Financial inflows, crisis, and recovery in small open economies: A Stock–Flow Consistent (SFC) approach

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Abstract

This paper attempts to explain the role of capital inflows in creating economic booms and busts in a small open economy with sovereign currency. We develop a Stock–Flow Consistent (SFC) model for a small open economy while relying on the experience of Icelandic crisis. We demonstrate the destabilising effects of capital inflows on the economy by allowing for a sudden stop, and also discuss the role of capital controls as a policy response in the event of a crisis due to sudden stops. Finally, we discuss the policy implications of our results in order to tackle the destabilising effects associated with financial flows in a small economy.

1 Introduction

Lifting restrictions on capital movements has proven to be a double–edged sword for many countries as expectations of greater prosperity have given way to financial turmoil and crisis. Iceland is a prime example where short period of open capital markets gave rise to intensive domestic growth fuelled by exuberant capital inflows. This eventually turned into a nightmare scenario when access to capital markets dried up dragging the economy into a recession.

While the Icelandic story is relatively well–known in general,[1] few attempts have been made to explicitly model the origins and channels of capital inflows to Iceland, which led to the build–up of external imbalances. A significant proportion of the capital inflows can be traced to bond issuance of the Icelandic banking sector held by international portfolio investors. This made fixed income securities as one of the main sources of credit inflow in the beginning years of financial expansion. Another main source of the inflows into Iceland was the retail deposit accounts offered by the Icelandic banks during the last couple of years prior to the financial crisis. By offering significantly higher deposit rates, Icelandic banks were able to collect huge amounts of deposits, allowing them to lower their capital market exposure while maintaining high growth momentum.

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[1]For example, Matthiasson (2008); Danielsson and Zoega (2009); Benediktsdottir et al. (2011); Baldursson and Portes (2013); Gumundsson (2016).

Capital inflows can induce financial sector growth, which in turn can have strong impacts on the real sector of the economy. Thus, explicitly modelling capital inflows alongside a financial and real sector enables us to understand the instability associated with capital inflows. The role of capital inflows in particular is crucial to understand the balance of payments and exchange rate dynamics in a small open economy with sovereign currency like Iceland.

Traditional models of exchange rate determination tend to play down the role of capital flows, treating them as an independent source of exchange rate movements. The main focus of these models has been centred on the trade flows usually within an inter–temporal optimizing setup.[2] In such settings, movements on the capital account play a passive role relative to current account while resting on the usual assumptions of purchasing power parity and uncovered interest parity. The Icelandic experience is somewhat at odds with the above view. Iceland was able to maintain a current account deficit for a long time, suggesting that access to foreign financing was easily forthcoming despite obvious macroeconomic imbalances.

With the rise in cross–border flows, many models acknowledged the role of capital markets in explaining the balance of payments and exchange rate dynamics. Most of these models, however, considered the balance of payments in isolation[3] or ignored the special role played by the banks in attracting financial flows[4] (Benes et al., 2014). Thus, the effects of capital inflows on real economy largely remains unclear. Similarly, the role of capital controls, as described by (Eichengreen, 2004) is one of the most controversial and least understood issues in macroeconomics.

This paper attempts to explain the role of capital inflows in creating economic booms in a small open economy with sovereign currency. We develop a Stock–Flow Consistent (SFC) model for a small open economy while relying on the experience of Icelandic crisis. We demonstrate the destabilising effects of capital inflows on the economy by allowing for a sudden stop, and also discuss the role of capital controls in response to a crisis due to sudden stops.

The paper is organized as follows. Section 2 discusses the theoretical framework around SFC models in general, emphasizing the importance of balance sheets and the accounting framework in order to maintain consistency among stocks and flows. Section 3 presents the structure of our model for a small open economy. Section **??** concludes the paper.

2 The post-Keynesian SFC tradition

Stock Flow Consistent (SFC) Models, are a group of macro models built mainly in the post-Keynesian tradition.[5] The stock–flow interaction is based on standard accounting principles, and a set of behavioural equations as will be discussed. The pioneering contribution in the methodology came from Wynne Godley, who developed a comprehensive

[2] See Dornbusch (1975) for explanation.

[3] For example, Magud et al. (2011).

[4] For example, Engel and Matsumoto (2006). While some progress has been made after the crisis, Benes et al. (2014) argues substantial work is still required in order to examine the role of financial sector from a balance sheet perspective in particular.

[5] A comprehensive survey on SFC models can be found in Caverzasi and Godin (2015).

framework in order to understand the interactions between real and financial sectors. A comprehensive and systematic representation of the models can be found in Godley and Lavoie (2007) – (GL). Apart from authors' own significant contribution, the book compiles the dispersed literature and systematically presents it in a coherent framework. [6]

The structure of the models is largely based on post–Keynesian and Kaleckian approach in a sense that the level of economic activity is largely demand-driven. Supply side is flexible and accommodates the level of demand, thus establishing an equilibrium in every period. This approach allows for a natural integration of short periods to reach a long–run while short periods are interlinked through stocks. Flows in the short run will keep changing the stocks and in turn these stocks will change the flows until a steady state.

In general, theoretical SFC models consist of three main components, i) The accounting framework, ii) The Behavioural equations, and iii) Solution to the system. The accounting framework in SFC approach as discussed in GL consists of three matrices: First, the balance sheet matrix reporting stocks (assets and liabilities of different sectors). Second, the transaction flow matrix reporting all the transactions (flows) taking place in the economy. Third, stocks-revaluation matrix which shows how flows affect the stocks at the end of each period. All these three matrices consist of different sectors assumed in the model (e.g., Household, Financial corporations, Non-financial corporations, Government and Rest of the world). The stock and flow of money must satisfy accounting identities both within the individual sectors and in the economy as a whole. Someone's inflow is someone's outflow, similarly someone's asset is someone's liability and vice versa. In other words, the accounting framework of the matrices is designed in such a way that there are no leakages in the stocks and flows between the sectors in the economy (Godley and Lavoie, 2007, p.14). The accounting framework in any SFC model clearly specifies the constraints of each sector, i.e., "sectoral inflow" (sources of funds for the sector) and "sectoral outflow" (use of funds by the sector).

The accounting framework is followed by a set of behavioural equations in SFC model. Behavioural equations are defined for different sectors based on economic theory, explaining the relationship between different variables; such relationships are not directly determined by the accounting framework. These behavioural equations explain the causal chain and the feedback effects in the system.

The third component of SFC models is solving the system. Finding a solution to the system in SFC models is a pre–requisite for completion as the model structure rests on a system of behavioural equations. The system is either solved numerically or analytically.

2.1 Open economies

Modelling an open economy in SFC tradition is a tough challenge due to cross–border capital flows, originating from complex financial systems. Several authors have attempted to extend SFC analysis from close to open economies. A very basic framework of an open economy with no cross–border financial movements is discussed in chapter 6 of GL. The analysis is then extended to a more advanced model in chapter 12 by introducing a number

[6] An important part of Godley's work related to SFC approach can be traced back to some of his earlier contributions, e.g., Godley (1996, 1997, 1999).

of realistic features such as flexible exchange rates, trading foreign assets, and settling official imbalances through foreign currency denominated assets. Lavoie and Daigle (2011) further extended chapter 12 of GL while mainly focusing on the issue of exchange rate expectations. Duwicquet and Mazier (2010) developed a model for two countries with asymmetric size in a monetary union. They introduced three different shocks (loss of competitiveness, fall in consumption, and a reduction in capital accumulation) to analyse macroeconomic adjustment and stabilization in a monetary union. Kinsella and Khalil (2012) used a two-country SFC model to study a small economy experiencing debt deflation. They performed a series of simulations, including the impact of investment shock on debt deflation in a small economy under two different currency regimes (floating exchange rate and currency union). Greenwood-Nimmo (2014) examined the role of fiscal and monetary policy in an open economy SFC model. A recent study by Burgess et al. (2016) developed an open economy SFC model for the UK economy to address financial balances.

3 A theoretical model of a very small open economy

We adopt the SFC framework to develop a model for a small open economy with sovereign currency like Iceland. The model structure draws on the GL modelling technique, combining the open economy aspects allowing for international trade and capital flows guided by portfolio choice equations of the advanced open economy model.

Open economy models in the SFC tradition emphasise the importance of completeness and reciprocity in order to catch the dynamics of economic interconnections of countries trading with each other. Built around the same general idea, our model slightly relaxes these conditions by adopting the "small country assumption" for Iceland, assuming negligible impact of the Icelandic economy on the rest of the word. As a consequence, only model equations for the domestic economy need to be considered.

3.1 Transaction flow and balance sheet matrices

Table 1 below presents an aggregated transaction flow matrix of a small open economy (Iceland) and the rest of the world (ROW). The matrix tracks all the flows between different sectors within the economy as well as the cross border flows. The plus (+) sign in the matrix indicates that the flow has been received or it can simply be considered as an income, while the minus (–) sign represents an outflow or simply an expenditure.

Table 1: Transaction Flow Matrix (TFM)

	Small Economy					**ROW**			
Flows	**Households**	**Firms**		**Govt**	**Banks**	**Foreign branch**	**Households**	**Firms**	**ROW banks**
		current	capital						
Consumption	$-C$	$+C$							
Investment		$+I$	$-I$						
Gov. exp		$+G$		$-G$					
Exports		$+X$						$-M_{row}$	
Imports		$-M$						$+X_{row}$	
(GDP)		$[Y]$							
Wages	$+WB$	$-WB$							
Tax	$-T^h$	$-T^f$		$+T$					
Interest on deposits in Iceland's domestic banks	$+r^D_{ice}(D^{h,ice,d}_{ice})$				$-r^D_{ice}(D^{h,ice,d}_{ice})$				
Interest on deposits in Iceland's foreign banks						$-r^{D,row}_{ice}(D^{h,ice,d}_{row})$	$+r^{D,eu}_{ice}(D^{h,ice,d}_{row})$		
Interest on deposits in ROW banks							$+r^D_{row}(D^{h,row,d}_{row})$		$-r^D_{row}(D^{h,row,d}_{row})$
Interest on Fx denominated loans in Iceland	$-r^{L,row}_{ice}(L^{h,row,d})$	$-r^{L,row}(L^{f,row,d})$			$+r^{L,row}(L^{row,d})$				
Interest on lSK denominated loans in Iceland	$-r^{L,ice}_{ice}(L^{h,ice,d})$	$-r^{L,ice}_{ice}(L^{f,ice,d})$			$+r^{L,ice}_{ice}(L^{ice,d})$				
Interest on Icelandic banks bills					$-r^B_{ice}(B^{b,s}_{ice})$				$+r^B_{ice}(B^{eb,b,d}_{row})$
Interest on ROW bills	$+r^B_{row}(B^{h,row,d}_{ice})$						$+r^B_{row}(B^{h,row,d}$	$-r^B_{row}(B^{f,s}_{row}$	
Profits (Firms)		$-F^f$	$+F^f$						
Change in Icelandic banks' bills					$+\Delta B^{b,s}_{ice}$				$-\Delta B^{b,s}_{ice}$
Change in ROW bills	$-\Delta B^{h,row,d}_{ice}$						$-\Delta B^{h,row,d}_{row}$	$+\Delta B^{f,s}_{row}$	
Change in Iceland's euro denominated loans	$+\Delta L^{h,row,d}$		$+\Delta L^{f,row,d}$		$-\Delta L^{row,s}$				
Change in Iceland's ISK denominated loans	$+\Delta L^{h,ice,d}$		$+\Delta L^{f,ice,d}$		$-\Delta L^{ice,s}$				
Change in deposits in Icelandic domestic banks	$-\Delta D^{h,ice,d}_{ice}$				$+\Delta D^{h,ice,d}_{ice}$				
Change in deposits in Icelandic foreign banks						$+\Delta D^{h,ice,d}_{row}$	$-\Delta D^{h,ice,d}_{row}$		
Change in deposits in European banks							$-\Delta D^{h,row,d}_{row}$		$+\Delta D^{h,row,d}_{row}$
	0	0	0	0	**0**		0	0	0

The transaction flow matrix consists of flows which can be divided into three main categories. The upper part of the matrix represents real macroeconomic flows. The mid part of the matrix represents financial flows. The lower part of the matrix represents the changes in balance sheet items or simply the flows occurring due to changes in the stocks.

The production in the economy takes place as described in the standard GDP identity. Trade and production of goods take place in the firm sector. Firms pay wage bills to its workers (household), taxes to the government, and finance their investment through borrowing. They pay interest on their loans to the financial sector.

Households finance their consumption by receiving income in the form of wages and interest payments on deposits and bills. They pay income taxes to the government sector.

The government sector receives income in the form of taxes from the firms and the households. It adjusts its expenditures according to its revenue, hence, running a balanced budget.

The banking sector has two branches, a) domestic branch, which holds domestic assets on its balance sheets, b) foreign branch, which attracts foreign deposit holders. The banking sector as a whole offers both the domestic currency denominated loans and the foreign currency denominated loans. The banking sector receives income in the form of interest on its lending. Banks also issue bills internationally to meet the demand for credit in the economy. The banks pay interest on their liabilities, which are deposits and bills. Finally, the rest of the world receives interest from Iceland on their bill–holdings, and engage in trade with Iceland.

In our model, the balance of payments dynamics are driven by the negative net position of the corporate sector. This setting is consistent with the sectoral balances of Iceland before the crisis. In Figure 1, it can be seen how the position of Iceland relative to ROW sector (which is the balance of payments deficits, and accumulation of external debt) is driven by the negative net position of the corporate sector. While the banks relatively maintained a net position somewhat closer to zero, they fulfilled (as well as induced) the demand for credit in the economy by holding external debt on their balance sheets, which made them vulnerable to a sudden stop.

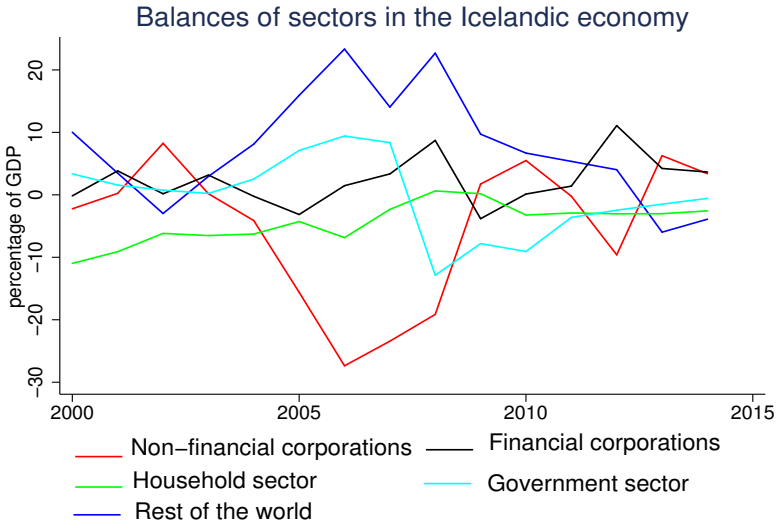

Figure 1: Sectoral balances of the Icelandic economy

We now proceed to present the interactions amongst the balance sheets of different sectors in the economy. A formal representation of assets and liabilities can be seen in the Balance Sheet Matrix in Table 2. The items reported with plus (+) signs represent assets while minus (–) signs represent liabilities.

Table 2: The Balance Sheet Matrix

	Small Economy			ROW		Net
	Household	Firms	Banks	Foreign branch	ROW	
Deposits	$+D_{ice}$		$-D_b$		$+D_{row}$	0
Loans		$-L_f$	$+L_b$			0
Fixed capital		$+K$				$+K$
Banks Bills	$+B_{ice}$		$-B_b$		$+B_{row}$	0
ROW Bills	$+B^{row}_{row}$				$-B_{row}$	0

As can be seen from the balance sheet matrix, credit in our model takes the form of deposits, bills and loans.

3.2 Structure of the model

The structure of our model makes clear reference to the exceptional growth of Icelandic financial sector. The institutional elements of the model relates to the specific social and economic conditions that evolved during the early 2000s when Icelandic banks could attract huge amounts of portfolio capital without seemingly raising concerns about systemic sustainability. By implementing policies such as financial sector privatization and deregulation of market activity, Iceland was seen as following a benign recipe for institutional improvement. Obviously some concerns were raised and during the Mini-crisis in early 2006, access to financial markets was temporarily restricted. However, confidence was restored as markets became convinced once again of the sustainability of the Icelandic financial model following protective measures by the Icelandic banks and assurances by the authorities that public support would be forthcoming if needed.

With the global financial crisis, it became gradually more and more evident that the likelihood of systemic failure could not be excluded and investors' confidence disappeared, resulting in a sudden stop. This fits well into the Harvey (2009) framework, explaining the role of psychological or behavioural factors, with regard to exchange rate dynamics. The role of market psychology was perhaps even more important during the earlier stages when financial expansion took place in the early 2000s. The newly privatized Icelandic banks rushed into expansion mode attacking large amounts of capital supporting further expansion. Bandwagon effects or chartist investment strategies clearly seemed to be driving factors while economic fundamentals such as current account imbalances were given less attention until the eruption of the crisis.

In order to capture the above aspects, the structure of the model is specified as follows:

Firms

Firms produce goods by employing workers while paying them wages (equations 1 – 17).

Following partial adjusement accelarator model, the level of investment in the economy is determined by which in turn is determined by a partial adjustment of existing stock of capital towards a targeted stock of capital. The targeted stock of capital is determined by the previous level of real sales in the economy. Profits are used to finance investment in every period. If the targeted investment is higher than the profits, which is the case in our model, investment is financed by directly borrowing from the banks.

Firms can borrow both the domestic and foreign currency denominated loans (equations 18 – 21). This feature is consistent with the experience of Icelandic firms, which borrowed both domestic and foreign currency denominated loans. In Iceland's particular case, two main motives for Fx denominated loans can be identified as follows: a) a proportion of firms' revenue – coming from exports – was in the foreign currency, and b) interest rate charged on domesic denominated loans was higher than on the foreign currency denominated loans. Based on this argument, the demand for loans in our model has an inverse relationship with the associated interest rate, i.e., if interest rate on domestic currency borrowing increases, the proportion of domestic currency borrowing will fall while the proportion for FX denominated loans will increase by the same amount.

Households

Households' consumption is a function of disposable income and their past wealth (equation 22 – 28). The households allocate their wealth in financial assets and receive returns in the form of interests. The idea behind portfolio allocation dates back to the work of James Tobin and his co-workers in the late 1960s in an effort to model basic relationships in a financial economy with several assets and their allocation among sectors (Brainard and Tobin, 1968).

However, our setting slightly differs from the standard practice of modelling financial assets. Following a more practical approach in Iceland's case, the household sector in Iceland is faced with a decision of allocating their wealth in three financial assets, namely Icelandic bills, foreign bills and deposits in Icelandic banks operating domestically (equation 29 – 31). On the other hand, rest of the world can allocate their wealth in four assets, i.e., Icelandic bills, ROW bills, deposits in the ROW banks, and deposits in the foreign branches of Icelandic banks (equation 32 – 35). The portfolio allocation in our model is based on the fact that Icelandic households were not allowed to hold deposits in the foreign branches of Icelandic banks. Clearly this might seem to be at odds with the principle of free importance of completeness and reciprocity in order to catch the dynamics of capital movements, but in practice this is precisely what happened when Icelandic banks were offering foreign depositors considerably higher rates than to depositors in Iceland.

The international traders investing in Icelandic bills also consider their exposure to currency risks, i.e., a rise in currency risk would lower the demand for Icelandic bills. However, the exchange rate risk in our model does not affect the demand for deposits in the banks because these deposits are held in the foreign branches of the Icelandic banks. For example, a UK resident holding a deposit in an Icelandic bank that operates in the UK will not consider exchange rate risks on his deposits as the bank account is in GBP.

Banks

The banking sector is the sole provider of credit in the economy. It fulfils the demand for loans and will only issue bills if the demand for loans is greater than the available credit in the system (equation 39). As can be seen, the first source of credit in the economy is provided by the available deposits in the banking sector. This, however, does not put a restriction on the process of credit creation, i.e., if the demand for loans exceeds the available credit in the banking sector, the banks will issue bills to finance their operations and fulfil the demand for loans in the economy. As described earlier, these bills are held by households and rest of the world, providing credit and willing to take a counter party risk on Icelandic banks. Moreover, we do not put a restriction on the flow of credit between the domestic and foreign branches of the Icelandic banks. This implies the deposits accumulated in the foreign branches can be used by the banks domestically without any direct risks involved. The deposits in the foreign branches of Icelandic banks are also considered as an inflow in the financial account even if these deposits are not transferred to the domestic banks.

It is worth mentioning that traditional models designed for conventional monetary policy, especially before the crisis, ignored the special role played by the banks in creating credit from a balance sheet perspective as discussed above. In general, the banking sector in these models in itself is not a source of shock and vulnerabilities (Benes et al., 2014). In contrast, based on the balance sheet approach, the banking sector in our framework can be a source of vulnerability and shocks by fulfilling all demand for credit due to their optimistic expectations concerning growth prospects. This feature of the financial sector is widely acknowledged by several authors (see Jakab and Kumhof (2015)).

Government

For completeness, we include a simple government sector in the model which finances its expenditures through taxes. The expenditure of the government is simply determined by its tax revenue (equation 36 – 37), hence, running a balanced budget. This is a strong assumption but our setting here is based on the Icelandic experience where government sector had a minor or apparently no role in the accumulation of external debt. Icelandic firms and banks are generally held responsible for creating economic instability as they accumulated a large volume of external debt.

Balance of Payments and exchange rate setting

The determination of trade flows in our model is based on the standard demand theory. The volumes of exports and imports are presented in log-linear form (equation 3.2 – 47) in order to estimate elasticities, and satisfy Marshall–Lerner condition. Exports are modelled as partly exogenous, reflecting Iceland's natural resource export base and partly dependent on the real exchange rate, reflecting the rise in price sensitive service exports such as tourism. The current account and financial account balances are presented in equations 50 and 51, taking into account net exports and factor payments in both directions.

The nominal exchange rate (equation 52), based on portfolio balance approach, is determined by the ratio of bills supplied and demanded in the FX market. During normal times, the traders consider a fundamental currency risk by taking into account

the exchange rate misalignment, i.e., the deviation of exchange rate from its long-run path. This particular measure of risk is based on the model of Lavoie and Daigle (2011), however, the authors consider two type of agents in the FX market, speculators and fundamentalists, with fixed weights. Our setting of exchange rate risks and expectations differs from Lavoie and Daigle (2011). We allow for regime shift where investors during an event of a sudden stop change their expectations as they anticipate a currency crisis. This will be discussed in more detail when we introduce a sudden stop in the model.

We do not allow deposits in the foreign branches of the banks to affect the exchange rate dynamics in the model. Deposits held in foreign branches do not directly affect the currency unless converted into local currency. This, however, is an internal operation of the banking system, and is not entirely clear from the literature or existing studies. Finally, the real exchange rate in our model reflects price competitiveness vis-a-vis foreign countries measured in common currency.

Model equations

FIRMS

National income

$$Y = C + I + G + X - M \tag{1}$$

Sales in Iceland

$$S = C + I + G + X \tag{2}$$

Value of real output

$$Yk = Sk - Mk \tag{3}$$

GDP deflator

$$P^y = Y/Yk \tag{4}$$

Employment

$$n = Yk/A \tag{5}$$

Wage bill

$$WB = W(n) \tag{6}$$

Unit Cost

$$UC = (WB + M)/Sk \tag{7}$$

Price of sales

$$P^s = (1 + \phi)(UC) \tag{8}$$

Domestic sales price

$$P^{ds} = \frac{S - X}{Sk - Xk} \tag{9}$$

Real sales

$$Sk = Ck + Gk + Ik + Xk \tag{10}$$

Real investment

$$Ik_t = \gamma(K^T - K_{t-1}) + DA \tag{11}$$

Targeted stock of capital

$$K^T = \eta(Sk_{t-1}) \tag{12}$$

Depreciation of capital

$$DA = \delta(Sk_{t-1}) \tag{13}$$

Change in stock of capital

$$\Delta K_t = Ik_t - DA \tag{14}$$

Nominal value of investment

$$I = Ik(P^{ds}) \tag{15}$$

Nominal value of sales

$$S = Sk(P^s) \tag{16}$$

Profit of the firms

$$F^f = (S - M - WB)(1 - \theta) \tag{17}$$

Demand for loans to finance investment

$$\text{L}^{f,d} = L^{f,d}_{t-1} + I - F^f + r^{L,ice}_{t-1}(L^{f,ice,d}_{t-1}) + r^{L,row}_{t-1}(L^{f,row,d}_{t-1}) \tag{18}$$

Demand for ISK and foreign denominated loans

$$L^{f,ice,d} = L^{f,d}(\omega_1 - \omega_2 r^{L,ice}_{ice} + \omega_3 r^{L,row}_{ice}) \tag{19}$$

$$L^{f,row,d} = L^{f,d}(\omega_4 + \omega_5 r^{L,ice}_{ice} - \omega_6 r^{L,row}_{ice}) \tag{20}$$

Total demand for loans by firms

$$L^{f,d} = L^{f,row,d} + L^{f,ice,d} \tag{21}$$

HOUSEHOLDS

Households disposable income

$$YD = \left(WB + r^B_{ice_{(t-1)}}(B^{ice,d}_{ice_{(t-1)}}) + r^B_{row_{(t-1)}}(B^{row,d}_{ice_{(t-1)}}) + r^D_{ice_{(t-1)}}(D^{h,ice,d}_{ice_{(t-1)}})\right)(1 - \theta) \tag{22}$$

Haig-Simons disposable income

$$YDHS = YD + (\Delta x r^{row}_t)B^{row,s}_{ice} \tag{23}$$

Wealth accumulation

$$V = V_{t-1} + YDHS - C \tag{24}$$

Real Haig-Simons disposable income

$$YDHSk = \frac{YD}{P^{ds}} - \frac{Vk_{t-1}(\Delta P^{ds})}{P^{ds}} \tag{25}$$

Real wealth

$$Vk = V/P^{ds} \tag{26}$$

Nominal consumption

$$Ck = \alpha_1(YDHSk) + \alpha_2(Vk_{t-1}) \tag{27}$$

Real consumption

$$C = Ck(P^{ds}) \tag{28}$$

Portfolio allocation:

Icelandic Households:

Demand for deposits in Iceland

$$D^{h,ice,d}_{ice} = V\left[\lambda_{10} + \lambda_{11}(r^D_{ice}) - \lambda_{12}(r^B_{ice}) - \lambda_{13}(r^B_{row} + dxre^{row})\right] \tag{29}$$

Demand for Icelandic bills

$$B^{h,ice,d}_{ice} = V\left[\lambda_{20} - \lambda_{21}(r^D_{ice}) + \lambda_{22}(r^B_{ice}) - \lambda_{23}(r^B_{row} + dxre^{row})\right] \tag{30}$$

Demand for foreign bills

$$B^{h,row,d}_{ice} = V\left[\lambda_{30} - \lambda_{31}(r^D_{ice}) - \lambda_{32}(r^B_{ice}) + \lambda_{33}(r^B_{row} + dxre^{row})\right] \tag{31}$$

Foreign households:

Demand for deposits in foreign banks

$$D^{h,row,d}_{row} = V_{row}\left[\lambda_{50} + \lambda_{51}(r^D_{row}) - \lambda_{52}(r^{D,row}_{ice}) - \lambda_{53}(r^B_{row}) - \lambda_{54}(r^B_{ice} - dxre^{row}\right] \tag{32}$$

Demand for deposits in the foreign branches of Icelandic banks

$$D_{row}^{h,ice,d} = V_{row}\Big[\lambda_{60} - \lambda_{61}(r_{row}^{D}) + \lambda_{62}(r_{ice}^{D,row}) - \lambda_{63}(r_{row}^{B}) - \lambda_{64}(r_{ice}^{B} - dxre^{row})\Big] \tag{33}$$

Demand for ROW bills

$$B_{row}^{h,row,d} = V_{row}\Big[\lambda_{70} - \lambda_{71}(r_{row}^{D}) - \lambda_{72}(r_{ice}^{D,row}) + \lambda_{73}(r_{row}^{B}) - \lambda_{74}(r_{ice}^{B} - dxre^{row})\Big] \tag{34}$$

Demand for Icelandic bills

$$B_{row}^{h,ice,d} = V_{row}\Big[\lambda_{80} - \lambda_{81}(r_{row}^{D}) - \lambda_{82}(r_{ice}^{D,row}) - \lambda_{83}(r_{row}^{B}) + \lambda_{84}(r_{ice}^{B} - dxre^{row})\Big] \tag{35}$$

GOVERNMENT

Tax revenue

$$T = \theta\Big(WB + r_{ice_{(t-1)}}^{B}(B_{ice_{(t-1)}}^{ice,d}) + r_{row_{(t-1)}}^{B}(B_{ice_{(t-1)}}^{row,d}) + r_{ice_{(t-1)}}^{D}(B_{ice_{(t-1)}}^{h,ice,d})\Big) + \theta\Big(Y - WB\Big) \tag{36}$$

Government budget balance

$$G = T \tag{37}$$

BANKING SECTOR

Icelandic Banks:

Profit of the banks

$$\begin{aligned} F^{b} = {} & r_{ice}^{L,ice}(L^{h,ice,d}) + r_{ice}^{L,ice}(L^{f,ice,d}) + r_{ice}^{L,row}(L^{h,row,d}) + r_{ice}^{L,row}(L^{f,row,d}) \\ & - r_{ice}^{D,row}(D_{row}^{h,ice,d}) - r_{ice}^{D}(D_{ice}^{h,ice,d}) - r_{ice}^{B}(B_{ice}^{b,s}) \end{aligned} \tag{38}$$

Bills supplied by the Icelandic banks

$$\begin{aligned} \Delta B_{ice}^{b,ice,s} = {} & z_2(\Delta L_{ice}^{s} - (\Delta D_{ice}^{d} + F_{ice}^{b})) \\ & z_2 = 1, \text{if } L_{ice}^{s} > (\Delta D_{ice}^{d} + F_{ice}^{b}), \text{otherwise } 0 \end{aligned} \tag{39}$$

Foreign Bank:

Icelandic bills supplied to the foreign bank

$$B_{row}^{eb,s} = \underbrace{B_{ice}^{b,ice,s}}_{\text{bills issued}} - \underbrace{B_{ice}^{h,ice,d} - B_{row}^{h,ice,d}(xr^{row}) - B_{ice}^{b,ice,d}}_{\text{bills demanded}} \tag{40}$$

BALANCE OF PAYMENTS AND TRADE

Import prices

$$P^{m} = P_{row}^{x}(xr^{row}) \tag{41}$$

$$P_{row}^{m} = P^{x}(xr^{ice}) \tag{42}$$

Export prices

$$log(P^{x}) = \nu_{x_0} + \nu_{x_1} log(P_{row}^{y}) + (1 - \nu_{x_1}) log(P^{y}) + \nu_{x_1} log(xr^{row}) \tag{43}$$

Real imports

$$Mk = \mu_0 - \mu_1 log\left(\frac{P^{m}}{P^{y}}\right) + \mu_2 log(Yk) \tag{44}$$

Real imports:

Tourism

$$Xk_1 = \epsilon_0 - \epsilon_1 log\left(\frac{P_{row}^{m}}{P_{row}^{y}}\right) + \epsilon_2 log(Yk_{row}^{*}) \tag{45}$$

Exports based on natural resources

$$Xk_2 = \epsilon_0 + \epsilon_2 log(Yk^*_{row}) \tag{46}$$

Total exports

$$Xk = \alpha_4(Xk_2) + 1 - \alpha_4(Xk_1) \tag{47}$$

Nominal imports

$$M = Mk(P^m) \tag{48}$$

Nominal exports

$$X = Xk(P^x) \tag{49}$$

Current account balance

$$\begin{aligned} CAB =& X - M + r^B_{row_{(t-1)}}(B^{h,row,d}_{ice_{(t-1)}}) - r^B_{ice_{(t-1)}}(B^{h,ice,d}_{row_{(t-1)}})xr^{row} \\ & - r^{D,row}_{ice_{(t-1)}}(D^{h,ice,d}_{row_{(t-1)}})xr^{row} - r^B_{ice_{(t-1)}}(B^{eb,d}_{row_{(t-1)}})xr^{row} \end{aligned} \tag{50}$$

Financial account balance

$$FAB = (\Delta B^{h,ice,d}_{row})xr^{row} + (\Delta B^{eb,d}_{row})xr^{row} + (\Delta D^{h,ice,d}_{row})xr^{row} - \Delta B^{h,row,d}_{ice} \tag{51}$$

Exchange rate setting:

ISK per foreign currency

$$xr^{row} = \left(\frac{B^{h,row,d}_{ice}}{B^{h,ice,d}_{row}}\right) \tag{52}$$

foreign currency per ISK

$$xr^{ice} = 1/xr^{row} \tag{53}$$

Real exchange rate

$$rxr^{row} = xr^{row}\left(\frac{P^y_{row}}{P^y}\right) \tag{54}$$

Exchange rate expectations

$$dxre^{row} = \frac{\Omega(xr^{row^*} - xr^{row})}{xr^{row}} \tag{55}$$

EQUILIBRIUM CONDITIONS IN THE ECONOMY

Total demand and supply of bills

$$B^s_{ice} = B^{b,ice,s}_{ice} \tag{56}$$

Total demand and supply of loans

$$L^d_{ice} = L^{f,d}_{ice} = L^s_{ice} \tag{57}$$

Total demand and supply of deposits in Icelandic banks

$$D^d_{ice} = \underbrace{D^{h,ice,d}_{row}(xr^{row})}_{\text{Deposits in foreign branches}} + \underbrace{D^{h,ice,d}_{ice}}_{\text{Deposits in domestic branches}} = D^s_{ice} \tag{58}$$

3.3 Simulations

To understand the dynamics of the real and financial sector in general and the role of capital flows in particular, we numerically solve the model to achieve a baseline scenario. In obtaining a numerical solution, we use a combination of estimation and calibration with the aim of replicating certain key features of the Icelandic economy.[7] We then introduce two shocks in different time periods to see the response of the economy.

[7] We include the real sector of the rest of the world in order to determine the dynamics of wealth and prices. However, we do not explicitly model the financing decisions of the firms and the banking sector within the rest of the world and treat these variables as exogenous.

The shocks generated in the model are explained as follows:

Shock 1: increase in real investment

First, we introduce a real investment (gross fixed capital formation) shock where we increase the real investment by increasing the η from 1 to 1.10 after 10 iterations. This increases the share of real investment in total output, making it a major driver of output. The increase in investment, however, requires financing through credit, therefore the economic growth in this sense is finance–led.

Shock 2: increase in interest rate differentials

While keeping the effects of shock 1 in the system, we introduce an interest rate differentials shock after 30 iterations in the model by increasing the Icelandic interest rates.[8] We adjust all the interest rates so that the interest rates in Iceland are higher than the interest rates abroad. In particular, we increase the return on Icelandic bills from 2% to 3.5% and also increase the interest rate on loans linked to domestic currency from 4% to 4.5%.

3.4 Discussion

Figure 2 below shows the dynamics of current account balance and financial account balance for three different scenarios, a) the baseline scenario, b) the scenario after investment shock, and c) the scenario in which investment shock is followed by an interest differentials shock in the system.

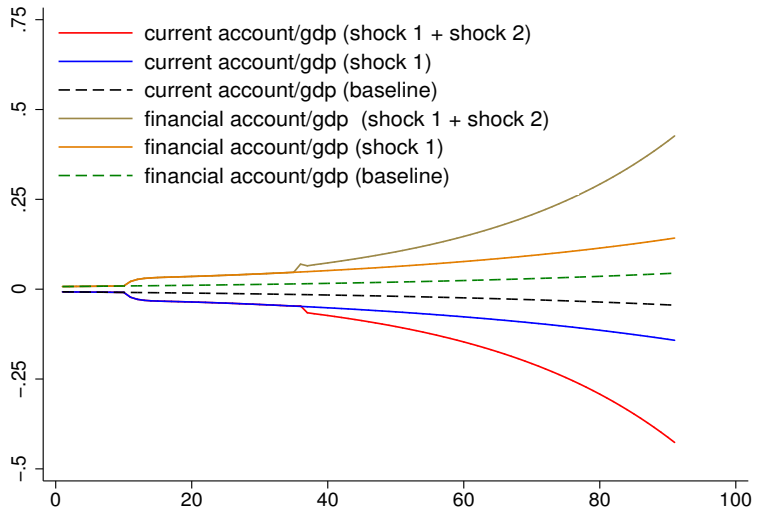

Figure 2: Balance of payments

The small open economy in our model is a net borrower and is running a small current account deficit and a financial account surplus in the baseline scenario. In effect the

[8]The increases in interest rates – highlighted in red – can be seen in Table 3 in the appendix.

economy is operating very close to a current account balance. The economy interacts with the rest of the world through trade and financial assets. The financial sector issue bills and holds deposits internationally to fulfil the demand for credit in the economy. An increase in the investment (gross fixed capital formation) will induce credit inflow into the economy while pushing the current account into a further deficit. This scenario reflects a simple stylised fact: if the demand for loans by firms is not fulfilled by domestic credit, banks internationally borrow to fulfil the demand for loans in the economy. Increased international borrowing generates a financial account surplus and a current account deficit.

If investment shock is followed by a rise in the interest rate differentials, the current account deficit further deteriorates. A rise in the interest rate differentials creates an opportunity for the carry trade. The international traders, despite considering exchange rate misalignment (i.e., the deviation of exchange rate from its long-run path), allocate their wealth into Icelandic assets, triggering inflow of credit in the economy. The introduction of shock 2 in the model allows a speculative attack on the currency.

The deteriorating balance of payments position, apart from a speculative attack, is due to an increase in the cost of borrowing in the economy, which in turn results in even higher demand for credit. The burden of higher interest rate in our model is directly borne by the firms.

We now turn to the real economic indicators in the model. Figure 8 below shows that an increase in real investment boosts real output. A rise in the investment followed by a rise in the interest rate differentials further increases the real output. The transmission channel can be explained as follows: a rise in the interest rate differentials in Iceland (with good sovereign rating) makes Icelandic assets look more profitable than foreign assets. Thus, households allocate their wealth in assets with higher returns, which in turn increases their wealth as shown in Figure 5. The interest rate differentials increases real output through wealth effect in the model.

Focusing on the dynamics of exchange rate, Figure 6 shows that a rise in the interest rate differentials results in the deviation (appreciation in this case) of exchange rate from its baseline, which has negative effects on the trade balance. Investment shock alone (with no direct speculative attack on the currency) has small effects on the exchange rate. The asset traders do not change their wealth allocation if the investment returns on Icelandic and foreign assets are uniform. The mild depreciation in this case is the result of an increased wealth effect in the model. An increase in the Icelandic wealth as compared to its trading partners will increase the holding of foreign assets by the Icelandic households as they become richer.

Exchange rate dynamics in the model also affects domestic sales prices, i.e., a currency appreciation (depreciation) results in lower (higher) import prices, which decreases (increases) the domestic sales prices.

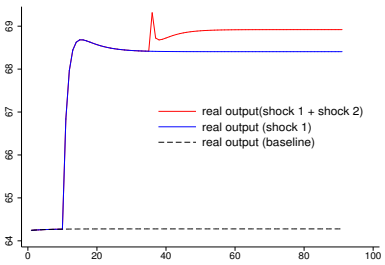

Figure 3: Real GDP

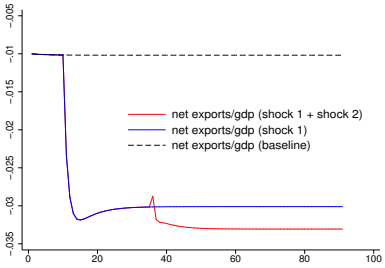

Figure 4: Net exports

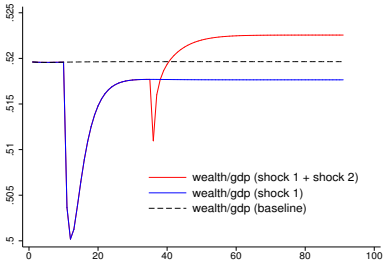

Figure 5: Wealth

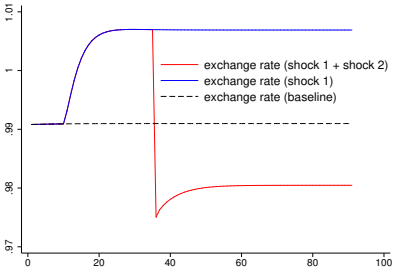

Figure 6: Exchange rate

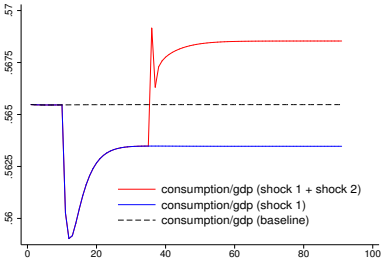

Figure 7: Consumption

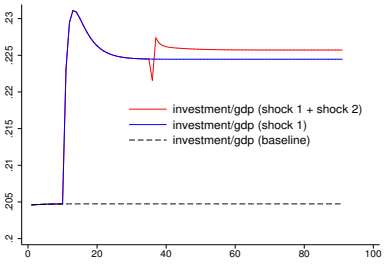

Figure 8: Investment

Figure 9 & 10 show two important financial indicators in the economy. The effects of both shocks in the model are clearly reflected in the rising external debt to gdp and increased M4 (money supply) to gdp. The dynamics of these stock flow norms following an increasing trend are consistent with the actual data of Iceland, where the main financial indicators relative to gdp follow an upward trend before the crisis. The increased trend in these financial indicators implies that the growth of financial sector is faster than the real growth of the economy.

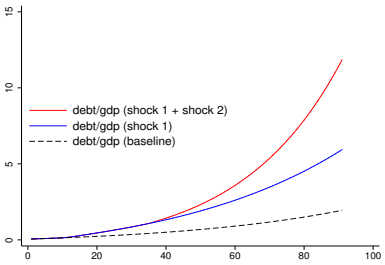

Figure 9: Debt to gdp

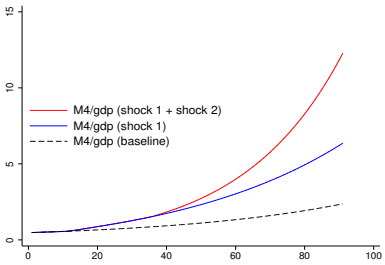

Figure 10: M4 to gdp

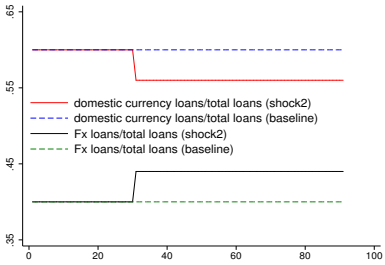

Figure 11: Loans breakdown

Figure 11 shows the demand for ISK and foreign denominated loans by the firms. An increase in the interest rate differentials will trigger borrowing in foreign denominated loans. It can therefore be argued that when the channel of borrowing in foreign currency is open, as was the case in Iceland, the increase in interest rate is not very effective to control domestic demand. Apart from lower interest rates on FX loans, the rise in demand for FX borrowing could also be the result of currency appreciation as domestic sectors such as firms and households are encouraged to speculate and benefit from exchange rate movements.

In the section above, we demonstrated how international financial flows can fuel credit boom, which in turn can create an economic boom. This, however, comes at a cost of persistent current account deficits and growing external debt as discussed above. Such scenarios prevailed in many small open economies in the years preceding the crisis. The situation, however, changed dramatically when a wave of international bankruptcies affected many small open economies. The sudden stop of capital inflows revealed the fragility and inability of small open economies to deal with the crisis.

Crises and sudden stops

In order to capture the destabilising role of international credit in small economies, we create a scenario where shock 1 and shock 2 are followed by a sudden stop. We allow the external debt to gdp to reach 6 times the size of the economy. Such a high level of external debt relative to the economy raises concerns and the international creditors stop lending to the economy. We impose the following restriction on Equation 40:
Change in Icelandic bills supplied to the foreign bank:

$$\Delta B^{eb,s}_{row} = 0, \text{if } (\underbrace{B^{s}_{ice}/y}_{\text{debt to GDP}} \geq 5) \tag{40a}$$

The foreign banks stop holding Icelandic bills and the flow of credit comes to a halt.[9] The firms are unable to finance their investments, resulting in the collapse of real investments.

After sudden stops, the credit rating of the debt issuers fall, and the international traders re–adjust their strategy in the financial markets. The interest rate differentials, which in normal times with good credit rating is seen as an opportunity to make profit, during the crises is seen as a measure of risk premia. During such circumstances, an increase in the interest rate differentials induces capital reversals. Equation 55 can be augmented as follows:

Changes in expectations during the crisis:

$$dxre^{row} = \frac{\Omega(xr^{row^*} - xr^{eu})}{xr^{row}} + (r^{B}_{ice} - r^{B}_{row}) \tag{55a}$$

Hence, any further increase in the interest rate differentials would further increase the expectations of a currency crises. The anticipation of a currency crisis is exactly what erupts a currency crisis, when international traders start selling the Icelandic assets.

During an event of a sudden stop, the sectors with higher debt are the first ones to go bankrupt as they fail to pay their liabilities. Bankruptcy form one sector quickly spreads to the other sectors of the economy. In our model firms cannot remain solvent even if the level of investment is significantly reduced, and no new borrowing takes place. The reason is that firms have to pay a higher interest on the large pile of existing debt, trapped in the economy. This triggers the balance of payments crisis. Figure 12 shows that the balance of payments identity is violated during the crises, which implies such a scenario

[9] It should be noted here that the flow of credit (inflows) goes to zero which means the stock of debt will remain constant. The stock of debt will only reduce when an outflow of credit takes place.

is not possible, leaving no option other than to impose capital controls. The crisis makes the financial sector unable to repay their debt along with the interest payments on the current account as they go bankrupt.

The anticipated currency crisis in the model results in the foreign households selling their assets in Iceland, resulting into capital reversal up to some extent. This market run on the banking sector generates currency crisis as shown in Figure 14. It is important to highlight that capital reversal takes the form of foreign households selling their assets in Iceland to a certain limit after they realise that the foreign financial institutions have stopped lending to the economy. However, the debt held by foreign financial institutions remains trapped because no one is able as well as willing to buy such a large pile of a country's debt that is going through the crisis.

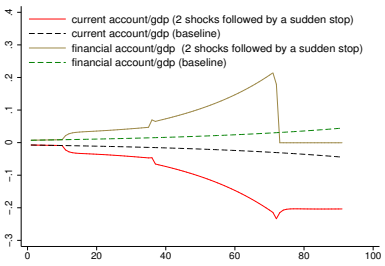

Figure 12: Balance of payments

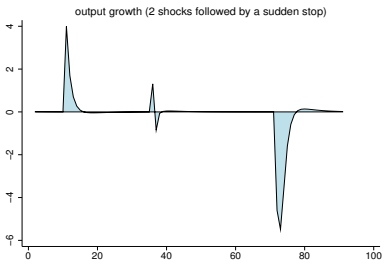

Figure 13: Real GDP

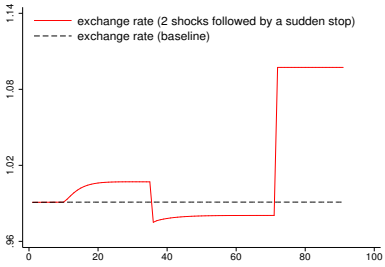

Figure 14: Exchange rate

The crisis due to sudden stop also results in the collapse of the real economy as shown by the contraction of output in Figure 13. The level of economic activities greatly reduces, resulting in a phase of economic recession which in our model is explained by a compression of domestic demand. Apart from domestic demand compression, currency depreciation after the crisis in our model results in a significant reduction in real imports, improving the trade balance. This transforms the growth engine of the economy from investment–led to export–led.

Our model assumes asymmetric effects regarding exchange rate dynamics, i.e., the depreciating effect of capital outflow on the currency is much stronger than the appreciating effect associated with the capital inflows in the years before the crisis. This, as explained earlier, is due to the shift in the strategy of international investors. This result is consistent with the Icelandic crisis as well as many other currency crisis of the past.

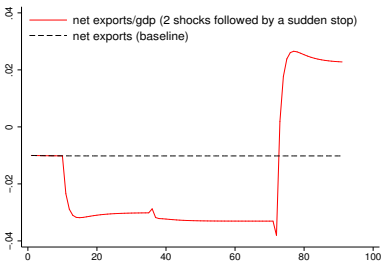

Figure 15: Net exports

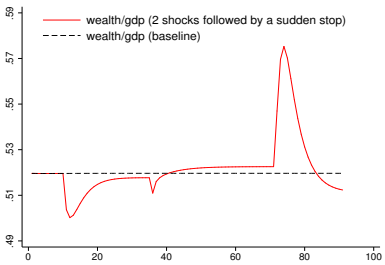

Figure 16: Wealth

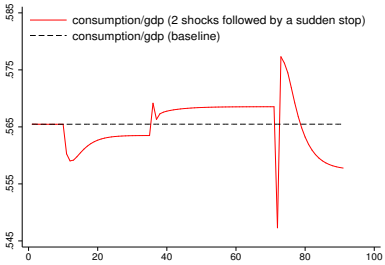

Figure 17: Consmption

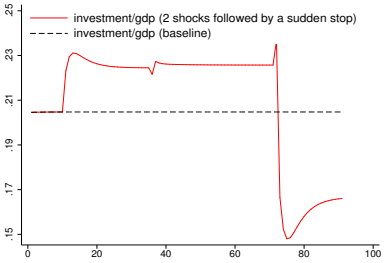

Figure 18: Investment

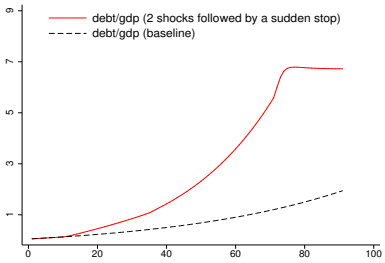

Figure 19: Debt

Figure 20: Sales prices

Capital controls and leakages

As shown above, once the crisis hits, the balance of payment condition is violated and the economy is not able to finance the deficit on its current account. Consequently, the economy cannot pay any interest on its debt and has to implement capital controls in order to prevent any further outflows.

We now add the following conditions to equation 31 and 35:

$$\underbrace{\Delta B_{ice}^{h,row,d} = 0}_{\text{capital controls}}, \text{if } \underbrace{\Delta B_{row}^{eb,s} = 0}_{\text{sudden stop}} \tag{31a}$$

$$\underbrace{\Delta B_{row}^{h,ice,d} = 0}_{\text{capital controls}}, \text{if } \underbrace{\Delta B_{row}^{eb,s} = 0}_{\text{sudden stop}} \tag{35a}$$

Figure 21 shows a plausible scenario after the implementation of strong capital controls in our model. The country is not able to pay any interest on the external debt trapped in the economy as a wave of bankruptcies propagates through the balance sheets of all the sectors in the economy. This situation forces the economy to implement capital controls immediately in order to restrict outflows and prevent a currency crisis.

The situation in Figure 21 is based on a proactive response by the authorities, where capital controls with zero leakages are implemented before the outflow has occurred. In reality, international traders are quicker in selling their assets before the authorities can respond. Thus, implementation of capital controls can never fully prevent outflows. Moreover, tighter capital controls with zero leakages are practically impossible, and international traders will take their capital out of the economy whenever there is an opportunity. Capital controls, however, can slowdown the outflow of international capital.

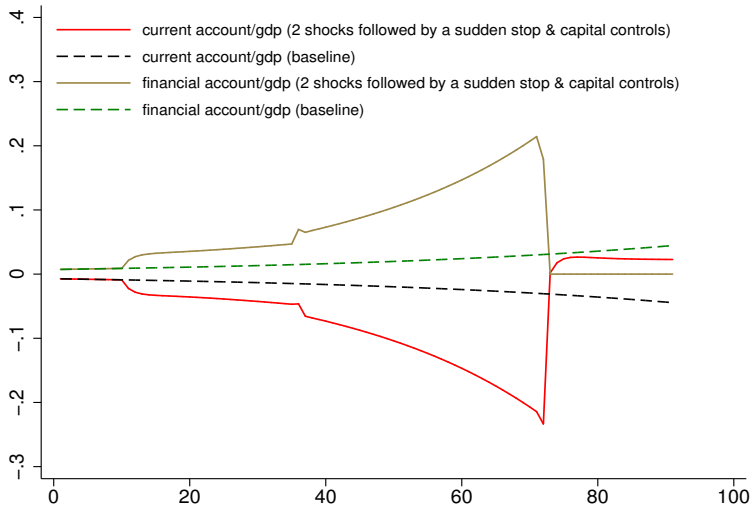

Figure 21: Balance of payments

We introduce capital leakages in our model by allowing a small fraction of foreign capital to escape in every period. Figure 22 below shows the dynamics of exchange rate after capital leakages in every period. If the capital continues to leak, the exchange rate will continuously depreciate as shown in Figure 22. The gradual depreciation due to leakages is still less harmful than a full–blown currency crisis taking place in a very short period of time. In our model, small leakages have some effect on the currency but in reality small leakages may or may not put any pressure on the currency.

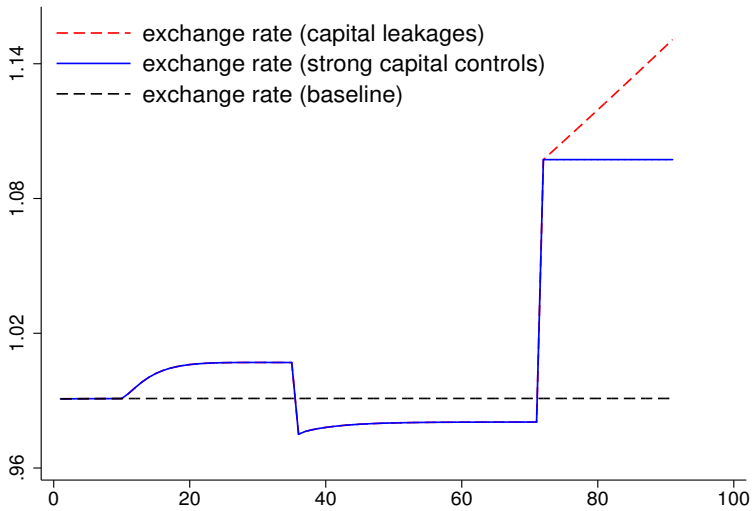

Figure 22: Exchange rate

Capital controls give a country enough time to restructure the financial structure and

stabilise the economy. During strong capital control regime or even with low leakages, the country can gradually lower the interest rates which can restore domestic demand by channelling savings into investment having little or no impact on the currency as was the case in Iceland. Thus, the economy can retain export–led growth and ease the burden of interest repayments on current account. The trade surplus in the economy can be used to repay its debt. The effects of lowering interest rates as opposed to IMF's insistence on keeping them high under capital control regime in the case of Iceland are discussed in Gudmundsson and Zoega (2016).[10]

3.5 Sensitivity analyses

We now turn to the analysis of changes in the key parameter values. After changing the parameter values, we simulate the model for two shocks – investment shock followed by interest rates differential shock - defined in the Section 3.3. We focus on the parameter values determining the balance of payments and exchange rate dynamics in the model. We perform three main experiments.

We begin by changing the portfolio allocation of the Icelandic households i.e., we reduce the proportion of domestic investors' wealth allocated in foreign assets, hence, introducing home bias in the portfolio allocation. In particular, we reduce the value of λ_{30} from 0.25 to 0.10 in equation 31, and increase the value of λ_{20} from 0.25 to 0.40 in equation 30. This implies that the domestic investors' allocate only 10% of their wealth in foreign assets and prefer to invest 40% of their total wealth in their domestic assets.

Second, we change the value of our strategic parameter we introduced in the exchange rate setting in equation 55, i.e., the currency risk premium considered by the international investors when considering their investment returns on Icelandic assets. We change the adjustment of exchange rate towards its long–run path, i.e., the speed of the correction of currency misalignment is first lowered by decreasing the adjustment parameter Ω to 0, and then increasing it to 0.75, as compared to the baseline value of 0.25.

Third, we change the parameters in the consumption function of the households. We initially increase the propensity to consume out of income to $\alpha_1 = 0.9$ and decrease the propensity to consume out of wealth to $\alpha_2 = 0.1$. Then, we reduce α_1 to 0.7 and increase $\alpha 2$ to 0.3 .

As expected, changes in key parameters leads to different steady states. However, the effects of the shocks and the implications of our original model do not change in any fundamental way, i.e., the simulations of the system still reveal the same dynamics. The only major impact is observed in the case of exchange rate, which achieves a very different steady state in response to a change in the portfolio allocation but the effects of the shocks are still in line with our main analysis. Overall, we can argue that our model is not sensitive to changes in the values used in the baseline.

[10]The authors provide an extensive discussion on the effects of lowering interest rates under capital control regime in Iceland.

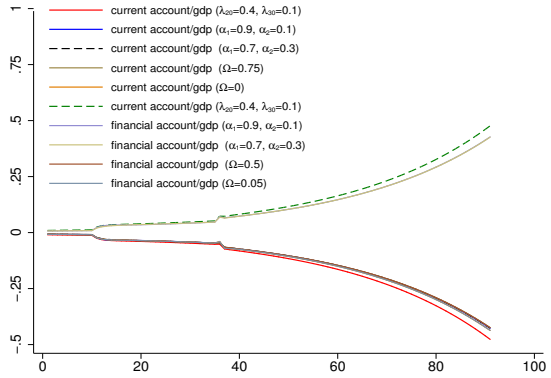

Figure 23: Balance of payments

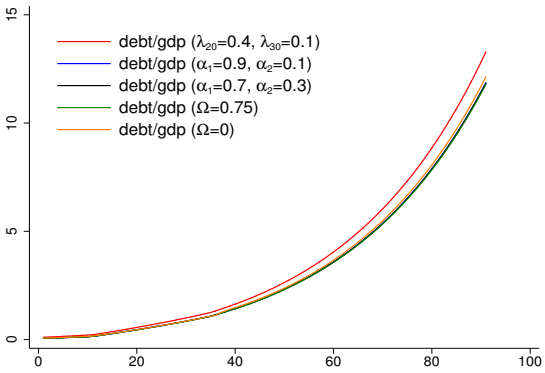

Figure 24: Debt to gdp

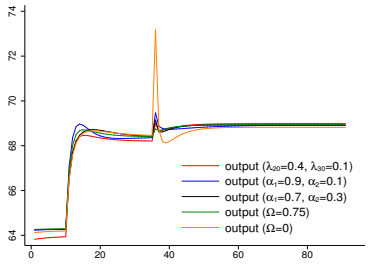

Figure 25: Real GDP

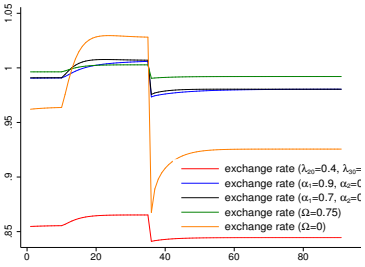

Figure 26: Exchange rate

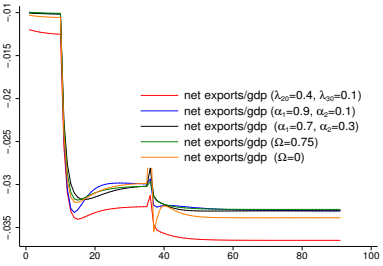

Figure 27: Trade balance

4 Conclusion

This paper proposed a framework for a small open economy with sovereign currency while focusing on the role of international financial flows. We demonstrated that borrowing to finance real investment under lower interest rates has a mild impact on the current account balance and a stronger impact on the real output. However, international borrowings in a small open economy with sovereign currency often require offering better incentives to international investors than its competitors due to exchange rate risks. This in Iceland took the form of higher interest returns on Icelandic financial assets relative to foreign assets. In this regard, our findings – both theoretically and empirically – suggested that positive interest rate differentials attract a large amount of short–term inflows by creating an opportunity for short–term profits. These persistent inflows are found to overvalue exchange rate, deteriorate trade balance, and generate an economic boom with a fast growing debt.

The accumulation of external debt may or may not reach unsustainable levels, but nonetheless will at some point create concerns in the markets regarding the potential of debt repayments. These market fears take the form of a sudden stop as international short–term capital due to its fleeting nature flows out of the economy in a very short–period of time. These sudden outflows convert liquidity crises into solvency crises and sustainable debts into unsustainable debts, creating serious financial and real economic crises.

A sudden outflow severely impacts the whole economy. It generates a balance of payments crisis and also compresses domestic demand, resulting in a severe recession. A small open economy reliant on international credit is not able to finance its economic activities after the channel of international capital is closed. An appropriate immediate response in the short–run is to impose strong capital controls in order to stabilise the currency and gain enough time to restructure the economy. To facilitate the balance of payments adjustment and a quick economic recovery, capital controls requires the backing of careful monetary policy decisions. The cost of borrowing at the time of the crisis skyrockets, and a financial crisis usually leaves the country to operate in an environment of high interest rates. This further triggers the 'paradox of thrift' effect with a rise in savings and a considerable decline in real investments due to economic uncertainties and heavy costs of borrowing.

Monetary authorities can gradually reduce interest rates to recover domestic demand in order to facilitate economic growth. In a capital control regime, interest rates can have weak or no significant effects on the currency as the channel of trading financial assets is restricted. Thus, lowering interest rates will not affect the export–led growth in the capital control regime but ease the burden of interest payments to international creditors, further improving the balance of payments. This argument in Iceland's particular is supported by Gudmundsson and Zoega (2016). The removal of capital controls, however, still remains a challenge for small open economies going forward. The effects of relaxation in capital controls, and the future strategy regarding capital inflows in Iceland are discussed in Zoega (2016).

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Appendix D

Parameter	**Description**	**Value**
ϕ	Price mark–up	0.24
A	productivity in Iceland	1.25
w	nominal wage rate in Iceland	1
θ	tax rate	0.25
η	real investment	1–1.10
r^B_{ice}	interest on Icelandic bills	0.02–0.035
r^B_{row}	interest on foreign bills	0.02
$r^{L,ice}_{ice}$	interest on ISK denominated loans	0.04–0.045
$r^{L,row}_{ice}$	interest on FX denominated loans	0.04
$r^{D,row}_{ice}$	interest on deposits in foreign branches of Icelandic banks	0.015
$r^{D,ice}_{ice}$	interest on deposits in domestic branches of Icelandic banks	0.015
$r^{D,row}_{row}$	interest on deposits in foreign banks	0.015
ω_1	proportion of loans demanded in local currency	0.6
ω_4	proportion of loans demanded in foreign currency	0.4
$\omega_2 = \omega_3 = \omega_5 = \omega_6$	sensitivity of loans to changes in interest	8
α_1	propensity to consume out of disposable income	0.8
α_2	propensity to consume out of wealth	0.2
λ_{10}	Icelandic wealth allocation in deposits in local banks	0.5
λ_{20}	Icelandic wealth allocation in domestic bills	0.25
λ_{30}	Icelandic wealth allocation in foreign bills	0.25
λ_{50}	foreign wealth allocation in deposits in foreign banks	0.25
λ_{60}	foreign wealth allocation in deposits in Icelandic banks	0.25
λ_{70}	foreign wealth allocation in foreign bills	0.25
λ_{80}	foreign wealth allocation in foreign bills	0.25
$\lambda_{11} = \lambda_{22} = \lambda_{33}$	sensitivity of Icelandic portfolios to interest changes	1.5
$\lambda_{12} = \lambda_{13} = \lambda_{21} = \lambda_{23} = \lambda_{31} = \lambda_{32}$	sensitivity of Icelandic portfolios to interest changes	0.75
$\lambda_{51} = \lambda_{62} = \lambda_{73} = \lambda_{84}$	sensitivity of foreign portfolios to interest changes	1.5
$\lambda_{52} = \lambda_{53} = \lambda_{54} = \lambda_{61} = \lambda_{63} = \lambda_{64} = \lambda_{71} = \lambda_{72} = \lambda_{74} = \lambda_{81} = \lambda_{81} = \lambda_{83}$	sensitivity of foreign portfolios to interest changes	0.5
ν_{m_0}	exogenous component of import prices	-0.00001
ν_{m_1}	import prices sensitivity to prices in Iceland and trade partners	0.7
ν_{x_0}	exogenous component of export prices	-0.00001
ν_{x_1}	export prices sensitivity to prices in Iceland and trade partners	0.5
μ_0	exogenous component of real imports	-1.05
μ_1	price elasticity of imports	0.7
μ_2	income elasticity of imports	1
ϵ_0	exogenous component of real imports	-1.05
ϵ_1	price elasticity of imports	0.7
ϵ_2	income elasticity of imports	1
Ω	speed of convergence towards long–run exchange rate	0.25
xr^{row^*}	long–run path of exchange rate	1
γ	Speed of adjustment of stock of capital towards targeted capital	0.25
δ	Depreciation rate of capital	0.10

Table 3: Parameters and exogenous variables

Symbol	**Description**
$B_{ice}^{h,ice,d}$	Demand for Icelandic bills by Icelandic households
$B_{ice}^{h,row,d}$	Demand for ROW bills by Icelandic households
$B_{row}^{h,eu,d}$	Demand for ROW bills by ROW households
$B_{row}^{h,ice,d}$	Demand for Icelandic bills by ROW households
$B_{ice}^{b,ice,s}$	Bills supplied by Icelandic banks
$B_{row}^{eb,s}$	Icelandic bills held by foreign banks
B_{ice}^{s}	Total bills issued by Iceland
CAB	Current account balance
C	Nominal consumption
Ck	Real consumption
DA	Capital depreciation
$D_{ice}^{h,ice,d}$	Demand for deposits in Icelandic domestic banks by Icelandic households
$D_{row}^{h,row,d}$	Demand for deposits in ROW banks by ROW households
$D_{row}^{h,ice,d}$	Demand for deposits in Icelandic banks by ROW households
D_{ice}^{d}	Total demand for deposits in Icelandic banking system
$dxre^{row}$	changes in exchange rate expectations
F	Gross capital inflows
F^{f}	Profit of the firms
F^{b}	Profit of the banks
FAB	Financial account balance
G	Government expenditure
I	Nominal investment
Ik	Real investment
K	Fixed capital
K^{T}	Targeted capital
$L^{f,d}$	Total demand for loans by firms
$L^{f,ice,d}$	Demand for ISK denominated loans by firms
$L^{f,row,d}$	Demand for FX denominated loans by firms
$L^{h,row,d}$	Demand for FX denominated loans by households
L^{d}	Total demand for loans in Iceland
L^{s}	Total supply of loans
M	Nominal imports
Mk	Real imports
n	Employment
P^{s}	Total sales price
P^{ds}	Domestic sales price
P^{m}	Import prices
P^{x}	Export prices
P^{y}	GDP deflator
r_{ice}^{B}	Interest on Icelandic bills
r_{row}^{B}	Interest on ROW bills
$r_{ice}^{L,ice}$	Interest on ISK denominated loans
$r_{ice}^{L,row}$	Interest on FX denominated loans
$r_{ice}^{D,row}$	Interest on deposits in foreign branches of Icelandic banks

$r_{ice}^{D,ice}$	Interest on deposits in domestic branches of Icelandic banks
S	Share prices
xr^{row}	Nominal exchange rate (ISK per FX currency)

Table 4: Symbols and description of variables