CAPITAL ACCOUNT CONVERTIBILITY, THE UNFINISHED AGENDA: MARK I

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ABSTRACT

This paper deals with issue of Capital Account Convertibility, in the context of the Indian economy. The issue has been in and out of fashion as far as the priority of the policy makers in India is concerned. The paper essentially derives from the earlier work done by Rao et al, and uses optimal control to gain insight into the functioning of the Indian economy. The underlying model is a small prototype 'monetary model' and represents mark I of the ongoing debate. The limitations and possible extensions of the study have been indicated. The general conclusion of the paper is that whilst CAC continues to represent a desirable objective, it would be prudent to attain it cautiously. Haste in this regard can seriously and disproportionately cause the Indian economy great harm whereas not attaining it immediately will probably not hinder the consolidation of the Indian economy's progress towards attainment of 8% trend growth. Thus while continuing on an even and steady keel, what is of utmost importance is to strengthen the domestic economy further in the first instance.

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CAPITAL ACCOUNT CONVERTIBILITY, THE UNFINISHED AGENDA: MARK I

I. Introduction

Capital account convertibility has been on the Indian economic agenda for a while now. Given the prevailing economic climate and the ruling ethos. It is but a natural extension of the steps taken in the direction of creating a global and liberalized economy. There have been, of course, ebbs and flows in the intensity that capital account convertibility has been discussed. It is in this context that the study (reported in the present paper) has been undertaken. The paper reports results based on a small prototype model (borrowed straight from Rao and Singh 1998) which is essentially monetarist in character. The inspiration for this paper is derived from the agenda of putting the economy firmly yet securely on a path of 8% rate of growth. This problem needs to be addressed severally. It involves a regulatory and institutional aspect, the micro-dynamic aspect, the macro-economic aspect, the socio-political dimension and indeed the external dimension. As is clear from the title of the paper, here we deal with a limited aspect of the last mentioned dimension. Thus, it should be clear that rather than treat this paper as a stand alone, it needs to be looked at as a component of an ongoing research of comprehensive nature. Here we are concerned generally with the question of the direction and pace of CAC in the context of achieving an eight per cent growth of the Indian economy as a whole. It can be nobody's case that if the configuration of the macro-economic variables as depicted in our results were to be realized, we shall definitely have an 8% growth. We rather see our configuration as being *mildly* necessary if such a growth were to be brought about. The paper is divided into seven sections including the introduction. In the next section, we briefly explain the title. In the third section, we present a backdrop of the discussion surrounding the issue of capital account convertibility. In the fourth section the model is specified and the estimates are provided. In the fifth section, we report the results of the optimal control experiments that we have conducted, using the estimated model. In the sixth section, we discuss the limitations and possible extension of the research work as reported in the paper. In the seventh and the final section, we conclude.

II. Explaining the Title

This is a brief explanation of the two phrases, viz., ‘unfinished agenda’ and ‘mark I’. This paper deals with capital account convertibility, which as an economic process as well as a debate represent ‘unfinished agenda’. This is the more obvious reason, the other reason being that Prof. M.J.M. Rao had agreed to undertake this study just before his tragic and untimely death. It is in the spirit of completing his work that the authors (who are all Prof. M.J.M. Rao’s students and owe more than just an intellectual debt to him) have called this an 'unfinished agenda'. We have called it Mark I, because as the section on limitations will make clear, we believe that much can and should be done (by us or indeed anyone else) to add serious value to the study. That it is a part of a rather comprehensive research agenda we have already indicated in the introduction. But even with the narrow scope we have defined for us, we think much can be done – on another day. In order to communicate our view of the work reported here as being interim in nature – and indeed in the process of refinement and enlargement – that we have chosen to refer to it as mark I.

III. The Backdrop: Circa 1991 to Present

Early nineties saw a paradigmatic change in the system of macro economic management of the Indian economy. It is partly true that many of the consequent changes were foisted on us by the international agencies, in the wake of the so-called Washington consensus that emerged. Whatever the initial impulse, the fact of the matter is that the changes have been significant and are here to stay. The sequencing and pace of reforms (as these changes have been termed) have been a matter of considerable and ongoing debate. Yet another aspect of this debate was the ushering in of full capital account convertibility. Tentative steps had been taken in this regard (dual exchange rate is a case in point) and yet Indian policy makers stopped short of going the whole distance, for reasons that we shall discuss. The prevailing consensus amongst the Indian policy makers and the academia seems to be to look at capital account convertibility (CAC, henceforth) as a process rather than as an event. But, let us begin – on a general note – at the beginning.

Freeing transactions involving flows of capital / debt portfolio, equity and real estate between nations is termed as capital account convertibility. Out flows include residents purchase of foreign assets and repayments of foreign loans. Inflows include foreigners' investments in our country's markets (including financial markets) and loans to our residents. Over the past quarter of a century, several countries have undertaken measures to open up their capital accounts of their balance of payments as a part of a broad process of financial liberalization and international economic integration. The move to CAC in industrial countries was facilitated by the introduction of code of liberalization of capital movements by the OECD and the second directive by the European Union. Until recently, IMF had not considered CAC in a comprehensive way but rather in the context of surveillance, the use of Fund resources and technical assistance. For developing countries, the IMF has adopted a case by case approach. The IMF has underscored the crucial importance of prudential regulations and supervision. There has been a general discouragement of re-imposition of capital controls, though unlike under current account convertibility where re-imposition of controls is not permitted, the IMF recognizes the need for temporary re-imposition of capital controls. In the recent period, the IMF has been considering a proposal to amend the Articles of Agreement to incorporate CAC as one of the obligations of fund membership. For the developing countries CAC has been perceived to be necessary because their traditional sources of external funds have dried up and access to international capital markets have been thought to be essential for their continued growth and development. More recent arguments in favor of CAC emphasize the gains from trade in international financial assets as CAC allows domestic residents to hold an internationally diversified portfolio, which reduce vulnerability of income streams and wealth to domestic shocks. The quality of financial assets as well as the depth and liquidity of markets also improve. This also has obvious disciplining and aligning (with international regime) influence on domestic players and markets. It relatively facilitates the fiscal policy and severely constrains monetary policy and this may not necessarily be good news for democratic developing nations. Also there is some theoretical controversy about the distribution of welfare emanating from CAC. Be that as it may the fact of the matter is that the given the balance of power in the international arena, it is

almost certain that the developing countries will be statutorily mandated to fall in line as far as CAC is concerned. *The question is no more whether but rather only confined to 'when' and 'how'.* The emerging consensus based on both, the empirical evidence of countries that have ushered in CAC as well as the academic debate is that the matters of *sequencing* and the *pace* of ushering in CAC are of paramount importance, because getting it right here is rather crucial. This has largely been because, while the benefits of free capital mobility are widely acknowledged, the recent volatility of flows in emerging markets and the consequent costs associated have raised questions about unrestrained mobility. New technologies and the speed of transactions that are now possible have instilled a new fear of contagion across sectors that were previously unknown. Thus, as the noted U.S. economist Larry Summers has pointed out, 'Global financial markets let us go where we want more quickly and most of the time more safely than was possible before. But the crashes when they occur are that much more spectacular'. Fortunately, CAC is not an all or nothing affair. Carefully crafted controls can still be designed to suit a particular country. Capital controls can be of direct quantitative type or indeed can be tax induced in nature. The purpose of these is to gain a greater degree of independence for the domestic macro policy maker as well as to safe guard an economy from volatility of inflows. The process of CAC would have proceeded far ahead but for the fact of the East Asian financial crisis and we turn to that for a brief discussion.

There is much theoretical discussion and empirical referencing about CAC and related issues in papers by Rao et al, that we have referred to at the end and indeed from where we have almost totally borrowed the model specification. We have therefore not repeated many of the discussion points that they have covered, relevant though they may be. Let us now turn to the Asian Crisis. Much has been written about what has been termed as the Asian financial crisis or meltdown. It seems clear now that the crisis was triggered by large scale inflow of foreign funds into unregulated and immature markets of Asia. These funds were utilised for unproductive activities, leading to creation of idle capacity in real estate and hospitality industry. The resultant long-term asset creation was not temporarily matched by short-term liabilities. When panic struck it lead to well known distress and more than commensurate real damage. As Stanley

Fischer has noted, liberalisation without a necessary set of preconditions in place may be extremely risky. Important preconditions for CAC are:

- A sound macro economic policy framework; in particular monetary and fiscal policies that are consistent with the choice of exchange rate regimes.
- A strong domestic financial system, including improved supervision and prudential regulations.
- A strong and autonomous central bank.
- Timely accurate and comprehensive data disclosure, including information on central bank reserves and forward operations.

In general countries which initiated the move to CAC on the basis of strong fundamentals were able to modulate the pace of CAC without dramatic changes in macro economic policy stance. Those who went for drastic changes had to rethink, back track or in extreme case face a crisis. It needs to be noted that most of the countries that suffered the crisis under discussion had strong fundamentals at the macro economic levels. Indeed the World Bank along with other rating agencies had given clean chits to these very countries. The lesson to be learnt is that macro economic variables by their nature are summary statistics and as such are at most weak necessary indicators for future paths. It is crucial to look at the structural details – say the quantum and temporal aspect of asset liabilities of the banking sector – of the economy if one has to be reasonably sure of its immunity from possible and impending crisis. Thus the message, to repeat is loud and clear: put your house in order as far as the details of regulation, policies and reforms are concerned. Look at the structural details and do not rush into positions that you would have to retract from. Slow and steady is in order. We now turn to briefly tracing the evolution of CAC in India.

Historically, India pursued the model of ‘self reliance’. This was narrowly interpreted in actual fact to be inward looking, import substituting model of development where we tried to shun trade whenever possible. Well into the eighties, external financing was mainly confined to external assistance through multi-lateral and bi-lateral

sources, often at concessional rates to and through the government. The onset of the nineties as is well known changed it all. The varied challenges in sum termed as the multi faceted macro-economic crisis in a sense forced the hand of India's policy makers. The response came in two tracks. One, the immediate fire fighting and two, the longer term structural adjustment program. The latter ushered in a reforms era that touched almost all the sectors of the Indian economy, none more prominently than the financial sector, a process that still continues at varying pace.

The broad approach to the reform in the external sector was laid out in the report of a high level committee chaired by Dr. C. Rangarajan, the then Governor of RBI. As an aside we may mention that whilst the governors have changed there has been a noticeable continuity in the approach of the RBI as articulated by its successive Governors over time. Some of the recommendations included, Current Account Convertibility, regulations on external commercial borrowings (since considerably liberalised) and gradual liberalisation of outflows. The reforms in the arena of Banking have been guided by a critical appreciation of Narasimham I and II (the latter on the backdrop of Asian Crisis). India accepted Article VII requiring Current Account Convertibility. Thence, it set up the now famous Tarapore committee to set out the road map to CAC. As is well known, events have overtaken the recommendations that have been relegated – perhaps temporarily and apparently – to back seat.

The Tarapore committee report set out a time frame for successful attainment of preconditions in a phased manner in India's progression towards CAC. These preconditions were not onetime achievements but rather to be interpreted in a consistent and sustainable frame. These preconditions referred to fiscal consolidation, mandated inflation rate and prudential consolidation of the overall financial sector (a huge task indeed!). The committee recognized that whilst these consolidation measures were being achieved, the policy makers could take measured and cautious steps towards CAC. Also the policy makers were not to proceed in a mechanical way but rather 'play it by the ear'. These seem to have been a lessons well imbibed and

practiced by Indian policy makers. Let us – while concluding this section – briefly look at the very latest thinking of the Indian policy makers in this regard.

There is currently a dominant view on the appropriate exchange rate management that is gaining wide consensus. The fixed exchange rate is certainly out of favor. Even strong currency board arrangements in the post Asian crisis have few backers. There is a paradigm shift in this regard. The managed float imparting flexibility is in vogue (especially for developing countries) and is seen as the sustainable way to pilot an economy in a crisis free path. Dr. Jalan (2003) further opines that in the light of volatility induced by capital flows, emerging economies as a matter of policy maintain adequate reserves. The adequacy instead of being measured in terms of 'months of imports' should be measured in terms of covering 'liquidity at risk'. Whilst there is no consensus on what the upper limit of reserves should be, the Central bank should take a view and intervene in order to moderate these flows so as to manage the 'impossible trinity' and undue appreciation. To quote Jalan with regard to CAC, 'it continues to be a desirable objective for all investment and business related transactions and India should be able to achieve this objective in not too distant a future. There are, however, two areas where we need to be extremely cautious – one is unlimited access to short term external commercial borrowings for meeting working capital and other domestic requirements. The other area concerns the question of providing unrestricted freedom to domestic residents to convert their domestic bank deposits and idle assets (such as real estate), in response to market developments or exchange rate expectations'. In each of these cases, if several agents take decisions in a self-fulfilling mode, a severe external crisis becomes a very real possibility. Both Jalan as well as Jadhav (2003) opine that the current accretion in reserves has built up slowly and due to fundamentals and all the argument about arbitrage motive does not seem to hold water. The current – well thought out – strategy of the monetary authority seems to be that the RBI should not fix a target for exchange rate which it tries to defend or pursue over a period of time further that RBI should be prepared to intervene in the market to dampen excess volatility as and when necessary. Whereas it seems reasonable to argue that the current interest rate differential (when discounted for other factors) does not seem to

warrant arbitrage motivated movements of foreign currency, there is another problem that looms on the horizon (indeed has been with us for a while). This has to do with relative movements between rupee and other currencies that can induce volatility. This calls for some fresh debate, thought and policy posture. As Mohan (2003) so graphically puts it, ‘ In more recent times, with the tail of capital mobility wagging the dog of balance of payments, the importance of capital flows in determining the exchange rate movements has increased considerably, rendering some of the earlier guideposts of monetary policy formulation anachronistic. As Jadhav (2003) has put it, ‘ the policy challenges for India arising from opening of capital account broadly fall under two categories, (1) management of surges in capital flows and (2) entrenchment of preconditions’. On both counts significant progress seems to have been made. The theoretical and empirical consensus, based on international country experience shows that whereas costs are fairly well documented, evidence on the beneficial effects are rather ambiguous (see Kaminsky, 2003, Reddy, 2000 and Rodrik, 1998). The jury is still out the matter. The over all consensus however on capital account convertibility appears to be of *cautious movement towards it without any undue haste.*

IV. The Model

Our paper follows Rao (1997) and Rao & Singh (1998) and hence we have avoided elaboration of the model equations and the theoretical underpinnings. These are to be found in the above quoted papers, along with several relevant papers. We consider a semi-open economy where the nominal exchange rate is kept floating in a managed way at every period. The domestic inflation rate is a weighed average of the difference between money growth and output growth (the Quantity Theory) and nominal exchange rate variations (the Purchasing Power Parity Theory). With incomplete financial openness, the actual domestic nominal interest would be a weighted average of the external (uncovered parity) rate and the domestic rate that would prevail in a financially closed economy. There are no private banks, so that the money stock is equal to the sum of domestic credit issued by the central bank and the domestic-currency value of foreign reserve held by the central bank. Finally domestic credit expands at a constant rate. Imports are modeled in a standard fashion.

IV.1 Specification

The model is thus defined by the following set of equations:

$$m_t - p_t = \alpha_1 + \alpha_2 y - \alpha_3 i \quad \ldots\ldots(1.1)$$

$$m_t = \sigma_1 D_t + \sigma_2 R_t \quad \ldots\ldots(1.2)$$

$$\dot{D}_t = \mu, \mu > 0 \quad \ldots\ldots(1.3)$$

$$\dot{p}_t = \delta_1(\dot{m}_t - \dot{y}_t) + (1 - \delta_1)\dot{e}_t \quad \ldots\ldots(1.4)$$

$$\dot{y}_t = \theta_1 + \theta_2(\dot{D}_t - \dot{p}_t) + \theta_2(i_t - \dot{p}_t) \quad \ldots\ldots(1.5)$$

$$i_t = (1 - \Omega)(r + \dot{p}_t) + \Omega(i_t^f + \dot{e}_t) \quad \ldots\ldots(1.6)$$

$$Z_t = \beta_1 + \beta_2 y_t - \beta_3 e_t + \beta_4 p_t \quad \ldots\ldots(1.7)$$

where,

m_t = nominal money stock

y_t = real output

i_t = nominal interest rate

D_t = domestic credit

R_t = domestic currency value of foreign exchange reserve

E = growth rate of nominal exchange rate

$\dot{p}$ = growth rate of price level

$\dot{y}$ = growth rate of real output

r = real interest rate

i_f = foreign interest rate

Z_t = Imports measured in domestic currency

Equation (1.1) relates real money demand is positively to real income and negatively related to the nominal interest rate. Equation (1.2) is a log-linear approximation of the identity defining the money stock as the sum of reserve and domestic credit. Equation (1.3) specifies that domestic credit grows at a constant rate μ. Equation (1.4) indicates that the inflation rate is a weighed average of excess liquidity

(i.e. money growth less output growth) and the depreciation rate. Equation (1.5) indicates that the real growth rate of output is positively related to the growth rate of real domestic credit as well as to the real rate of interest. Equation (1.6) postulates that the actual domestic rate in a developing economy can be expressed as a weighted average of the external (uncovered parity) rate and the domestic interest rate that would prevail in a financially open economy. Denoting these weights by omega and one minus omega yields the above equation for the nominal interest rate, where the (possibly time varying) parameter omega which lies between 0 and 1. This may be considered as an index (proxy), which measures the degree of financial openness of an economy. In such a context, full capital account convertibility can be assumed to imply a unitary that is value of one. This would indicate that the interest rate, being governed by the uncovered interest parity rate, would be unaffected by domestic monetary and fiscal policy – except to the extent that these affect the expected rate of exchange rate variation. Equation (1.7) relates that the imports are positively related to income & prices and negatively related to exchange rate. This equation also captures the elasticity of imports with respect to income, prices & exchange rate. It needs to be noted that equation related to money as the weighted sum of reserves and credit (1.2), as well as the equation related to imports (1.7) are treated as epilogue. This means that after solving the model we use these models to estimate the values of foreign reserves and imports that are in sync with the value of other model variables.

IV.2 Estimation

The above stated model comprises of 4 behavioural equations. All these were estimated using annual time-series data over the 9-year period 1993 to 2001. The time-varying parameter estimates were obtained using the Kalman filtering and smoothing recursion algorithms discussed in Rao (1997). We have provided below only the final Kalman smoother estimators of each equation for 2001. It needs to be noted that following analytical derivation α_2 has been set equal to unity, which would forecast the conditional means of each of the concerned endogenous variables beyond the sample period based on the complete data span.

The final set of equations were:

$$m_t - p_t = -4.77 + y_t - 0.035 i_t \quad \ldots\ldots(2.1)$$

$$m_t = 0.80 D_t + 0.24 R_t \quad \ldots\ldots(2.2)$$

$$\dot{p}_t = 0.55(\dot{m}_t - \dot{y}_t) + 0.45 \dot{e}_t \quad \ldots\ldots(2.3)$$

$$\dot{y}_t = 3.75 + 0.58(\dot{D}_t - \dot{p}_t) - 0.54(i_t - \dot{p}_t) \quad \ldots\ldots(2.4)$$

$$i_t = 0.65(r + \dot{p}_t) + 0.35(i_t^f + \dot{e}_t) \quad \ldots\ldots(2.5)$$

$$Z_t = -26.77 + 2.85 y_t - 0.81 e_t + 0.49 p_t \quad \ldots\ldots(2.6)$$

The interpretation of these equations – that have correct *a priori* signs – is fairly straightforward. The first equation specifies the real money demand equation. The second equation shows that an increase in forex reserves by a unit leads to a 0.24 units increase in money supply and a unit increase in domestic credit leads to a 0.80 units increase in money supply and so on for the rest of the equations. The theoretical underpinnings are – to repeat – to be found in Rao's work cited earlier and in any case are in conformity with standard macroeconomic theory. The above equations were estimated using E-views 4.0 econometric software. E-views is a user friendly, self contained software developed by Engle and others.

V. Optimal Control Experiments

Studies on applying control theory within the framework of an estimated econometric model to derive optimal policies for the Indian economy are numerous and include Rao (1987, 1997), amongst others. The mandate of control theory is to ensure that the optimal macro-economic outcomes expected to occur in the presence of deliberate policy manipulation, as well as required changes in the magnitude and phasing of policy instruments in order to attain pre-specified targets can be estimated as precisely as possible on an empirical basis. The optimal control technique is an optimisation technique with a tremendous potential. When used sensibly it can be seen to be a tool, which makes possible a wide range of policy experimentation yielding sharp insights into the model dynamics. Optimal control – both the stochastic and

deterministic variety - have been applied in different contexts the world over and even in India. For a survey of applications and also for specific applications to the Indian economy the interested reader may refer to say Pethe, (1994). For the underlying mathematics, the best reference continues to be the seminal contribution of David Kendrick (1981). Optimal control is not a magic wand and has to be used with utmost care, if it is to yield useful insights. Setting up of meaningful control experiments is as much an art as it is science. For discussion on methodological issues underlying the issues and applications of relevant experimentation see Pethe and Pethe (1990) or Pethe (1996).

Like any programming problem the optimal control problem comprises of a numerical (estimated) model, an objective function as well as the specification of any other constraints on the values that the relevant variables may take. In order to operationalise an experiment thus, one has to specify an objective function, which evaluates the outcomes, associated with each (optimal) policy. The loss function or the objective function naturally is to be minimized. In the simplest case the loss function is specified as a linear quadratic function. This involves specifying the paths of the exogenous (including the control) variables. The endogenous paths need to be specified too along with the penalty matrix and then we are ready with the help of an package of algorithm to solve the model. The desired paths of the variables are termed as the nominal or desired trajectories or paths of the variables. Thus, the objective function is given by:

$$L = \frac{1}{2} \sum_{t=1}^{T} [(x_t - x_t^*)' Q (x_t - x_t^*) + (u_t - u_t^*)' R (u_t - u_t^*)]$$

where,

x_t = actual values of the target variable
x^* = desired values of the target variable
u_t = actual values of the instrument variable

u* = desired values of the instrument variable
T = planning horizon

Q and R are diagonal matrices whose elements indicate the penalties imposed on the deviations between the desired values of the target variable and instrument from their actual levels. These can be time varying, however in our case we have specified them as being time invariant.

V.1 Empirical Results

Given an estimated dynamic econometric model, it is then possible to determine an optimal policy sequence, which minimizes such a welfare loss function over a pre-specified time horizon.

The vector of target variables was given by:

$$x_t = [\dot{y}, \dot{m}, \dot{p}, R, \dot{e}, i_t]$$

The vector of instrument variables was given by:

$$u_t = [\dot{D}, \dot{e}, \Omega]$$

The time horizon of the control exercise was from 2001 to 2005, with 2001 forming the base year. Over this period the desired annual rate of growth was set at 8.5%, the desired annual rate of inflation was fixed at 4.5%, and the desired annual rate of growth of money supply was fixed at 16%. Also the desired annual rate of domestic credit was set at 15%, the desired annual rate of foreign reserve was fixed at 22%.

The estimated econometric model was thus formulated in terms of a non-linear control problem, which was solved using General Algebraic Modeling Systems or GAMS [see Brooke, Kendrick and Meeraus, 1988] to derive optimal policies. This is a

user-friendly software package that has great utility in terms of economic applications and has been extensively used for quite a while now (see Pethe and Karnik 1992). While it is useful to solve non-linear model without having to linearise them first the obvious limitation of this code is that it is unable to solve stochastic control problems. The sample GAMS (Input) file for a particular run is provided in Appendix II.

The nominal trajectories of variables – except omega – were held constant across the runs that were conducted. Given the focus of our paper, the nominal trajectory of omega was set on different paths to represent either opening up or stagnating, with consequent implication for attainment of CAC. Many sets of experiments were conducted however we report only those here that were 'sensible' and satisfy our primary purpose which was to track income growth at around 8 percent.

a) Base line omega was held constant at 0.35 and then allowing m, p, domestic credit and interest rate to be free (no penalty was imposed on them).

Run 1: In this run omega was kept constant at 0.35 and the penalty was kept unchanged. This run was able to track y, m, p. This run shows that the growth rate of domestic credit, instead of 15% has to fall down to 13%, 12%, 10% and 9% for the 2^{nd}, 3^{rd}, 4^{th} and 5^{th} period respectively. It also shows that domestic interest rate has to fall from 5% in the 2^{nd} period to 2% in the 4^{th} period. Also the exchange has to depreciate. Finally omega is shown to increase over time and it is 1.2 in the 4^{th} period. The computed forex reserve growth is at 16% and the imports would have to be around 20%. Thus, this is not a realistic run, neither as far as the behavior of omega goes nor as far as the paths of interest rates or domestic credit are concerned.

Run 2: In this run omega of course was kept constant at 0.35 and no penalty was imposed on p. This run shows that inflation has to be negative for all the periods except for the 4^{th} period where it is positive. In this run y, m, d and interest-rate were tracked correctly. It however shows that exchange rate has to appreciate by huge magnitude. Here omega is positive in the 2^{nd} period and then afterwards it takes a negative sign.

The forex reserves have to grow at 16% and imports would grow at a whopping 30%. Unrealistic scenario, in terms of accompanying variables!

Run 3: In this run omega was kept constant at 0.35 and no penalty was imposed on interest rate. In this run y, m and p were tracked correctly whereas it shows that interest rate have to fall from 4% in the 2nd period to 1% in the 4th period. It also showed that initially exchange rate has to appreciate in the 2nd period and then onwards it depreciates. Omega goes on monotonically increasing through the periods. The imports and reserves are to rise at 18 and 16% respectively. Interest at 1% would be improbable from the point of view of policy feasibility.

Run 4: In this run omega was kept constant at 0.35 and no penalty was imposed on dcr and d. Here y, m and p were tracked correctly. It shows that growth rate of domestic credit should be 13% in the 2nd period and then to 10% in the 4th period. It also shows that interest rate have to fall from 5% in the 2nd period to 2% in the 4th period. It also mentions that exchange rate has to depreciate at a constant rate (0.84%) in each subsequent period. Omega increases from 0.38 in the 2nd period to 0.90 in the 4th period. The forex growth is pegged at just over 16% and the imports are to grow at 22%. This is perhaps the most realistic scenario except that the interest rate has to be reduced to 1%!

b) Omega was allowed to increase by 0.15 and then allowing m, p, domestic credit and interest rate to be free (no penalty was imposed on them).

Run 5: In this run omega was allowed to increase by 0.15 and penalty was imposed on all the required variables. This run was able to track y, m and p correctly. In this the domestic credit is showed to grow at a decreasing rate starting from 13% in the 2nd period to 10% in the 4th period. Here the interest rate is shown to fall from 5% in the 2nd period to 2% in the 4th period and the foreign interest is also shown to fall from 3.3% in the 2nd period to 2.2% in the 4th period. It suggests that the exchange rate have to appreciate at a constant rate (0.83). Finally omega increases from 0.6 in the 2nd period

to 1.2 in the 4th period as against 0.5 in the 2nd period and 0.8 in the 4th period. The imports and forex grows at 18 and 16% respectively.

Run 6: In this run omega was allowed to increase by 0.15 and no penalty was imposed on prices and inflation. This run shows that inflation has to be negative for all the periods except for the 4th period where it is positive. In this run y, m, d and interest rate were tracked correctly. It also shows that exchange rate has to appreciate by huge magnitude. Here omega follows a flip-flop pattern. Also foreign interest rates have to increase by a huge magnitude in the 2nd and 3rd period whereas in the 4th period it is 7% approximately. No need to look at imports and forex as it is obviously unrealistic.

Run 7: In this run omega was allowed to increase by 0.15 and no penalty was imposed on interest rate. In this run y, m and p were tracked correctly whereas it shows that interest rate have to fall from 4% in the 2nd period to 1% in the 4th period. It also showed that initially exchange rate has to appreciate in the 2nd period and then onwards it depreciates. Omega is 0.6 in the 2nd period against 0.5 and 0.97 in the 4th period against 0.8. Here domestic credit has to grow at a decreasing rate from 13% in the 2nd period to 9% in the 4th period. The interest rate path (domestic and foreign) has unreasonable values. The imports and forex are within range of acceptability.

Run 8: In this run omega was allowed to increase by 0.15 and no penalty was imposed on dcr and d. Here y, m and p were tracked correctly. It shows that growth rate of domestic credit should be 13% in the 2nd period and then to 10% in the 4th period. It also shows that interest rate have to fall from 5% in the 2nd period to 2% in the 4th period. It also mentions that exchange rate has to depreciate at a constant rate (0.84%) in each subsequent period. Omega increases from 0.38 in the 2nd period against 0.5 to 0.90 in the 4th period against 0.8.

In run 5,6, and 7 the foreign interest rate was shown to be falling. In all the above runs (Run 5 to 8) annual growth rate of foreign exchange reserve was 16% approximately. The import growth rate was between 22 to 30%.

c) Omega was held constant at 0.35, a penalty was imposed on m and then allowing p, domestic credit and interest rate to be free (no penalty was imposed on them).

Run 9: In this run omega was kept constant at 0.35 and no penalty was imposed on ms and growth of money. Here y, d, p, foreign interest rate and omega were tracked correctly. It shows that growth rate of money supply should be 13% in the 2nd period and then to 15% in the 4th period. It also shows that interest rate was moderately tracked. It also requires that exchange rate has to depreciate by 3% in the 2nd period to 2% in the 4th period. The growth of foreign exchange reserve was 13.8% in the 2nd period, 14.5% in the 3rd period and 15% in the 4th period. Imports have to grow at 15%.

Run 10: In this run omega was kept constant at 0.35 and no penalty was imposed on ms, m, p and wpi. Here y, d, foreign interest rate, domestic interest rate and omega were tracked correctly. In this run inflation is negative in the 2nd and 3rd period and then positive in the 4th period. Here exchange rate is shown to appreciate by a huge magnitude. The growth of foreign exchange reserve was –17.9% in the 2nd period, -6.02% in the 3rd period and 6.7% in the 4th period. This is clearly unrealistic and needs no further consideration.

Run 11: In this run omega was kept constant at 0.35 and no penalty was imposed on ms, growth of money and domestic interest rate. Here y, d, p, foreign interest rate and omega were tracked correctly. It shows that money supply has to grow at a constant rate of 15.3% in the 2nd, 3rd and the 4th period respectively. Interest rate is shown to be at a constant rate of 6.8% in the 2nd, 3rd and the 4th period respectively. Exchange rate should appreciate at a constant rate of 1.6% for 2nd, 3rd and 4th period respectively. The growth of foreign exchange reserve was constant at a rate of 15.43% for all periods.

Run 12: In this run omega was kept constant at 0.35 and no penalty was imposed on ms, m, dcr and d. Here y, p, foreign interest rate, domestic interest rate and omega were tracked correctly. It shows that growth rate of money supply to be 13.7% in the 2nd

period to 15% in the 4th period. Domestic credit growth is shown to be 15.6% in the 2nd period to 15.1% in the 4th period. Exchange rate should appreciate from 3.5% in the 2nd period to 2.1% in the 4th period. The growth of foreign exchange reserve was 13.68% in the 2nd period, 14.34% in the 3rd period and 15.20% in the 4th period.

In runs 9 through 12 omega is tracked.

d) Omega was allowed to increase by 0.15, a penalty was imposed on m and then allowing p, domestic credit and interest rate to be free (no penalty was imposed on them).

Run 13: In this run omega was allowed to increase by 0.15 and no penalty was imposed on m and ms. This run was able to track y, p, foreign interest rate and omega correctly. Also it tracked domestic interest rate moderately whereas domestic credit growth was slightly above the given path by 0.5%. It suggests that the exchange rate have to appreciate between 3% to 3.5% approx. Finally, money supply growth was shown as 13.7% in the 2nd period to 14.1% in the 4th period. The growth of foreign exchange reserve was 13.69% in the 2nd period, 14.02% in the 3rd period and 14.13% in the 4th period. The imports have to grow at 20%.

Run 14: In this run omega was allowed to increase by 0.15 and no penalty was imposed on ms, m, p and inflation. Here y, d, foreign interest rate, domestic interest rate and omega were tracked correctly. In this run inflation is negative in the 2nd and 3rd period and then positive in the 4th period. Here exchange rate is shown to appreciate by a . Also growth of money supply is negative (-9.7%) in the 2nd period and then 1.4% and 9.5% in the 3rd and 4th period respectively. The growth of foreign exchange reserve was –11.38% in the 2nd period, 0.38% in the 3rd period and 9.09% in the 4th period. Unrealistic!

Run 15: In this run omega was allowed to increase by 0.15 and no penalty was imposed on ms, m and domestic interest rate. Here y, d, p, foreign interest rate and

omega were tracked correctly. It shows that money supply has to grow at a rate of 14.5% approx. in all the periods. Interest rate is shown to be at a constant rate of 6.8% in the 2nd, 3rd and the 4th period respectively. Exchange rate should depreciate at a rate of 2.6% approx. in all the periods. The growth of foreign exchange reserve was constant at 14.5% approx. for all periods. Imports to grow at 18%.

Run 16: In this run omega was allowed to increase by 0.15 and no penalty was imposed on ms, m, dcr and d. Here y, p, foreign interest rate, and omega were tracked correctly. It shows that growth rate of money supply to be 13.7% in the 2nd period to 15% in the 4th period. Domestic credit growth is shown to be 15.6% in the 2nd period to 15.1% in the 4th period. Exchange rate should appreciate at a rate of 3.5% approx. in all period.

In short it was noticed that in an overwhelming number of cases whenever the opening up is rapid, the control algorithm shows up as an unrealistic constellation of other accompanying variables – including policy regimes – so as to render the scenario unrealistic. Either the monetary policy regime that is called for is politically and /or technically infeasible or indeed the prices, imports, domestic credit or forex reserves that accompany it is economically not very meaningful. Indeed in case of constant or rarely in case of gradually increasing opening up path do we have a realistic configuration of variables. The message is loud and clear: do not rush into CAC just yet. Rather, concentrate on domestic economy so as to strengthen it and consolidate the gains made so far. There is likely to be no serious hindrance from the non-attainment of CAC to the growth prospects of the Indian economy. We may note that this message (as we have interpreted it) is in consonance with the view taken by the policy makers. We thus believe that they seem to have got it right.

VI. Our Own Critique: Limitations and Extensions of the Model

It is obvious that any given model will attract several criticisms and our model is no exception. Clearly it is a prototype model that is of a rock bottom variety, perhaps taking the principle of parsimony a little too far. While it is true that a model is not expected to be realistically descriptive – that would be akin to drawing a map to scale one – it is also true that every complex and interrelated process requires a certain size of a model so as not to miss out on the essentials of the process being modeled. Of course the increase in size brings about a possible loss of transparency and garbling of interconnections and causalities. Clearly in further refinements of this model (and there will hopefully be many) one will have to work out the trade off involved while at the same time retain the feature of manageability in terms of carrying out insightful and meaningful experiments. Given the delimitation set by us for the purpose of this paper we have left such an endeavor for another day.

Partly arising out of the above is the fact that the model is clearly and admittedly confined to monetary realm. The real variables are largely missing! This is a lacuna that cannot be easily glossed over. We do not need Robertson who so long ago and famously remarked that ‘money cannot grow even a blade of grass’. After all who can deny that growth is a real phenomenon fired by changes in real variables and inspired and facilitated by reorganization institutions and regulatory practices! This limitation and critique can only partly be taken care of by augmentation of the model. After all models can – indeed are supposed to – provide only broad parametric framework within which the real processes work themselves out with the help of the social dynamics of body politic. The details of particular sectors that serve as instruments of growth and the consequent distribution aspects of growth in an economy, as also the specific strategies to be employed to usher in growth lie clearly far afield from the point of reference of a mere modeling exercise.

Yet another limitation of our effort is that it is a purely deterministic exercise. Uncertainty is left out completely. This has been partly deliberate. After all if the

underlying model is small and of a prototype nature there is no point in getting too sophisticated with the statistical tools. The resultant complexity of equations and complicated nature of computations involved would – we believe – be nothing but an example of obscurantism. We have thus advisedly 'kept it simple' and not allowed tools to run far ahead of the analysis. We may point out that the current state of art in computational tools does not allow us to analyze and incorporate uncertainty in realistically sized models. Of course in case of the size of the model reported here it is possible (see Pethe and Lalvani 1997). Finally, we will only mention the fact that prices are being modeled in a way that will lead to a revival of a debate about whether inflation – in India – is indeed a monetary phenomenon. Also, the fact that exchange rate is incorporated taking into consideration only the dollar relation, in this day and age the euro being left out of reckoning is a serious lacuna, especially given that the different currencies are moving in relatively different directions and/or paces.

VII. Conclusion

The issue of Capital Account Convertibility has been one of enduring interest for India policymakers for over a dozen years now. Indeed the recent RBI publication of Currency and Finance (2004) has made external sector reforms within the open economy macro framework as its central theme. There is a dearth of analytical work in the context of CAC and perhaps with good reason. The basic model is simple and with the usual assumption fairly obvious results accrue. The institutional and regulatory practices queer the pitch. The empirical reality that is contingent on the rapidly changing international environment is a messy affair. The correspondence between the clean theoretical model and reality are tenuous. Thus there is no recourse but to depend on empirical model add a healthy dose of received wisdom and hunch in order to formulate one's view on the matter.

We have in this paper specified and estimated a simple model (indeed updated Rao's work) and subjected it to optimal control experimentation. As we have noted, this is, in a sense, a 'Mark I' effort. Much more refinement and fleshing out needs to be done. But that must await another day. For the present, our conclusion is that there is

no evidence to suggest that rushing into CAC is essential for attaining the pronounced agenda of the Indian economy, notwithstanding that it continues to be a desirable objective. The pace and time for ushering in full CAC must be of our choosing. It is half jokingly said that the number of opinions on any economic issue normally exceeds the numbers of economists consulted, but in the matter of CAC there seems to be a consensus between theoretical empirical and policy economists that seems at once scary and almost collusive.

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APPENDIX – I

YEAR	DCR	EXRATE	FOREX	GDPF	IF	MS	WPI	Z	DEPR
1993	374856	31.44	60420	781345	3.6837	344238	100	73101.01	9.375
1994	423455	31.37	79780	838031	5.7176	399048	112.5	89970.66	8.3033
1995	472017	32.42	74384	899563	6.1617	478196	121.6	122678.1	12.249
1996	552002	35.43	94932	970083	5.8033	552953	127.2	138919.7	10.947
1997	627806	36.32	115905	1016594	6.0699	642631	132.8	154176.3	6.9917
1998	704126	41.27	138005	1082748	5.6226	752028	140.7	178331.9	8.0642
1999	819032	43.06	165913	1148442	5.7852	900892	145.3	215236.5	9.1058
2000	948956	44.94	197204	1198685	6.8497	1055676	155.7	230872.8	9.0492
2001	1112389	47.19	264036	1265429	3.738	1222316	161.3	245199.7	7.4933

Source: Handbook of Statistics, 2002, Reserve Bank of India Publication.

Where,

DCR = Domestic Credit (Govt. Credit + Comm. Credit) (in Rs.Crores)
EXRATE = Exchange Rate (Rs/$)
FOREX = Foreign Exchange Reserves (in Rs.Crores)
GDPF = Gross Domestic Product at Factor Cost (at Constant Prices) (in Rs.Crores)
IF = Foreign Interest Rate (LIBOR)
MS = Money Supply (M3) (in Rs.Crores)
WPI = Wholesale Price Index
Z = Imports (in Rs.Crores)
DEPR = Domestic Interest Rate (91 day Treasury Bill Rate)

APPENDIX – II

GAMS Input File :

```
*-------------------------------------------------------------
*Explanatory note on:
*AN OPTIMAL CONTROL MACRO MODEL: (OMEGA CONSTANT at 0.35)
*GROWTH OF GDP by 8.5%, WPI (inflation) by 4.5%, MS (money
*supply) by 16%, DCR (dom. credit growth) by 15%;
*PENALTY ON y,p,D (100 on all), Y (100000), P (1000), I (1000)
*PENALTY ON d,m,M (10 on all); Tracking OMEGA, M3 is money
*stock, p is price level, y is growth of GDP. TB is domestic
*exchange rate. DEPF libor rate. FER Forex Reserves.
*-------------------------------------------------------------



 17          SETS   N  STATES /  GDP
 18                            WPI
 19                             M3
 20                             Y
 21                             P
 22                             MS
 23                             LZ  /
 24
 25                M CONTROL /  DCR
 26                             DC
 27                             TB
 28                           DEPF
 29                           DEXR
 30                            FER
 31                          OMEGA  /
 32
 33               INDEX   RESULTS /ACTUAL, ESTIMATE /
 34               K  HORIZON  /  0, 1, 2, 3, 4 /
 35               KU(K)   CONTROL HORIZONS
 36               ZT(K)  RESULTS STORED/0, 1, 2, 3, 4 /;
 37        ALIAS          (N,NP), (M,MP);
 38        KU(K)   = YES$(ORD(K) LT CARD(K));
 39        DISPLAY K,KU;




 41        TABLE WT(N,NP) PENALTY MATRIX FOR STATE VARIABLES

 43        GDP     WPI     M3    MS          Y        P
```

```
  44  GDP   100
  45  WPI           100
  46  M3                    10
  47  MS                            10
  48  Y                                     100000
  49  P                                                  1000

52   TABLE LAMBDAT(M,MP) PENALTY MATRIX FOR CONTROL VARIABLES
54             DCR      DC       TB       DEPF     DEXR       OMEGA
55  DCR         10
56  DC                  100
57  TB                          1000
58  DEPF                                      0
59  DEXR                                               0
61  OMEGA
62

63  TABLE XTILDE (N,K) DESIRED PATH FOR STATE VARIABLES

65              0         1         2          3          4
66  WPI      166.30    173.75    182.00     190.00     198.00
67  GDP     1265429   1372990   1434775    1499340    1626783
68  M3      1500003   1740003   2018403    2341347    2715962
69  MS       14.20     16.00     16.00      16.00      16.00
70  Y         5.50      8.50      8.50       8.50       8.50
71  P         3.20      4.50      4.50       4.50       4.50


74   TABLE  UTILDE(M,K)  DESIRED PATH FOR CONTROL VARIABLES
76              0         1          2          3          4
77  DCR      112389    129247     148634     170929     196568
78  DC        17.20     15.00      15.00      15.00      15.00
79  TB         7.50      7.50       7.25       7.00       6.75
80  DEXR       5.00      4.00       3.00       2.00       1.00
82  DEPF       3.75      3.75       3.75       3.75       3.75
83  OMEGA      0.35      0.35       0.35       0.35       0.35

85      PARAMETER    W(N,NP,K) PENALTY MATRIX ON STATE VARIABLES

87      PARAMETER    W(N,NP,K) PENALTY MATRIX ON STATE VARIABLES

88      LAMBDA(M,MP,K) PENALTY MATRIX ON CONTROL VARIABLES ;

89                   UUP(M) / 0 /
90                   ULO(M) / 0 /;

93       W(N,NP,K)      = WT(N,NP) ;
```

```
94       LAMBDA(M,MP,K)  = LAMBDAT(M,MP);
95       DISPLAY  W ,LAMBDA ,XTILDE ,UTILDE ;
96       OPTION  LIMCOL = 0 ;
98       VARIABLES    X(N,K)       STATE VARIABLES
99                    U(M,K)       CONTROL VARIABLES
100                   J            CRITERION
101
102       EQUATIONS   CRITERION        CRITERION DEFINITION
103
104        MD(*,K)
106         P(*,K)
107         Y(*,K)
108        TB(*,K) ;

109        UPPER(M,K)       UPPER BOUNDS OF CONTROL
110        LOWER(M,K)       LOWER BOUNDS OF CONTROL ;
111
112
113    CRITERION..
114    J =E=  .5*SUM((K,N,NP),
115    (X(N,K) - XTILDE(N,K)) * W(N,NP,K) * (X(NP,K) -
XTILDE(NP,K)))+.5*SUM((KU,M,MP),

116  (U(M,KU) - UTILDE(M,KU)) * LAMBDA(M,MP,KU) * (U(MP,KU) -
UTILDE(MP,KU)));
117
118   MD("MD",K+1)..
119  LOG(X("M3",K+1))-LOG(X("WPI",K+1))=E=-
4.76+LOG(X("GDP",K+1))-0.034*U("TB",K+1);

124  P("P",K+1)..
125   X("P",K+1)=E=0.55*((X("MS",K+1))-
(X("Y",K+1)))+0.45*(U("DEXR",K+1));

127  Y("Y",K+1)..
128    X("Y",K+1)=E=3.75+0.57*((U("DC",K+1))-(X("P",K+1)))-
0.53*((U("TB",K+1))-(X("P",K+1)));

130  TB("TB",K+1)..
131    U("TB",K+1)=E=(1-
(U("OMEGA",K+1)))*(3.10+(X("P",K+1)))+(U("OMEGA",K+1))*
      ((U("DEPF",K+1))+(U("DEXR",K+1)));

133     UPPER(M,K)..
134     U(M,K) =L= UUP(M) ;
135
136     LOWER(M,K)..
```

```
137     U(M,K) =G= ULO(M) ;
138
139     MODEL MACRO / ALL /;
140
141    X.L(N,K) = XTILDE(N,K) ;
142    U.L(M,K) = UTILDE(M,K) ;

144    X.FX (N,"0") = XTILDE(N,"0")   ;
145    U.FX (M,"0") = UTILDE(M,"0") ;

147     SOLVE MACRO MINIMIZING J USING NLP;
148     DISPLAY  X.L ,U.L ;
149     DISPLAY " END OF MACRO " ;
150 DISPLAY " COMPARISON OF ACTUAL & ESTIMATE POLICIES ";

152     PARAMETER FIGURE1 (ZT,INDEX) M3 ;
153     FIGURE1 (ZT,"ACTUAL") = XTILDE("M3",ZT);
154     FIGURE1 (ZT,"ESTIMATE") = X.L("M3",ZT);

156     PARAMETER FIGURE2 (ZT,INDEX) GDP ;
157     FIGURE2 (ZT,"ACTUAL") = XTILDE("GDP",ZT);
158     FIGURE2 (ZT,"ESTIMATE") = X.L("GDP",ZT);

160     PARAMETER FIGURE3 (ZT,INDEX) WPI ;
161     FIGURE3 (ZT,"ACTUAL") = XTILDE("WPI",ZT);
162     FIGURE3 (ZT,"ESTIMATE") = X.L("WPI",ZT);

168     PARAMETER FIGURE5 (ZT,INDEX) Y ;
169     FIGURE5 (ZT,"ACTUAL") = XTILDE("Y",ZT);
170     FIGURE5 (ZT,"ESTIMATE") = X.L("Y",ZT);

172     PARAMETER FIGURE6 (ZT,INDEX) P ;
173     FIGURE6 (ZT,"ACTUAL") = XTILDE("P",ZT);
174     FIGURE6 (ZT,"ESTIMATE") = X.L("P",ZT);

176     PARAMETER FIGURE7  (ZT,INDEX) MS;
177     FIGURE7  (ZT,"ACTUAL") = XTILDE("MS",ZT);
178     FIGURE7  (ZT,"ESTIMATE") = X.L("MS",ZT);

184     PARAMETER FIGURE9 (ZT,INDEX) DC ;
185     FIGURE9 (ZT,"ACTUAL") = UTILDE("DC",ZT);
186     FIGURE9 (ZT,"ESTIMATE") = U.L("DC",ZT);

188     PARAMETER FIGURE10 (ZT,INDEX) TB ;
189     FIGURE10 (ZT,"ACTUAL") = UTILDE("TB",ZT);
190     FIGURE10 (ZT,"ESTIMATE") = U.L("TB",ZT);
```

```
192     PARAMETER FIGURE11 (ZT,INDEX) DEPF ;
193     FIGURE11 (ZT,"ACTUAL") = UTILDE("DEPF",ZT);
194     FIGURE11 (ZT,"ESTIMATE") = U.L("DEPF",ZT);

196     PARAMETER FIGURE12 (ZT,INDEX) DEXR ;
197     FIGURE12 (ZT,"ACTUAL") = UTILDE("DEXR",ZT);
198     FIGURE12 (ZT,"ESTIMATE") = U.L("DEXR",ZT);

204     PARAMETER FIGURE14 (ZT,INDEX) OMEGA ;
205     FIGURE14 (ZT,"ACTUAL") = UTILDE("OMEGA",ZT);
206     FIGURE14 (ZT,"ESTIMATE") = U.L("OMEGA",ZT);

208     DISPLAY  FIGURE1;
209     DISPLAY  FIGURE2;
210     DISPLAY  FIGURE3;
212     DISPLAY  FIGURE5;
213     DISPLAY  FIGURE6;
214     DISPLAY  FIGURE7;
216     DISPLAY  FIGURE9;
217     DISPLAY  FIGURE10;
218     DISPLAY  FIGURE11;
219     DISPLAY  FIGURE12;
221     DISPLAY FIGURE14;
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