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Financial Intermediation, Capital Flow and Macro Economy: An Effective Demand Model for an Emerging Market Economy

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Abstract

This paper examines two issues that are central to the macroeconomic implications of large external shock for an emerging market economy. First, the paper examines how capital reversal and credit squeeze can reduce aggregate demand that lead to cascading contraction in employment. Secondly, the paper investigates alternative policy options, when an economy is in the depths of financial crisis. What we chose for analytical purpose is an effective model of Blinder-Bernanke type which is modified in several directions so as to examine how financial shocks produce macroeconomic outcomes in a large class of emerging market economies.

- **JEL Classification:** E44, E51, F41, G21
- **Key Words:** Effective Demand, Financial Liberalization, Sudden Stops In Capital Flow, Credit Crunch

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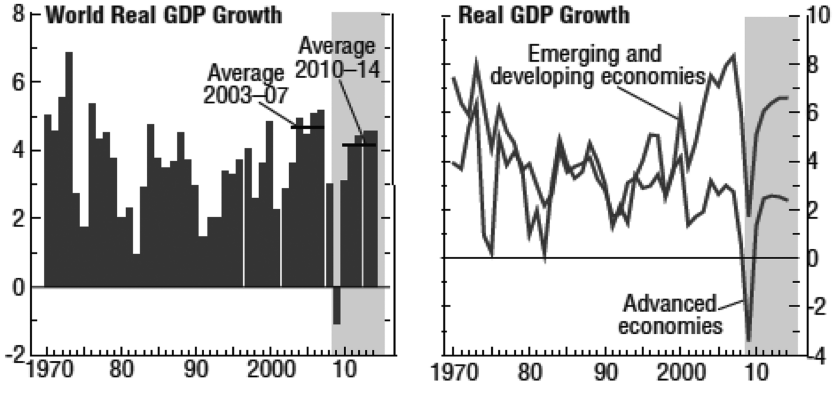
I. Introduction

The emerging market economies have witnessed tremendous increase in capital flows in the last decade. These trends have been driven by a surge of globalization which has enabled pursuit of higher returns and portfolio diversification accompanied by market-oriented reforms towards financial deregulation. Concurrent with these trends have been the rising concerns about financial fragility which has been demonstrated through the recurrence of financial crises.[1] It needs to be noted that most episodes of financial crisis (coupled with balance of payment crisis) are preceded by substantial capital inflows to emerging market economies. When the crisis erupts, sharp cutbacks in short-term financial flows occur and access to international capital markets by these economies is suddenly reversed. Thus, capital outflow and credit squeeze precipitate recession through many alternative channels of transmission.

Post the current financial crisis, the emerging and developing economies faced the challenges of controlling the downside risks from the slowdown in their developed counterparts and the increased stress in the global financial markets. The magnitude of the impact of financial turbulence on economic activity can be observed from a fall in the level of output as is evident from Figure 1(1).

Figure 1(1). Output growth in the world

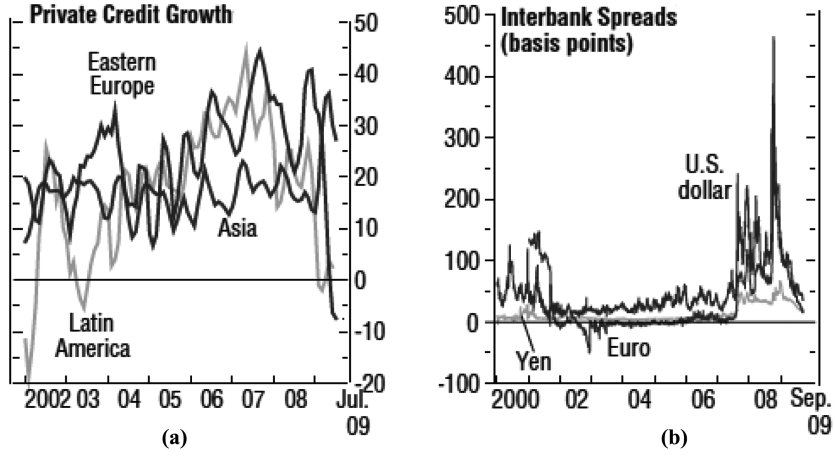


Source: World Economic Outlook, 2009

[1] In a recent paper, Demir (2009) argues that instead of fulfilling the objectives of deepening the capital market and increasing credit generation, financial liberalization has created a volatile macroeconomic environment from an increased exposure of domestic economies to the whims of international capital markets.

One of the aspects of the current crisis has been an unprecedented loss of liquidity with interest rates shooting higher than policy targets. This has been result of not only lower foreign financing but also a change in risk appetite of domestic banks. In particular, the banks sought to conserve liquidity in the face of mounting pressures of the off-balance sheet items. This is observed from the following figures.

Figure 1.2 (a) Growth of credit in emerging economies, (b) Inter-bank spreads[2]

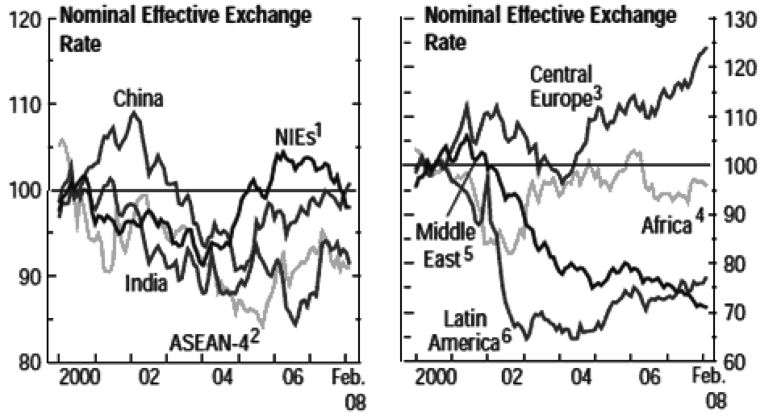


Source: World Economic Outlook, 2009

With deepening integration between domestic and international financial markets, the domestic foreign exchange markets are also significantly influenced by trans-national financial flows. Such exposures make the domestic economy and its financial markets more susceptible to negative shocks like capital outflow and a consequent depreciation of the domestic currency. Prior to the crisis, the emerging market economies displayed continuous currency appreciation. The trend was reversed in the trail of financial crisis due to sharp reversal in capital flow.

[2]Inter bank spread is given by the difference between three-month London inter bank offered rate and three-month government bill rate.

Figure 1.3 Trends of exchange rates in emerging market economies



Source: World Economic Outlook, 2008

This paper integrates the financial sector with the real sector in an open economy macroeconomic framework to examine how some adverse financial shocks generate recessionary tendencies. We will construct an effective demand model to show how the financial shock is transmitted to the real sector through the change in asset prices, namely, interest rates and exchange rates.

The organization of the paper is this. In section II, we undertake a brief review of literature in the context of financial liberalization of emerging market economies which will enable us to suggest value-added of this paper from both academic and policy perspectives. Section III develops an open economy, macro model based on effective demand principle. In section IV we carry out certain comparative static exercises. Section V relates to policy recommendations. Section VI concludes the paper.

II. Related Research

The process of globalization and emergence of new financial instruments for resource-mobilization have led to an extensive literature on the transitional dynamics of a developing country under reform. In the context of interrelation between real sector and financial sector, there do exist two alternative perspectives. One is bank-based view,[3] which emphasizes the importance of financial

[3]See Diamond and Dybvig (1983), King and Levine (1993), Rajan and Zingales (1998), Arestis *et al* (2001).

intermediaries in identifying good projects and mobilizing resources. According to this view, bank-based systems, especially in developing countries are more effective at promoting growth than market-based financial systems. On the other hand, the market-based view[4] stresses the role of markets in diversifying and managing risks and also argues that the market-oriented system is superior to the bank-based system in fostering long run economic growth.

Banking crises can disrupt the flow of credit to households and enterprises reduce investment and consumption and possibly force viable firms into bankruptcy. Banking crises may also compromise the functioning of the payments system, and by undermining confidence in domestic financial institutions, they may cause a decline in domestic savings and a large scale capital outflow. Rakshit[5] argued that commercial banks with their overwhelming presence in the financial market can make a significant contribution to investment in fixed capital. Joyce and Nabar (2008) suggest that a strong banking sector can withstand any negative fallout of international capital movements.[6]

With increased financial globalization, the transmission of financial contagion from the developed to the emerging markets takes place to three main channels:[7] (i) banking failures and reductions in domestic lending, (ii) reduction in financial flows to developing countries and (iii) reductions in export earnings. In other words, financial shock can be of internal sources or externally originated. One of the significant indicators of currency and financial crises is the share of short-term debt in a country's external liabilities and the portion of the debt that flows through the banking system.[8] There is a large body of empirical literature on the relation between capital flow and macroeconomic performance. However, the different studies failed to arrive at any specific consensus.[9] Hence, the issue is empirically unsettled. Moreover, there is hardly any theoretical analysis linking short term output

[4]See Dailami and Atkin (1990), Rousseau and Wachtel (2000), Beck and Levine (2003), Bekaert *et al* (2005).

[5]See Rakshit (2006, 2009).

[6]Empirical evidence in the Indian context suggests that bank is the primary source of finance for Indian private corporate sector and can make a significant contribution to investment in fixed capital. (Bagchi *et al*, 2002, Rakshit, 2006, 2009). In a similar study for China, Rousseau and Xiao (2007) show that increases in the size and sophistication of China's banking sector had positive and significant effects on both output and fixed investment.

[7]See Naude (2009).

[8]See Frankel and Rose (1997), Rodrick and Velasco (1999).

[9]A possible reason for this ambiguity arises from the difficulty in identifying and quantifying capital account liberalization in a consistent manner across countries. Differences in empirical results also occur from choices of different sample periods investigated, dataset employed and the different estimation techniques applied. See Klein (2003).

adjustment and movement in asset prices in presence of multitude of contemporaneous changes in the policy regime, namely current account convertibility, capital account liberalization and interest rate deregulation. The existing theoretical literature[10] is very much applicable to developed countries which have well defined financial markets. However, the structure of financial markets in developing countries warrants substantial modification of these models. The transmission of crisis from financial sector to the real sector depends on the financial structure of a developing country.[11] This paper is an attempt in this direction of constructing a theoretical model for a developing country which is open to both trade in both commodities and assets and sensitive to variety of shocks including financial shocks. In our model change in interest rates and exchange rates play a vital role in determining macroeconomic outcomes through the channel of bank credit.

The contributions that this paper can make are these. From an academic perspective, the value added of this paper is to construct an open economy macroeconomic model for a transitional economy in which both bank credit and portfolio investment have implications in an effective demand model. From the stand point of policy making, the paper explores effectiveness of short-term stabilization measures.

III. An Open Economy Macro Model with Money and Bank Credit

Our model is based on Blinder-Bernanke (1988) model which is modified in several directions to examine implications of financial shocks for an emerging market economy. An important aspect of the model is that loans and government securities are imperfect substitutes for both borrowers and banks. We assume that the domestic price level is fixed but the exchange rate is flexible. Hence, the nominal and the real exchange rates are perfectly correlated. First, we present the consolidated balance sheet of the economy:[12]

The following symbols will be used in our model:

[10]See Blinder (1987), Blinder-Bernanke (1988).

[11]The evolution of financial structure has been a core research agenda starting from the pioneering contributions of Goldsmith (1969) to more recent works of Demirguc-Kunt and Levine (2004), Beck *et al* (2004) among others.

[12]We ignore cash. This is a purposive abstraction.

Table 3.1 Consolidated balance sheet of the economy

Assets	Liabilities
CENTRAL BANK	
Domestic Credit (*DC*)	Reserves
Government Bond (B^{CB})	
Net foreign Asset (*NFA*)	
COMMERCIAL BANKS	
Excess Reserves(*ER*)	Deposits (*D*)
Required Reserves (*RR*)	
Government Bonds (B^{B})	
Loans (*L*)	
FIRMS	
Value of physical capital	Loans
Value of working capital	
Government Bonds (B^{F})	
HOUSEHOLDS	
Deposits	Wealth
Government Bonds (B^{H})	

The model is represented by the following equations:

Y : Domestic country output
C : Domestic consumption
T : Lumpsum Tax
NX : Net Exports of country
I : Investment
G : Government expenditure
i : Interest rate on bonds
ρ : Interest rate on loans
L^d : Loan demanded
L^S : Loan supplied
B^B : Bond holding by Commercial Banks
B^{CB} : Bond holding by Central Bank
B^H : Bonds held by Households
B^F : Bonds held by Firms
ER : Excess Reserves
RR : Required Reserves
D : Deposits
λ : Proportion of (1- τ)
τ : Required Reserve Ratio
γ : A shift parameter in the loan supply function. It includes factors like bankers' confidence, perception of credit risk associated with default etc.
ε : Proportion of loanable funds held in the form of excess reserves
m : Money multiplier
H : High power money
M : Money supply
e : Exchange- rate
Q : Consumer's Price Index
Y^* : Foreign country output
F : Foreign capital inflow
e^e : Expected exchange rate
i^* : World interest rate
P : Domestic Price level which is set equal to unity
P^* : Foreign Currency price of imported good set equal to unity

$$Y = \underset{+}{C}(Y-T) + \underset{-\ -}{I}(\rho, i) + G + \underset{+\ -\ +}{NX}(e, Y, Y^*) \tag{1}$$

$$\underset{-\ +\ +}{L}(\rho, i, Y) = \underset{+\ -\ -}{\lambda}(\rho, i, \gamma)[D(1-\tau)] \tag{2}$$

$$\underset{-\ +}{D}(i, y) = \frac{\overset{+}{m}(i)[DC + B^{CB} + NFA]}{\underset{+}{Q}(e)} \tag{3}$$

$$NX(e, Y, Y^*) + eF\left[\underset{+}{Y}, \left\{ i - \left(i^* + \frac{e^e}{e} - 1 \right) \right\}_{+}\right] = 0 \tag{4}$$

Equation (1) represents the commodity market equilibrium. Aggregate demand is composed of consumption, investment, government expenditure and net exports. Consumption is a stable rising function of output. Investment depends inversely on both ρ and i. The logic is simple. If there is an increase in bond interest rate, the retained earnings of firms will be used to buy government bonds, which reduce investment in physical capital. Again, if ρ rises, the cost of credit increases and investment declines. Net Exports (NX) varies directly with real exchange rate, indirectly with domestic income and directly with foreign country's output.

Equation (2) represents the credit market equilibrium. Demand for loan depends on ρ, i and Y. Relation between loan demand and output can be explained in terms of working capital requirements. Rise in output level leads to increase in loan demand to finance working capital. If bond rate increases, firms will borrow more to invest in government bonds, which will push up loan demand. Increase in ñ reduces demand for loan. Next we consider supply of loan. τ is the required reserve ratio and hence, $[D(1-\tau)]$ is the amount of loanable funds. However, banks use a fraction of surplus funds to supply credit.[13] Thus, the supply of loan is: $L^s = \lambda(\rho, i, \gamma)[D(1-\tau)]$. Rise in loan rate causes λ to go up. If bond rate increases, there will be more bond holding by the banks causing loan supply to fall. Hence, λ will fall.

Equation (3) represents money market equilibrium. The demand for money is demand for deposits, since we ignore cash holding, which in turn depends on income and interest rate on bonds. This follows from Baumol-Tobin's model of

[13]In many emerging economies, banks hold large quantities of excess liquidity, a large part of which is non-remunerated in their asset portfolio (See Fielding and Shortland, 2005; Khemraj, 2006; Saxegard, 2006).

transactions demand for money. Money is endogenous in this model since money multiplier depends on interest rate on government bonds. Since in the economy, both domestic and foreign goods are consumed, we deflate nominal money supply by consumer's price index (which is a weighted average of the domestic and foreign prices) to arrive at the supply of real balances.[14] However, the Central Bank can influence money supply by certain policy instruments.

Equation (4) represents the balance of payment equilibrium. Capital inflows into the domestic economy are guided by interest rate differential and output. The inclusion of GDP as a determinant of capital flow can be both empirically and theoretically justified.[15] Foreign investors' confidence depends on performance of the home country and the very standard proxy for macroeconomic performance is GDP. The net exports function has already been discussed.

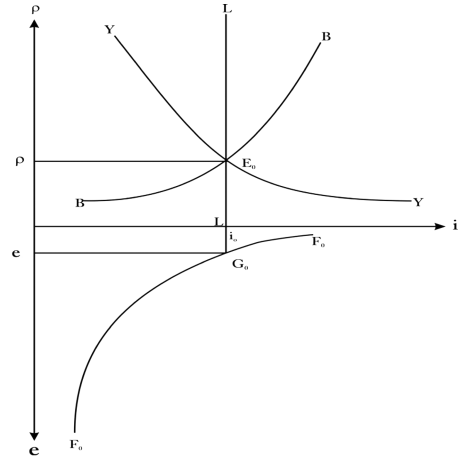
Thus, the model consists of four simultaneous equations from (1) to (4), which will be used to solve for equilibrium values of Y, i, ρ and e.

The working of the model is this. Output adjustment takes place in commodity market; interest rate on bank loan adjusts in loan market; while interest rate on government bond adjusts in money market and exchange rate adjusts to maintain balance of payment equilibrium.

The diagrammatic representation of the model is as follows:

In the (i, ρ) plane, the BB curve is the locus of the two interest rates which

Figure 3.1 Equilibrium in the model



[14]In our model since P and P* are set to unity, so the consumer price index varies with exchange rate. With exchange rate depreciation, imports become expensive and hence, CPI rises. See Dornbusch (1983).
[15]See Nwachukwu (2008).

equilibrate the loan market, given the level of output. As interest rate on bond goes up, loan supply falls while loan demand increases and hence, restoration of loan market equilibrium requires rise in ρ. Thus, BB curve is positively sloped. Given output level, LL is the locus of i and ρ which equilibrates the money market equilibrium obtained from equation 3. It is vertical. YY is the iso-output locus drawn on (i, ρ) space for any given level of output. If interest rate on government bonds increases, private investment falls which tend to reduce output. To maintain the same output level, ρ should fall. So, we obtain a negatively sloped YY locus. The FF curve drawn in the (i, e) plane shows the BOP equilibrium given output. A rise in bond interest rate causes inflow of capital and the resulting BOP surplus leads to appreciation of exchange rate. Hence, the negative slope of the FF curve.

The equilibrium is obtained at E_0, where the BB and LL curve intersect and YY passes through the point of intersection, E_0.

IV. Comparative Static Exercises

Financial markets are extremely sensitive to shifts in investor sentiment and confidence of lenders, depending on further developments in international financial markets and regulatory measures. The financial shock is transmitted to a developing country through varieties of channels which include inter-alia credit squeeze, sudden stop in financial flows to developing countries and reduction in export earnings. In this paper, we examine how parametric decline in credit[16] and reversal in capital flow can affect real sector.

A. Credit Squeeze

In times of a macroeconomic crisis the risk of insolvency increases for both corporate and households. This leads to crisis of confidence of banks. This is represented by a parametric decline in supply of credit.[17] Since loan supply falls,

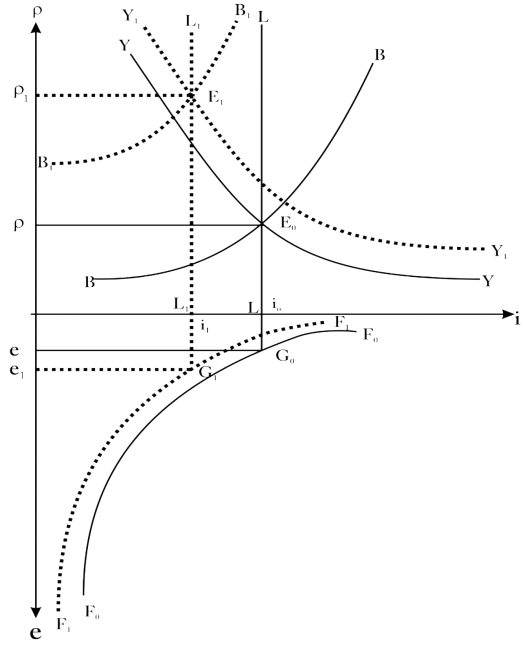
[16]This can be explained in terms of a loss of risk appetite for banks or a confidence crisis for domestic banks. According to World Economic Outlook, 2008, a bank credit squeeze can be defined as a slowdown in the growth rate of the bank credit-to-GDP ratio sharper than that experienced during a normal business cycle downturn.

[17]γ is a proxy or indicator for the default risk. Financial meltdown has made domestic banks skeptical about non performing assets, which in the case of our model can be interpreted as a rise in γ, such that the ratio of loans to liabilities decline. According to World Economic Outlook, 2008, a bank credit squeeze can be defined as a slowdown in the growth rate of the bank credit-to-GDP ratio sharper than that experienced during a normal business cycle downturn. The credit-deposit ratio of Indian banks has fallen to around 71% levels in January 2009, from above 75% levels seen in the beginning of November 2008. (Source: RBI Bulletin, 2009) This is primarily attributable to the global financial meltdown.

loan rate of interest increases. There is fall in investment and output tends to contract. This causes capital outflow while net exports rises due to a fall in imports. We assume that capital outflow dominates the rise in net exports such that exchange rate depreciates. There are two opposing effects on interest rate on government bonds. Output contraction reduces demand for money. On the other hand, there is a fall in real money balance due to exchange rate depreciation. Hence, interest on government bond goes up which causes further reduction in investment and output. Thus, financial openness of a developing country magnifies the contractionary effect of credit squeeze.[18] This is shown in Figure 4.1.

With a parametric fall in loan supply, the BB curve shifts upward, given the level of output. As a result loan rate rises. Hence, investment falls and the iso-output locus, YY, shifts rightwards. Capital flow reverses and as a consequence FF curve shifts inwards. Here, we assume a fall in government bond rate which shifts the LL curve leftwards. This can be summed up as the following proposition.

Figure 4.1 Effect of a credit squeeze



[18]Mathematical results are shown in appendix Case I.

B. Reversal in Capital Flow

The crisis dealt a negative shock to investments in emerging markets.[19] With greater risk aversion, capital stays close to home and portfolio investment falls.[20] Sudden stops in capital flow is essentially an outcome of financial contagion. This causes exchange rate depreciation. Since nominal money balance is deflated by consumer's price index, real money balance falls and thus interest on government bond goes up. This leads to increase in firms' demand for loans, which causes interest on bank credit to rise. Thus, private investment declines on both counts namely rise in lending rates and interest rate on government securities.[21] Thus, capital outflow can trigger output collapse.

V. Policies

There is no consensus on the correct policies that each country should adopt in the wake of a financial crisis. However, there are some immediate short-term measures and some long term policies. Short term policies typically include countercyclical fiscal and monetary expansions. In what follows we examine macroeconomic effects of both rise in government expenditure and money supply.

A. Fiscal Policy

Fiscal policy takes on new relevance as a macroeconomic stabilizer in times of recession. An expansionary fiscal policy causes output expansion. This in turn tends to reverse capital outflow since higher output boosts up investors' confidence. Since demand for loan goes up, interest on bank loan rises. However, effect on interest on government securities is ambiguous. The explanation is this. On the one hand, output expansion causes demand for deposits to rise. On the other hand, rise in real balance due to exchange rate appreciation tends to reduce interest on government securities. Since interest rate on government securities may fall, severity of crowding out is reduced.[22]

[19]Cali, Massa and Te Velde (2008) estimated the fall in foreign inflows to emerging economies to be around us$300 billion.

[20]Post crisis, half of the developing countries have been running current account deficits of 5% of GDP or more, and in some cases the deficit has been around 10%. (Lin, 2008)

[21]There will be a second set of effects following a fall in the level of output. There will be an increase in net exports along with reversal in capital inflow. However, the final effect on BOP will depend upon the sensitivity of net exports and capital flow with output. See Appendix, case II.

[22]See Appendix, case III.

B. Monetary Policy

The transmission of monetary policy through banks has been long noted as one of the key channels for policy effectiveness. Monetary policy is conducted through the provision of Central Bank credit to the banking system, and the transmission mechanism involves the impact of such measures on bank lending and deposit rates which determine the responses of output and employment to the actions of the central bank.[23] An expansionary monetary policy can play a crucial role in altering asset prices and effective demand. An increase in money supply induces a fall in bond interest rate, which has two effects on the economy. The first is a rise in investment which leads to output expansion. The second effect operates through a rise in foreign capital which leads to exchange rate appreciation to maintain BOP equilibrium.[24]

Counter cyclical fiscal and monetary policies are essentially short term measures designed to reduce the fall out of a financial shock in a developing economy. The long term policies should aim at strengthening financial system of a developing country.[25] This requires careful management of forces of globalization.

VI. Conclusion

In this paper, we have constructed an open economy effective demand model suitable for an emerging market economy to examine transmission of financial shock to the real sector. The specific focus of the model is on the role that financial intermediation plays in shaping macroeconomic developments. The results of the paper can be summed up as follows. Confidence crisis and capital outflow can precipitate recession. The model drives home the importance of expansionary fiscal and monetary policies as effective tools of stabilization in times of recession. In particular, counter-cyclical macroeconomic policies may not reverse the original financial shocks but can mitigate the contractionary effects that such financial shocks generate.

[23] See Agenor and Montiel (2008).
[24] See Appendix, case IV.
[25] Financial development refers to deepening of the financial sector, providing greater access to credit and imparting greater efficiency in the system.

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Appendix:

The model is represented by the following set of equations:

$$Y = \underset{+}{C}(Y - T) + \underset{- \ -}{I}(\rho, i) + G + \underset{+ \ - \ +}{NX}(e, Y, Y^*) \tag{1}$$

$$\underset{- \ + \ +}{L}(\rho, i, Y) = \underset{+ \ - \ -}{\lambda}(\rho, i, \gamma)\underset{- \ +}{D}(i, Y)k, \text{ where } k = (1 - \tau) \tag{2}$$

$$\underset{+}{Q}(e)\underset{- \ +}{D}(i, Y) = \underset{+}{m}(i)H \tag{3}$$

$$\underset{+ \ - \ +}{NX}(e, Y, Y^*) + eF\left[\underset{+}{Y}, \left\{ i - \left(\underset{+}{i^*} + \frac{e}{P} - 1 \right) \right\}\right] = 0 \tag{4}$$

Case I: The effect of a credit crunch on macroeconomic variables.

$$\begin{pmatrix} a & -I_1 & -I_2 & -NX_1 \\ h & b & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{pmatrix} \begin{pmatrix} \frac{dY}{d\gamma} \\ \frac{d\rho}{d\gamma} \\ \frac{di}{d\gamma} \\ \frac{de}{d\gamma} \end{pmatrix} = \begin{pmatrix} 0 \\ \lambda_3 Dk \\ 0 \\ 0 \end{pmatrix}$$

where, $a = 1 - c' - NX_2 > 0,\ b = L_1 - \lambda_1 Dk < 0,\ c = L_2 - \lambda_2 Dk - \lambda kD_1 > 0,$

$f = QD_1 - m'H < 0,\ g = N\mathrm{H}_1 + eF_2\frac{e^e}{e^2} + F > 0,\ h = L_3 - \lambda kD_2 > 0,\ l = NX_2 + eF_1 < 0,$
$I_1, I_2 < 0, 0 < c' < 1,\ NX_1, NX_3 > 0,\ NX_2 < 0,\ L_1 < 0,\ L_2, L_3 > 0,\ \lambda_1 > 0,\ \lambda_2, \lambda_3 < 0,$
$D_1 < 0,\ D_2 > 0,\ m' > 0,\ Q' > 0,\ F_1, F_2 > 0.$

Solving using Cramer's rule:

$$\frac{dY}{d\gamma} = \frac{\begin{pmatrix} 0 & -I_1 & -I_2 & -NX_1 \\ 0 & b & c & 0 \\ \lambda_3 Dk & 0 & f & DQ' \\ 0 & 0 & eF_2 & g \end{pmatrix}}{\Delta} = \frac{\lambda_3 Dk(I_1 fg - I_1 eF_2 DQ')}{\Delta} < 0$$

$$\frac{d\rho}{d\gamma} = \frac{\begin{pmatrix} a & 0 & -I_2 & -NX_1 \\ h & \lambda_3 Dk & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{pmatrix}}{\Delta} > 0 \text{ if}$$

$$afg - aDQ'eF_2 + I_2 gQD_2 - I_2 DQ'l - NX_1 QD_2 eF_2 > NX_1 lf$$

$$\frac{di}{d\gamma} = \frac{\begin{pmatrix} a & -I_1 & 0 & -NX_1 \\ h & b & \lambda_3 Dk & 0 \\ QD_2 & 0 & 0 & DQ' \\ l & 0 & 0 & g \end{pmatrix}}{\Delta} > 0$$

$$\frac{de}{d\gamma} = \frac{\begin{pmatrix} a & -I_1 & -I_2 & 0 \\ h & b & c & \lambda_3 Dk \\ QD_2 & 0 & f & 0 \\ l & 0 & eF_2 & 0 \end{pmatrix}}{\Delta} > 0 \text{ given that } I_1 cl > I_1 QD_2 f$$

Case II: To study the effect of capital outflow on macroeconomic variables.

$$(1 - c' - NX_2)\frac{dY}{di^*} - I_1\frac{d\rho}{di^*} - I_2\frac{di}{di^*} - NX_1\frac{de}{di^*} = 0$$

$$(L_3 - \lambda kD_2)\frac{dy}{di^*} + (L_1 - \lambda_1 kD)\frac{d\rho}{di^*} + (L_2 - \lambda_2 Dk - \lambda kD_1)\frac{di}{di^*} = 0$$

$$QD_2\frac{dY}{di^*} + (QD_1 - m'H)\frac{di}{di^*} + DQ'\frac{de}{di^*} = 0$$

$$(NX_2 + eF_1)\frac{dY}{di^*} + eF_2\frac{di}{di^*} + \left(NX_1 + eF_2\frac{e^e}{e^2} + F\right)\frac{de}{di^*} = eF_2$$

Using Cramer's rule, we get

$$\begin{pmatrix} a & -I_1 & -I_2 & -NX_1 \\ h & b & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{pmatrix} \begin{pmatrix} \frac{dY}{di^*} \\ \frac{d\rho}{di^*} \\ \frac{di}{di^*} \\ \frac{de}{di^*} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ eF_2 \end{pmatrix}$$

where, $a = 1 - c' - NX_2 > 0,\ b = L_1 - \lambda_1 Dk < 0,\ c = L_2 - \lambda_2 Dk - \lambda kD_1 > 0,$,

$$f = QD_1 - m'H < 0,\ g = N\mathrm{H}_1 + eF_2\frac{e^e}{e^2} + F > 0,\ h = L_3 - \lambda kD_2 > 0,\ l = NX_2 + eF_1 < 0$$

$$I_1, I_2 < 0, 0 < c' < 1,\ NX_1, NX_3 > 0,\ NX_2 < 0,\ L_1 < 0,\ L_2, L_3 > 0,\ \lambda_1 > 0,\ \lambda_2, \lambda_3 < 0,$$
$$D_1 < 0,\ D_2 > 0,\ m' > 0,\ Q' > 0,\ F_1, F_2 > 0.$$

Solving the above, we get

$$\frac{dY}{di^*} = \frac{\begin{pmatrix} 0 & -I_1 & -I_2 & -NX_1 \\ 0 & b & c & 0 \\ 0 & 0 & f & DQ' \\ eF_2 & 0 & eF_2 & g \end{pmatrix}}{\Delta} = \frac{eF_2 I_1 cDQ' - eF_2 bI_2 DQ' - bNX_1 feF_2}{\Delta} < 0$$

where, $\Delta = \begin{bmatrix} a & -I_1 & -I_2 & -NX_1 \\ h & b & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{bmatrix} > 0$, to ensure stability of the equilibrium.

$$\frac{d\rho}{di^*} = \frac{\begin{pmatrix} a & 0 & -I_2 & -NX_1 \\ h & 0 & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & eF_2 & eF_2 & g \end{pmatrix}}{\Delta} = \frac{eF_2(-NX_1 heF_2 + NX_1 cl + gac + ghI_2)}{\Delta} > 0$$

iff $gac > ghI_2 + NX_1 cl - NX_1 heF$

$$\frac{di}{di^*} = \frac{\begin{pmatrix} a & -I_1 & 0 & -NX_1 \\ h & b & 0 & 0 \\ QD_2 & 0 & 0 & -DQ' \\ l & 0 & eF_2 & g \end{pmatrix}}{\Delta} = \frac{-eF_2(I_1 hDQ' + NX_1 bQD_2 + baDQ')}{\Delta} > 0$$

$$\frac{de}{di^*} = \frac{eF_2(I_1 hf - I_1 cQD_2 + baf + bI_2 QD_2)}{\Delta} > 0$$

Case III: The effect of an expansionary fiscal policy on output and interest rate.

$$\begin{bmatrix} a & -I_1 & -I_2 & -NX_1 \\ h & b & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{bmatrix} \begin{bmatrix} \frac{dY}{dG} \\ \frac{d\rho}{dG} \\ \frac{di}{dG} \\ \frac{de}{dG} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solving using Cramer's Rule:

$$\frac{dY}{dG} = \frac{\begin{bmatrix} 1 & -I_1 & -I_2 & -NX_1 \\ 0 & b & c & 0 \\ 0 & 0 & f & DQ' \\ 0 & 0 & eF_2 & g \end{bmatrix}}{\Delta} = \frac{bfg - beF_2DQ'}{\Delta} > 0$$

$$\frac{d\rho}{dG} = \frac{\begin{bmatrix} a & 1 & -I_2 & -NX_1 \\ h & 0 & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{bmatrix}}{\Delta} = \frac{-hfg + hDQ'eF_2 + cQD_2g - cQ'l}{\Delta} > 0$$

$$\frac{di}{dG} = \frac{\begin{bmatrix} a & -I_1 & 1 & -NX_1 \\ h & b & 0 & 0 \\ QD_2 & 0 & 0 & DQ' \\ l & 0 & 0 & g \end{bmatrix}}{\Delta} = \frac{-bQD_2g + bDQ'l}{\Delta} > 0$$

$$\frac{de}{dG} = \frac{\begin{bmatrix} a & -I_1 & -I_2 & 1 \\ h & b & c & 0 \\ QD_2 & 0 & f & 0 \\ l & 0 & eF_2 & 0 \end{bmatrix}}{\Delta} = \frac{bQD_2eF_2 - bfl}{\Delta} > 0, \; iff, fl < QD_2eF_2$$

Case IV: The effect of an increase in money supply on output and interest rate.

$$\begin{pmatrix} a & -I_1 & -I_2 & -NX_1 \\ h & b & c & 0 \\ QD_2 & 0 & f & DQ' \\ l & 0 & eF_2 & g \end{pmatrix} \begin{pmatrix} \frac{dY}{dH} \\ \frac{d\rho}{dH} \\ \frac{di}{dH} \\ \frac{de}{dH} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ m \\ 0 \end{pmatrix}$$

Solving using Cramer's Rule,

$$\frac{dY}{dH} = \frac{\begin{pmatrix} 0 & -I_1 & -I_2 & -NX_1 \\ 0 & b & c & 0 \\ m & 0 & f & DQ' \\ 0 & 0 & eF_2 & g \end{pmatrix}}{\Delta} > 0$$

$$\frac{d\rho}{dH} = \frac{\begin{bmatrix} a & -I_1 & 0 & -NX_1 \\ h & b & 0 & 0 \\ QD_2 & 0 & m & DQ' \\ l & 0 & 0 & g \end{bmatrix}}{\Delta} < 0 \quad if \quad gac - NX_1 heF_2 > gI_2 h - NX_1 cl$$

$$\frac{di}{dH} = \frac{\begin{bmatrix} a & -I_1 & 0 & -NX_1 \\ h & b & 0 & 0 \\ QD_2 & 0 & m & DQ' \\ l & 0 & 0 & g \end{bmatrix}}{\Delta} < 0$$