The Relationship Between Growth and Investment*

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Abstract

This paper utilizes the growth accounting framework to derive and analyze the relationship between the rate of growth of output and the ratio of investment to output. With plausible parametric assumptions this framework is used to examine the recent controversy in Fiji on investment and growth. Our results support the concerns of some USP economists that a 5% growth rate for Fiji needs significantly higher investment rates and institutional reforms.

JEL: E15.000, E15.001, E15.003, E15.004;

KEYWORDS: Investment ratio, Growth targets, Growth accounting, Total Factor Productivity.

* I wish to thank my colleagues A/Professor Biman Chand Prasad, Dr Sukhdev Shah, Gyaneshwar Rao and Umesh Chand and Dr Paresh Narayan of the Griffith University for useful suggestions and comments. I must especially thank Dr Peter Robertson of the University of New South Wales, for checking the accuracy of my methodology and suggesting improvements. But for Dr Robertson's valuable comments and suggestions this paper could not have been finalized because the comments by two referees of this journal were at tangent to my methodology. Nevertheless, I wish to thank both referees because their comments have been useful and helped to refresh my understanding of the classic contributions of Solow (1956, 1957). Special thanks are due to Professor Ron Duncan for his encouragement and constructive suggestions to clarify my methodology. However, remaining errors are my responsibility. This paper was presented at the 2004 Fiji Up Date, jointly held by the Australian National University and the University of the South Pacific. I thank the participants for their comments and in particular Dr Satish Chand of the ANU.

1. INTRODUCTION

Recently a controversy has emerged on whether Fiji can sustain a 5% output growth with an investment to GDP ratio (investment ratio, henceforth) of about 0.15. The government seems to thinks that a 5% growth target is realistic although it is not obvious whether this growth target can be sustained with the present investment ratio or the government plans to implement policies to raise the investment ratio, say to about 0.25. On the other hand some academic economists at the USP, notably Associate Professor Biman Chand Prasad and Dr Sukhdev Shah, take a cautious view. They argue that the 5% growth target is too optimistic and the current high rate of growth, at around 4.5%, is unsustainable and transient. Therefore, in their view the economy would revert back to its past average growth rate of about 2.5%.[1] Prasad and Shah, both experts in growth and development issues, think that to improve the growth performance important changes to the existing policies and institutions are necessary. For example, Prasad has taken a consistent view in many of his research publications, that changes to the existing uncertain land tenure system, property rights and political institutions are necessary to improve the economic and social environment in Fiji; see for example, Prasad (2003, 1999, 1997) and Prasad and Tisdell (1996a, 1996b). Although not related to the current controversy on investment and growth, Professor Ron Duncan has also emphasized the need for institutional reforms, especially to improve governance; see Duncan (2003).[2] Shah, a former IMF economist, with many years of practical experience in the development problems, takes a similar view but also argues for the

[1] The Reserve Bank of Fiji (RBF) also seems to think that the current growth rate cannot be sustained, unless some imbalances in the economy are corrected. RBF seems to think that Fiji's export performance needs improvement and the current consumption expenditure is high. Therefore, RBF has responded by increasing the rate of interest by 0.5% to dampen consumption expenditure. It may be said that RBF seems to think that current demand is relatively higher than current capacity and therefore demand should be reduced and its composition should be changed.

Unfortunately, the increase in the rate of interest is likely to adversely affect the investment rate and therefore the growth of the capacity in the economy. Furthermore, the effect of the rate of interest on Fiji's consumption expenditure is unlikely to be significant, partly because of the highly risk averse nature of consumers in the developing countries. For some discussion on Fiji's consumption function see Rao (2004) and Rao and Singh (2004).

[2] Duncan (2003) has also a useful survey of developments in growth theory and various factors influencing growth performance of which quality of governance is an important factor.

implementation of policies to increase the investment ratio; see Shah (2004).

However, the present controversy is limited to a single issue – whether investment in the private sector and public enterprises, as a ratio of GDP of between 0.13 to 0.15 is adequate to achieve a sustainable growth target of 5%.[3] In the current debate, the need for institutional reforms, highlighted by Prasad and Duncan, have been put aside. It is hard to quantify their impact on the rate of growth of output, although it should be admitted that it would be substantial.[4] We take the view that these institutional changes need considerable time and political will to implement. Consequently their effects are likely to be realized over a longer period. Therefore, the current debate on the adequacy of the investment ratio becomes important for the short to medium run policies. However, much of the present controversy is conducted on the basis of intuitively plausible arguments, charts and data. Therefore, it is hard to resolve the conflicting views without at least a simple if not a comprehensive analytical framework.

2. THE FRAMEWORK

A look at the relevant theoretical models of growth suggest that while the investment ratio is a key determinant of growth rate in the Harrod-Domar growth models, in the neo-classical growth model a higher investment ratio increases the growth rate only during the transition of the economy from one steady state to another. In the steady state, growth rate of per capita output is determined only by the rate of growth of technical progress.[5]

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[3] This controversy has recently received considerable public attention after a lecture by Shah (2004) at the Reserve Bank of Fiji (RBF). Some influential private sector economists and observers, thought that while the 5% target may be unrealistic, Shah is too pessimistic on the growth prospects. I am grateful to Dr Shah for sharing several comments he has received after his lecture at RBF.

[4] Duncan (2003) offers an interesting atheoretical justification, similar to the effects of improvements in trade on growth, for including quality of governance as an explanatory variable in empirical growth equations.

[5] There is also some empirical work on the significance of investment ratio in the growth equations. Using cross-section data of 87 (1965-1975 period) and 97 (1975-1985 period) developed and developing countries, Barro and Sala-I-Martin (1995) found that the coefficient of the investment ratio was positive but ranged from insignificance to significance depending on the method of estimation and inclusion or exclusion of the other variables. The highest significant value of this coefficient was 0.1, implying, for example, that if (I/Y) increases from 0.15 to 0.25, growth rate increases by 1% point. Since their sample includes countries which might be

Although the neo-classical growth model can be modified to examine the investment-growth controversy, in this paper we shall use the simpler growth accounting framework of Solow (1957). Since the growth accounting framework is an identity, it should be noted that it does not take into account the dynamic adjustments from one steady state to another. In fact there is no distinction between the steady and non-steady states in the growth accounting identity. In this respect the growth accounting approach has a limitation if in fact these dynamic adjustments in the economy are significant and rapid in real calendar time. Therefore, its implication that the rate of growth output can be maintained at a higher rate than implied by the growth of total factor productivity (TFP), in contrast to the neo-classical growth model of Solow (1956), should be treated with caution. However, at an empirical level, there seems to be some support that these dynamic adjustments are slow in the developing countries; see for example the high rates of growth achieved by the East-Asian countries, especially by Singapore with a negative TFP, mostly through factor accumulation and especially with high investment ratios.[6]

Consequently, it may be said that while the growth accounting framework seems useful for policies for the short to medium terms in the developing countries, the need to increase TFP, in the long run, should not be neglected.[7]

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in the steady state or near steady state (e.g. USA) as well as countries which are far away from the steady state (e.g. Singapore), it is difficult to accept these findings without reservations, since growth rate does not depend on investment ratio when the economy is in the steady state.

[6] In an experimental simulation with the neo-classical growth model, we have found that when the investment ratio is increased from 0.15 to 0.23 to increase the growth rate from about 2.8% (due to TFP and factor accumulation) to 5% (on the average), for several decades growth continues above the assumed growth rate of 2.8%. The model approaches its new steady state after 50 periods. Growth rates during the transition period are above 5% up to 6 periods and above 4% for 14 periods. The average growth in these 14 periods is 0.051.

[7] As the developing countries progress and industrialize, they would face more and more complex decision making problems. It is our view that, to make such complex decisions, there is a need for efficient institutions so that more and more negative feedback mechanisms can be built into the system. Needless to say the industrialized countries have considerable historical experiences in complex decision making processes, and the cumulative effects of incentives to develop appropriate institutions, over long historical time units, has resulted in efficient institutions. It is for this reason we believe that developing countries should pay attention to institutional reforms, instead of leaving this to evolve gradually in the course of history. The link between institutional development, good governance practices

3. GROWTH ACCOUNTING FRAMEWORK

Since these relationships, based on the growth accounting framework of Solow (1957), are identities with plausible assumptions about the production technology, they are essentially truisms. We start with a production function with the Hicks neutral technical progress:

$$Y_t = A_t \times F(K_t, L_t) \tag{1}$$

where A is the stock of knowledge, K is stock of capital and L is labour. If (1) is assumed to be a Cobb-Douglas (CD) function with constant returns and the assumption that the stock of knowledge increases at the rate of g per period, the above can be expressed as:

$$\begin{aligned} Y_t &= A_0 e^{gt}\ K_t^{\alpha}\ L^{(1-\alpha)} \\ implying:\ lnY_t &= lnA_0 + g\ t\ + \alpha\ lnK_t + (1-\alpha) lnL_t \\ or \Delta lnY_t &= g + \alpha \Delta lnK_t + (1-\alpha)\Delta lnL_t \\ \dot{Y}_t &= g + \alpha \dot{K}_t + (1-\alpha)\dot{L}_t \end{aligned} \tag{2}$$

where a dot on the variable denotes its proportionate change.

Suppose, in a country, the share of wages $(1-\alpha)$ in GDP is 0.65 and therefore the share of profits is 0.35. Suppose, capital grew at 1% and employment grew at 1% but output grew at 3%. It is easy to work out that capital and labour contributed only $0.35\%(= 0.35 \times 1)$ and $0.65\%(= 0.65 \times 1)$, respectively, to output growth. The residual is 2% and this is attributed to technological progress. Initially this is how Solow (1957) was used to estimate the rate of technical progress in many countries. It was found that the contribution of technical progress has been about 30% to 40% of the observed growth rates in the developed countries. This way of estimating technical progress is known as the Solow residual approach, based on the growth accounting framework.

Our objective here is to compute the required investment ratio, for a given target rate of growth of output, i.e., we would like to derive a relationship such as:

$$\frac{I_t}{Y_t} = F(\dot{Y}_t) \tag{3}$$

where I is gross investment in the economy. This can be deduced by

and economic growth is amply explained in the writings of the new economic historians. See Duncan (2003) for the need to promote good governance practices in Fiji.

inverting the growth accounting identity in (2) and solve for $\dot{K}_t$ as the residual, like TFP in the traditional growth accounting, to get:

$$\begin{aligned}\dot{K}_t &= \frac{\dot{Y}_t - (1-\alpha)\dot{L}_t - g}{\alpha} \\ &= \frac{\theta - (1-\alpha)n - g}{\alpha}\end{aligned} \tag{4}$$

where θ is the target rate of growth of output and n is the rate of growth of employment. If the share of wages in output $(1-\alpha)$ is known, equation (4) can determine the required growth in capital, given the output growth target, rates of growth of employment and technical progress .

The next step is to derive an expression for the investment ratio in (3), in terms of $\dot{K}_t$. First, the rate of growth of capital in (4) in discrete time can be denoted as follows and noting that the change in capital stock in period t equals to net investment in that period gives:

$$\frac{\Delta K_t}{K_{t-1}} \equiv \frac{I_t^{net}}{K_{t-1}} \tag{5}$$

By definition, gross invest equals net investment plus depreciation investment and with the assumption that depreciation rate is δ proportion of the capital stock, the ratio of gross investment to output will be:

$$\begin{aligned}\frac{I_t}{Y_t} &= \frac{I_t^{net}}{Y_t} + \frac{\delta K_t}{Y_t} \\ &= \frac{I_t^{net}}{Y_t} + \delta\Pi_t\end{aligned} \tag{6}$$

where Π is the capital-output ratio. Substituting for I^{net}, from the discrete version of (4) into (6), gives:

$$\begin{aligned}\frac{I_t}{Y_t} &= \frac{[\theta - (1-\alpha)n - g]}{\alpha}\ \frac{K_{t-1}}{Y_t} + \delta\Pi_t \\ &= \frac{[\theta - (1-\alpha)n - g]}{\alpha}\ \frac{K_{t-1}}{(1+\theta)Y_{t-1}} + \delta\Pi_t \\ &= \frac{[\theta - (1-\alpha)n - g]}{\alpha}\ \frac{\Pi_{t-1}}{(1+\theta)} + \delta\Pi_t \\ &= \left[\frac{(\theta - (1-\alpha)n - g)}{\alpha\ (1+\theta)} + \delta(1+\gamma)\right]\Pi_{t-1}\end{aligned} \tag{7}$$

where γ is the rate of change in the capital output ratio and equals

zero if this ratio is constant.

A quick application showed that equation (7) is promising. In Fiji, for example, during the period 1970 to 2002, the average growth rate of output was about 3% and capital stock grew at 1.6%. With further assumptions that the share of wages is 0.65, and employment grew at 1%, equation (2) implies that the rate of technical progress (TFP, hereafter) is 1.8%. Substitution of these values into (7) and with the further assumptions that the capital-output ratio is about 2 and the depreciation rate is 10% imply that the ratio of investment to output should be about 23%. The actual average ratio of investment to output was 22.5% during 1970-2002.

Even though these assumptions appear to have been made to fit the data, their use should be evaluated on their plausibility. In our view, these parametric assumptions are reasonable, provided the limitations of measuring TFP as a residual are noted. This measure, commonly known as the Solow residual, is a proxy for the effects of all other influences, not accounted by the growth in labour and capital, on output growth. In addition to the contribution of the growth of knowledge, these other factors could be diverse. For Fiji, for example, changes in the institutional environment, tax policy, weather, exports, output growth of the trading partners and a host of other unaccounted influences may affect its output growth; see, for example, Williams and Morling (2000).[8]

A pragmatic way to distinguish between growth related to technological progress due to growth in knowledge and other factors is to examine the variance of the estimated TFP. If improvements in factor productivities, due to the growth of knowledge, are the main source of technical progress, such improvements are unlikely to fluctuate by large magnitudes and therefore, the variance of TFP will be modest.

[8] Williams and Morling (2000) found that there is a strong long run relationship between Fiji's output and the weighted average of outputs of its trading partners. However, their unrestricted ARDL model in their equation (1) seems to be in need of attention. In such an ARDL equation the lagged levels of all the hypothesized factors affecting output should have been included. For example, although in their study terms of trade, effective exchange rate, rate of interest and agricultural supply proxy are also assumed to affect output, their lagged levels are not included in the ARDL. Only the lagged levels of trading partners' output and budget deficit are included. The contribution of technical progress and institutional factors did not receive attention but these are difficult to introduce into their model. However, a dummy was included to capture the effects of the 1987 political coup and its coefficient is negative. In spite of some limitations, the Williams and Morling study is interesting and deserves further attention.

Our year by year estimates of TFP has a standard deviation of 0.017 which is far less than 0.036 for an estimate of TFP by Chand (2002) for the period 1978 to 1997. Since, there are no other reliable empirical estimates of Fiji's TFP, we shall use our crude estimates with the aforesaid limitations. In the following section a few simulations are performed to examine the implications of pursuing alternative output growth targets.

4. EMPIRICAL RESULTS

Although a numerical solution for the relationship between the investment ratio and output growth can be derived by making plausible assumptions about the parameters in equation (7), it is convenient to present the relationship between the two in a tabular form. Our simulations allow for a plausible range of parametric values. In the static simulations alternative output growth targets, from 2.5% to 6.5% and TFP in the range of 0.5% to a high 3% are used. Alternative assumptions on TFP are useful because reliable estimates of this important parameter are not available and the assumed value for TFP plays an important role in the current controversy. Our prefered magnitude for TFP is 1.8% based on our earlier estimate. The assumed values for the other parameters, perhaps less controversial, are: $(1-\alpha) = 0.65, n = 0.01, \delta = 0.07, \Pi = 1.75$ and $\gamma = 0$. The average depreciation rate from 1970 to 2002 was 0.07 but data are not available to estimate other parameters. It should be also noted that these simulation results are sensitive to small variations in the assumed values for the depreciation rate δ and capital-output ratio, Π and we shall comment on this later in this paper. The simulation results with these assumptions are given in Table-1. These are static in the sense that the assumed values for parameters, other than θ and TFP, are held constant.

In the recent past i.e., from 1996 to 2002, the investment ratio has been around 0.15. To evaluate the current debate on the investment ratio, we set some benchmarks and compute the investment ratios implied by the assumed growth rates in rows and TFP rates in the columns of Table-1. It can be seen from these results that an investment ratio of approximately 0.15 implies an output growth rate of 3% with 1.8% TFP; see row2 and column 4. However, a higher output growth rate of approximately 4.5% can be achieved with this low investment ratio, if policies to double the rate of TFP are implemented; see row 5 and the last column. Such high rates of TFP are unlikely to be achieved and maintained without implementing significant institutional reforms, a view persistently pursued by Prasad. Shah's rather pessimistic prediction, in the view of some commentators, that

the output growth rate will decline from the current 5% to something like 2.5% seems to be not all that pessimistic. If the rate of TFP is between 1% to 1.5%, an investment ratio of 0.15 implies an output growth rate of only 2.5%. Since there are no reliable estimates for TFP in Fiji, Shah's implicit assumption that TFP is lower than our estimate of 1.8% is a reasonable assumption. Whatever is the actual rate of TFP in Fiji, our simulation exercise is useful in that it helps to understand the nature of assumptions, made by the proponents of this debate, about the underlying key parameters.

Table-1
Required Investment Ratios

	TFP 0	TFP 0.005	TFP 0.01	TFP 0.018	TFP 0.02	TFP 0.025	TFP 0.0275	TFP 0.03
OUTPUT 0.025	0.213	0.188	0.164	0.125	0.115	0.091	0.079	0.066
OUTPUT 0.03	0.237	0.212	0.188	0.149	0.139	0.115	0.103	0.091
OUTPUT 0.035	0.26	0.236	0.212	0.173	0.164	0.139	0.127	0.115
OUTPUT 0.04	0.284	0.26	0.235	0.197	0.187	0.163	0.151	0.139
OUTPUT 0.045	0.307	0.283	0.259	0.221	0.211	0.187	0.175	0.163
OUTPUT 0.05	0.33	0.306	0.282	0.244	0.234	0.211	0.199	0.187
OUTPUT 0.055	0.352	0.329	0.305	0.267	0.258	0.234	0.222	0.21
OUTPUT 0.06	0.375	0.351	0.328	0.29	0.281	0.257	0.245	0.233
OUTPUT 0.065	0.397	0.374	0.35	0.313	0.303	0.28	0.268	0.256

A few comments on the sensitivity of these results to the assumptions on the depreciation rate (δ) and the capital-output ratio (Π) are in order now. Our assumption that $\delta = 0.07$ is based on its sample average. It is well known that data on depreciation investment are generally based on the accounting and taxation needs and such data do not indicate the true depreciation expenditure. Our assumed value of 0.07 for δ implies a life span of about 13 years for the capital stock. However, if higher rates of TFP are targeted, perhaps there is a need to revise δ upwards than downwards, implying the need for

higher investment ratios to achieve any given output growth target. Therefore, it may be said that those who take a more optimistic view of Fiji's future growth performance, perhaps assume a lower value for Π than the assumed value of 1.7 in this simulation. We have resimulated our model with the assumption that $\Pi = 1.5$ and found that a 0.15 investment ratio with a rate of TFP of 1.8% can achieve, at the most, a 3.5% output growth target. To achieve 5% output growth with an investment ratio of 0.15, it is necessary to make the somewhat implausible assumption that the capital-output ratio in Fiji is 1.1.

We have extended the scope of our static simulation exercise with some plausible dynamic assumptions on the evolution of the key parameters. These results are for a slightly smaller range of output growth because of the difficult nature of these simulations. The dynamic simulations give a better indication of the sustainability of the output growth target over a longer period. These results are given in Table-2.

A few uniform assumptions are made about the evolution of the parameters. A termination period of 13 years is selected and period 1 is the starting period and period 13 is the termination period. During this time span, the rate of growth of employment (n) is set to reach 2%, the share of wages ($1 - \alpha$) to 0.75, capital to output ratio (Π) to 2, depreciation rate (δ) to 10% and TFP is assumed to reach 2.5%. The initial values of these parameters are shown in column 2 of Table-2. The growth rate of output in period 1 is assumed to be 3% and reach the target growth rate by period 3. This target rate is then held constant for the next 10 periods. Column 5 in Table-2, for example, gives the values of the relevant variable in period 13, i.e., the termination period, for the growth target of 4%. In the last row, the mean values of the investment ratio, over the 13 periods, are given. It is a good indicator of the average investment ratio target to achieve and sustain the target growth of output. For example, if the growth target is 4%, this can be achieved with an average investment ratio of 20%. All other column figures should be interpreted in a similar way.

It can be noted from the last but one row of this table that the required rates of investment are indeed higher than in column 7 of Table-1 lending support to our assumed values of the parameters and assumptions about their evolution.

On the basis of these results it may be said that at the current rates of investment of 0.15 even a 3.5% growth target is difficult to sustain. To achieve and sustain a higher growth rate of 5%, substantial investment promotion policies are necessary to raise the investment ratio on the average to 0.25 (see the last row of Table-2) and plus or minus a few percentage points during the transition period. If

Table-2
Dynamic Simulation Results

Period	1	13	13	13	13	13	13	13
Growth Target	0.03	0.03	0.035	0.04	0.045	0.05	0.055	0.06
Share of Wages	0.65	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Growth of Employment	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
TFP	0.018	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Depreciation Rate	0.07	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Capital-Output Ratio	1.75	2	2	2	2	2	2	2
Investment Ratio	0.149	0.127	0.166	0.205	0.243	0.281	0.319	0.356
Mean Investment Ratio		0.147	0.175	0.2	0.228	0.251	0.275	0.294

the investment ratio remains static at its current rate of about 0.15, growth may revert back to between 3.5% to 3%. For these reasons, Prasad's emphasis on the need for major institutional preforms in Fiji seem to be credible. Without such reforms, it is unlikely that TFP will show any significant improvement. Until then and in the medium term, Shah's warnings that growth may revert back to 2.5% is not unduly pessimistic since it is only a shade below the 3% rate implied by our simulation results. Furthermore, our results also support the recent concerns of the Reserve Bank of Fiji (RBF) that the economy is growing at an unsustainable rate although the 0.5% increase in the interest rate may further depress the investment rate.

Criticisms of the views of the USP economists in the popular press and by some interested observers are perhaps based on the observation that Fiji is currently growing at a near 5% rate, in spite of an inadequate investment rate. While that the economy is growing at 5% growth is not disputable, there is no guarantee that this high rate can be sustained in the coming years. As has already been mentioned, our measure of TFP is a proxy for the effects of various factors, other than the rise in factor productivity. The high growth rates in the recent past may be due to some good fortune, such as the buoyant trends in the visitor arrival rates and/or the improved growth rates in the trading partners. Fiji has no control over these good luck factors to ensure that the near 5% growth rate can be sustained. A minor suspected terrorist incident or a political coup will have significant adverse effects on tourism arrivals. Furthermore, given the present international tensions and the surge in oil prices, it is hard to assume that the current

increase in the trading partners' growth will continue. It is doubtful if the economy in fact has grown at this high rate during 2003, in spite of some early optimistic forecasts. However, this can be only verified when the national income data for 2003 become available.Therefore, it is appropriate to ask what is necessary to ensure the sustainability of a 5% growth rate. In this respect, the two USP academic economists, Prasad and Shah, seem to be far more foresighted than their critiques.

5. CONCLUSIONS

In this paper we have used the growth accounting framework of Solow (1957), to develop a relationship between the investment ratio and the rate of growth of output. Our model is simple and needs only minimum information on some key parameters. Our analysis implied that the current investment ratio in Fiji is well below the required rate of 0.25 to sustain a 5% growth target. Unless policies are implemented to raise the investment ratio to above 0.25 and institutional reforms and good governance practices are initiated, the economy may revert back to about 3% growth rate. Our application of this model to Fiji has highlighted that differences in the assumptions on the key parametric estimates are the main source for confusion and conflicting pessimistic and optimistic growth forecasts. By examining a range of plausible values for these key parameters, our model has narrowed the disparities in the growth forecasts. Furthermore, our model highlighted the need for research to obtain more accurate estimates of some important parameters like TFP, capital-output ratio, employment growth and factor share etc.

Although we found that it might be difficult to achieve and sustain a 5% growth rate of output in Fiji with an investment rate of 0.15, it is hard to predict what would be a viable target rate of growth of output in the absence of clear policy statements and institutional reforms. Nevertheless, we may say that with the present rate of TFP of around 2% and an investment ratio of 0.15, a growth rate of 3% can be sustained. If the government implements clear policies to raise the investment ratio to above 0.25, a 4% growth seems to be sustainable. It is difficult to justify a 5% sustainable growth target, in the absence of significant long-term institutional reforms because we believe that they are also necessary to improve the investment ratio by a significant amount. Those who argue that a 5% growth target is feasible, with the current investment ratio of 0.15, seem to have made either some implausible assumptions about some key parametric values, e.g. that the capital-output ratio is 1.1, or simply have no framework at all.

In conclusion, we emphasize that our findings and forecasts should be treated with caution until more accurate estimates of the key pa-

rameters become available. It is hoped that other researchers will fill these existing gaps. Finally, it would be interesting to examine the investment-growth controversy by extending Solow's (1956) although we suspect that it may yield very similar results for the first five to ten periods.

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