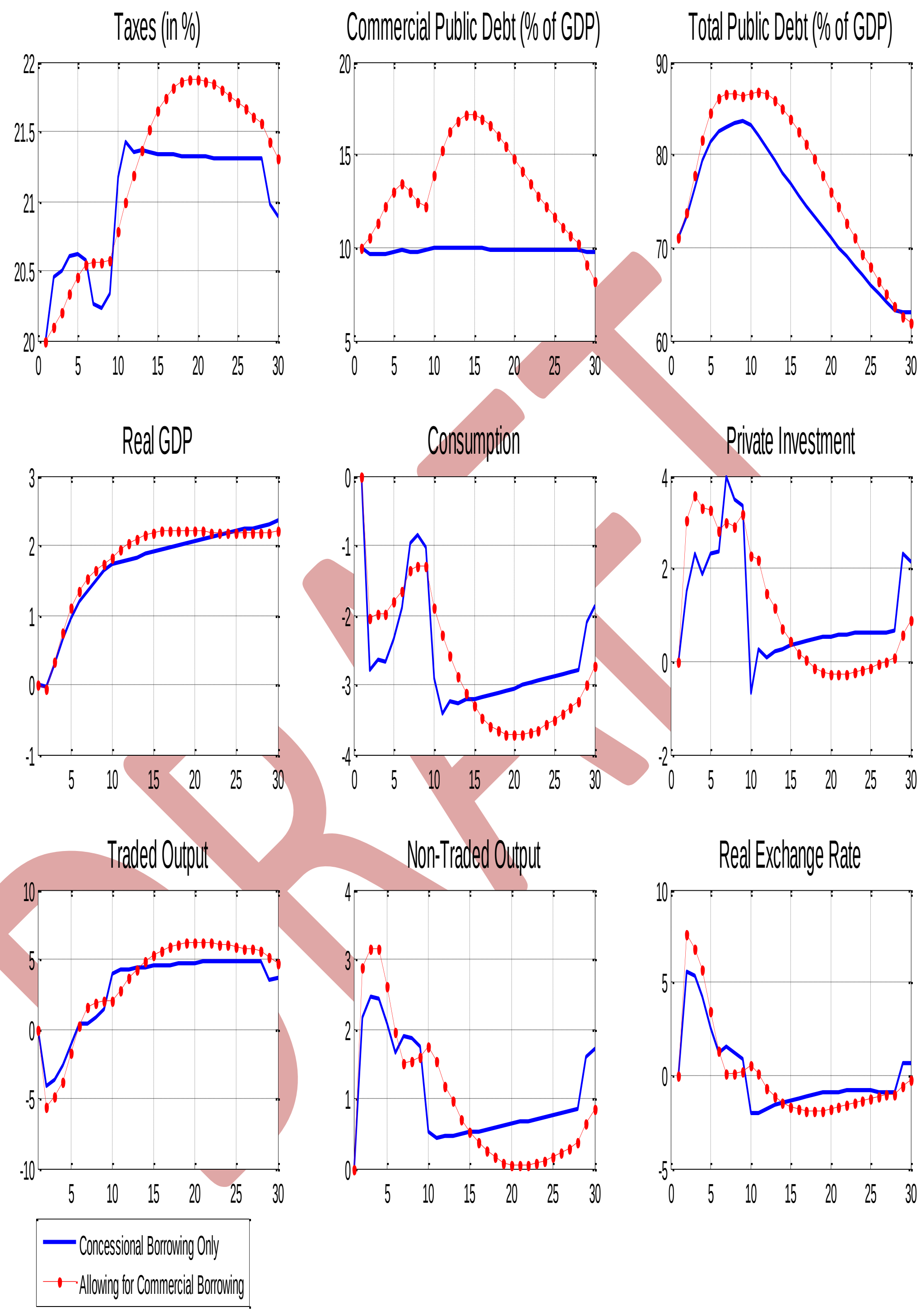
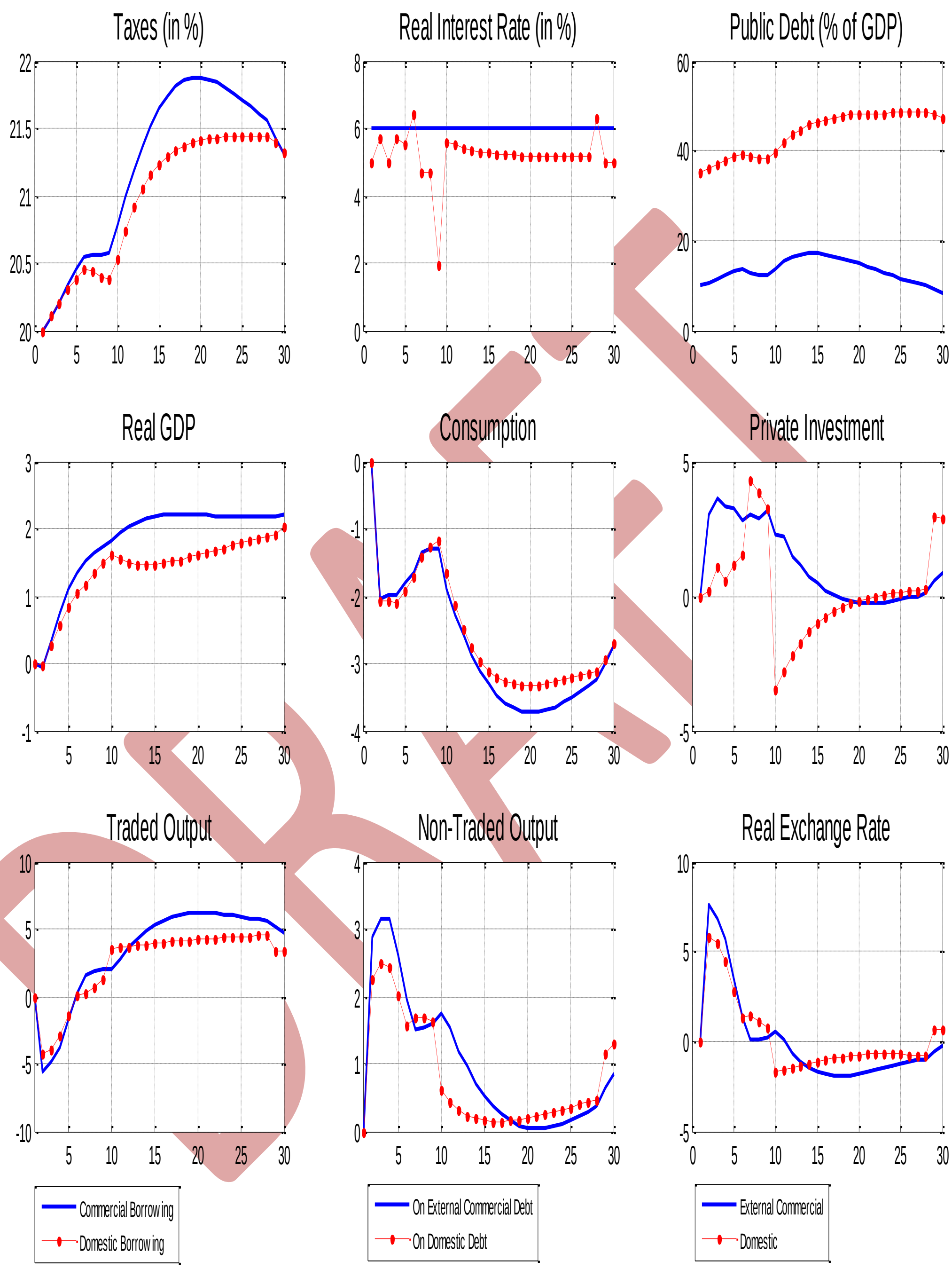

Taxes (in %)
Commercial Public Debt (% of GDP)
Total Public Debt (% of GDP)
Real GDP
Consumption
Private Investment
Traded Output
Non-Traded Output
Real Exchange Rate
Concessional Borrowing Only
Allowing for Commercial Borrowing

Figure 9 Pessimistic scenario allowing for domestic borrowing



VI. Conclusion

In conclusion the aim of this paper model that analyses the links between public investment, economic growth and debt sustainability. The aim of the model is to complement the standard IMF-World Bank debt sustainability framework and give preliminary guidance on the feasibility of scaling up public investments through borrowing under different assumptions. It is a two-sector open economy dynamic general equilibrium model elaborated by Buffie and others (2012) with three types of public sector debt (external concessional, external commercial and domestic debt). In the model, public capital (infrastructure) enters the production function for both tradable and non-tradable goods. The extent to which public investment produces additional infrastructure depends on a parameter reflecting the efficiency of investment. The government undertakes current expenditures, infrastructure investment and pays debt service. It collects revenue from a consumption tax and from user fees for infrastructure services, which are expressed as a fixed fraction/multiple of recurrent costs. When expenditures exceed revenues, the difference is financed from various sources of debt. The model allows comparisons of the implications of a range of financing options. Concessional loans by official creditors, domestic loans and grants from donors are both considered to be determined exogenously and a are therefore fixed. The model can simulate governments borrowing under non-concessional terms abroad. Meanwhile, governments can also modify tax policy and user fees in the model. The tax burden is a crucial policy variable, and changes in the speed and size of the fiscal adjustment (i.e., increases in the tax burden) eventually required to pay for the investment scaling-up are important for determining the resulting debt path.

The main lesson of the model is the need to consider the dynamic interactions of public investment, growth, recurrent costs, and fiscal policy. In addition to servicing the debt, the government needs to account/pay for depreciation, if it desires a sustained increase in public capital. Therefore, even when investment has a high rate of return, it may not fully pay for itself from the point of view of the fiscal authorities if tax rates and user fees are low and the benefits initially accrue mainly to the private sector. There may also be a transitional fiscal problem if the benefits of public investment do not fully materialize before the debt needs to be repaid.

The following conclusions can be drawn from the simulation analysis:

The key findings from the model are that, a well-executed high-yielding public investment program can substantially raise output/GDP growth and consumption and be self-financing in the long run. It is not sufficient to simply analyse whether the return of public investment projects is higher than their costs of financing. A coherent analysis needs to be employed to look into a set of factors: the efficiency of public investment, the absorptive capacity of the country, the response of the private sector, and the authorities' ability to adjust expenditure and taxes. The sensitivity analysis shows that it is critical for the authorities to ensure the quality of public investment, particularly in improving the efficiency of public capital and return of return on infrastructure.

Poor execution, sluggish fiscal policy reactions, or persistent negative weak structural conditions, strategy surge in public investment can easily lead to unsustainable public debt dynamics. Front-loaded investment programs and weak structural conditions (such as low returns to public capital, tight absorptive capacity of the country and poor execution of investments) make the fiscal adjustment more challenging and the risks greater.

The analysis has provided a rich discussion regarding the role of public investment in the economy but more importantly it highlights the structural features of the economy. As alluded to above careful attention has to be paid to factors such as the efficiency of public investment, the country's willingness to make tough decisions regarding fiscal adjustment in addition to policies regarding collection of user fees for public investment and return on public investment. Considering these factors will undoubtedly play a crucial role in the effects of a decision to increase the level of capital expenditure. Beyond these issues are issues related to the type of investment by the Government, that is, is all public capital created equally? In addition the paper highlights the fact that institutional framework for analysing and managing public investment projects are quintessential for such programs to work effectively. Projects need to be carefully scrutinised and analysed before they are undertaken and once they are undertaken they need to be managed well for the induced benefits. Simply undertaking public investment for spending sake simply does not work.