Capital Controls in Malaysia: Effectiveness and Side Effects

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Abstract

In 1998 and 1999, following the financial crisis, Malaysia imposed a set of constraints and taxes on the movement of capital out of the country. Using a quantitative equilibrium model, we attempt to construct estimates of the effects of these controls on Malaysia’s recovery from the East Asian crisis. The analysis is constructed around a model of a dependent economy with taxation on capital movements. We focus on the aftermath of a financial panic (the East Asian crisis) in which effective international interest rates rise. Capital taxation implicitly ameliorates the brunt of such a rise in the interest rate, and substantially limits its real effects. This

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amelioration is shown to be especially significant under fixed exchange rates, a policy used by the Malaysian government to complement the capital controls.

1 Introduction

Following many years of large capital inflows, in 1997 and 1998 a number of East Asian countries (including Indonesia, Korea, Malaysia, the Philippines, and Thailand) suffered a dramatic reversal in capital flows. This event, collectively, known as the Asian crisis, manifested itself as a sharp fall in GDP, accompanied by an even sharper fall in absorption. Over the course of the crisis, the affected countries implemented a variety of policies. A particular divergence occurred between the response of the Korean and Thai governments on the one hand and the Malaysian government on the other. Korea and Thailand, facing difficulties in meeting the demands by foreign creditors for repayment of debts incurred prior to the crisis, borrowed funds from the IMF. IMF funds were, of course, conditional on the implementation of certain fiscal, monetary policies and the implementation of certain neo-liberal trade and financial reforms. Malaysia, conversely did not receive funds from the IMF. Rather, in September 1998, Malaysia implemented a much less neo-liberal financial reform by imposing restrictions on capital repatriation by foreign investors and off-shore trading of ringgit-denominated assets, as well as imposing a requirement the Malaysian investors repatriate their own overseas capital. In addition to public controversy, this about-face in an economy that had generally been open to financial capital naturally generated substantial professional economic analysis. In this paper, we use a structural model of the Malaysian economy to generate a quantitative analysis of how capital controls might help an emerging economy recover from a financial crisis. Our model of the financial crisis will be based on previous work which identified the macroeconomic effects of an international financial panic based on a maturity mismatch between short term debt and long-term assets. Specifically, we will model capital flight and capital controls in a dynamic general equilibrium (DGE) model
with optimizing agents and sticky prices.

Diamond and Dybvig [21] developed the logic of a financial panic that can occur when a financial intermediary has a disparity in the maturity structure of its assets and liabilities. A bank that had raised funds by issuing short-term debt to finance an illiquid long-term investment project might be forced into insolvency if its creditors en masse refused to roll over the debt for the length of the project. The insolvency would itself confirm the decision of the creditors to cut off their funds as the liquidation losses would be severe. Conversely, in the absence of such a run on the bank, the creditors would earn sufficient returns to justify their decision to keep the funds with the bank. Thus, two potential outcomes could characterize these lending arrangements. Some recent studies outline the similarities of the East Asian crisis to the former (bad) equilibrium, relative to the latter (good) equilibrium. Radelet and Sachs [37] note that there were unprecedented capital flows to East Asia in the years immediately preceding the crisis, and that the majority of this external financing were liabilities of the commercial banks in East Asia. Chang and Velasco [9] emphasize that the bulk of this debt came to maturity with terms of 1 year or less. Thus, the stage was set for a financial panic. Radelet and Sachs [37] demonstrate that standard measures of market expectations showed little indication of concern of a potential crisis prior to the 3rd quarter of 1997 suggesting that either there was some (as yet unexplained) massive shock to fundamentals or the financial panic was itself unexplained.

In a series of papers, Chang and Velasco [8], [10], [11] have examined the theoretical effects of bank runs in open economies and some potential pitfalls for policy-makers in dealing with such a crisis. Cook and Devereux [17] extends this analysis to the specific case of a financial panic by foreign investors on banks which finance the intertemporal debt of an emerging market economy. There it is shown that a ‘financial panic’ based on maturity mismatch, when integrated into a complete DGE model of a small emerging market economy, can provide quite an accurate picture of the main macroeconomic
response of the Malaysian economy to the East Asian crisis, at least up to the imposition of capital controls. The model and results in that paper will be discussed in greater detail in the next section. The specific aim of this paper is to adapt this model to the analysis of the Malaysian capital controls, and to provide a general quantitative analysis of these controls. We then investigate the empirical support for the model by examining the macroeconomic experience of Malaysia along a number of dimensions in the post Asian crisis period.

2 Description of the modeling framework

Our discussion is based directly on the use of a model developed in Cook and Devereux [17]. In that paper, we describe the macroeconomic impact of a capital market panic, defined as an outcome where foreign lenders collectively withdraw investment funds from an emerging market, as a result of a self-fulfilling collapse in confidence. The reasoning is similar to many recent papers on financial crises in emerging markets that are based on the classic ‘bank-run’ model of Diamond and Dybvig [21]. The contribution of our previous paper was to place the essential elements of the ‘bank-run’ approach to financial crises into a structural intertemporal model of a small economy, and to show that the model could account for the main macroeconomic features of the East Asian crisis of 1997-1999, as applied in particular to the Malaysian economy. But the model can also be applied to more specific policy questions. Here we provide a detailed analysis of the impact of capital controls in an environment of financial panic. The model is calibrated towards an evaluation of the Malaysian capital controls introduced in September 1998.

The model combines a theory of ‘financial fragility’, following a series of recent papers in the literature, with a reasonably conventional structural two-sector model of a small economy. An important element in this second part of the analysis is the existence of Keynesian price rigidities. Although a financial panic will generate a costly breakdown of capital flows for a small economy, on its own it is not sufficient to provide an account
of the economic collapse in emerging markets following the capital outflow. To provide
a complete account of the macroeconomic elements of the East Asian crisis as applied
to Malaysia requires the combination of financial panic and slow price adjustment.

This rest of this section sketches out the essential details of the model. There is by
now widespread recognition that capital flows to emerging markets tend to be highly
volatile, and subject to sudden reversals. The theories based on ‘financial fragility’
(Chang and Velasco [11], Radelet and Sachs [37]) stress the role of investor expectations
and the possibility of self-fulfilling confidence collapse. Our framework integrates the
classic Diamond-Dybvig [21] theory of bank runs into a model of debt financing for
an emerging market economy. The appendix lays out the model in detail. The key
features are as follows. A small economy has a continual need to borrow on international
markets. All borrowing is intermediated through international banks (called ‘emerging
market funds’ or EMFs), playing the role of depositors in the DD framework. EMFs lend
to domestic banks in the emerging market. It is assumed that EMFs have unpredictable
needs for liquidity, which will to cause them to call in their loans from domestic banks
before the loans can be used to finance domestic investment or consumption expenditure
in the emerging market. Domestic banks offer demand deposit contracts to EMFs. This
contract offers a given return in the event of early withdrawal, and another return in the
event of late withdrawal. Domestic banks then hold some of the borrowed funds in liquid
form to cover anticipated withdrawals, and the rest convert into goods for lending to
domestic firms or households. An optimal contract, however, involves the domestic banks
being ‘illiquid’, in the sense that if all EMFs requested early withdrawal at the terms of
the contract, there would be insufficient resources to cover this. In that event, the bank
would be forced to close, and the loan offered to domestic borrowers in the emerging
market would be cancelled. This is what we term a ‘financial panic’. Conditional upon
deposits being made, a financial panic is a possible outcome, if expectations of EMFs
are such that they expect a financial panic.
In the original DD framework, the ex-ante probability of a ‘bank-run’ is zero. A financial panic is assumed to be an unanticipated event. But Cooper and Ross [18] show that if the financial panic is driven by a sunspot shock, upon which investors coordinate their expectations, and if the ex-ante probability of a sunspot shock which would generate a bank run is sufficiently high, then EMFs will prefer a contract which prevents runs from occurring. A run-preventing contract involves the domestic banks holding excess funds in liquid form, and reducing the share of the deposit that is extended to finance investment and consumption loans in the emerging market. This effectively raises the cost of capital to the emerging market. We may think of this increase in borrowing costs as a ‘risk-premium’ to ward off the risk of future financial panics.

The remainder of the model is quite a standard two-sector, dynamic choice theoretic model of a small open economy. The economy produces both traded and non-traded goods. It is assumed that the economy begins in a situation of current account deficit, so in each period, it has an outstanding need for capital. Borrowing is done via the banking system, as described in the previous paragraphs. The cost of foreign borrowing for domestic firms and consumers is that charged by the domestic banking system on funds deposited by the EMFs.

There is specific investment in each sector. Capital may not be moved from one sector to another. Labour may move between sectors, but it is assumed there are adjustment costs that firms must absorb when changing employment levels. In the traded goods sector, prices are fully flexible, and adjust instantaneously in response to shocks to the exchange rate. But in the non-traded goods sector, prices are sluggish, and move only over time, in response to deviations of non-traded goods marginal costs from their price. This nominal rigidity is an important part of the model, and generates an important role for monetary policy, as well as an important difference between different exchange rate regimes in dealing with the effects of a financial panic, or a policy of capital controls.
This model can be used to analyze the impact of a financial panic on the domestic economy of the emerging market. As discussed above, a financial panic occurs when there is an unexpected run on some of the domestic banks, leading them to abandon their domestic loan financing. Capital flows out of the country very sharply, as EMFs repatriate the recoverable part of their deposits. The sudden and unexpected cut-back in the supply of capital leads to a spike in the cost of capital in the domestic economy (real US dollar interest rates rise sharply).

Due to nominal rigidities, there is a clear role for monetary policy in the response to a financial panic. In Cook and Devereux [17], we contrast a passive monetary rule (such as a rule where the authorities maintain a constant growth rate of base money supply), with a rule that attempts to maintain a constant nominal exchange rate.

But the role of economic policy is not restricted to monetary policy. An alternative policy lever that can be used is to control the outflow of capital. Consequently, we introduce capital taxes into the analysis. Taxes are paid by foreign lenders when adjusting their lending to the emerging market. We follow Sutherland [41] in modeling capital taxation as isomorphic to adjustment costs by foreign lenders for changes in their net loan position with the domestic market. This implies that the tax paid is endogenous to the size of capital inflows. When the foreign lenders wish to withdraw funds from the emerging market, the effect of the tax will be to reduce the net return earned by taking funds out of domestic assets and placing them in foreign assets. As a result, in the presence of capital outflows, the capital tax will push real rates of return in the domestic economy down below the equivalent real return on foreign assets. Conversely, in the presence of capital inflows, real interest rates would be higher in the domestic economy than the foreign economy.

Capital taxes may be quite ineffective in stemming the full impact a financial panic once it is underway. This is because foreign creditors would still withdraw their funds in face of a capital tax rather than get nothing at all, which is the alternative they
would envisage if they failed to withdraw in the midst of a panic. But in any case, the Malaysian experience was not one where capital taxes were used immediately in response to the financial crisis, employed only a full year after the initial crisis. Consequently, in our analysis we restrict ourselves to the impact of capital taxes in responding to the post-crisis jump in the country risk-premium that is caused by the implementation of 'run-preventing contracts' by the domestic banks.

2.1 The impact of a financial panic

We first briefly describe the implications of the model for the effects of a financial panic. Within the model, this represents a sunspot-driven shock where a certain fraction of domestic banks experience sudden withdrawal of funds by the EMFs. In Cook and Devereux [17], the financial panic is quantified to match the scale of capital outflows in Malaysia. BIS-IMF-OECD-Word Bank data show that the stock of Malaysian debt to OECD banks was 26 percent of GDP in the second quarter of 1997, and declined by 21.2% in the third and fourth quarters of 1997 (see data appendix for more detailed sources). The rest of the model is calibrated as closely as possible to Malaysian data, and where this is not available, we use standard parameter values from the quantitative macroeconomics literature. The size of the non-traded sector, and the factor intensity of non-traded goods are important determinants of the scale of the response to a financial panic. We choose parameter values so that the share of non-traded goods in GDP is 55 percent, and the non-traded goods sector is more labour intensive than the traded goods sector.

Figure 1 (A) - (D) illustrate the effect of the financial panic measured in the way described, in the model. Our calibration requires that foreign borrowing fall by 21.2 percent. This leads to a reversal in the current account surplus relative to GDP equal to 25 percent, very close to that encountered in Malaysian data. The financial panic forces a large external transfer in Malaysia, as the current account turns around sharply
from deficit to surplus. This requires a large fall in absorption. Consumption falls by 24 percent, and investment by 60 percent. Combined with the external transfer, there is a large internal transfer, as resources must be shifted from the non-traded to the traded sector to generate a trade surplus. In our calibrated model, the fall in output in the non-traded sector exceeds the rise in output in the traded sector, so that overall, GDP falls by 13 percent. Again, these figures are reasonably close to that observed in Malaysia (see section 6 below).

Is there a role for monetary policy in the response to a financial panic? In Cook and Devereux [17], we show that an alternative monetary policy that attempts to maintain a fixed exchange rate in response to the capital market panic has much greater costs in terms of output and absorption, while an alternative expansionary monetary policy can reduce the output effects of the panic, but only at the cost of much higher nominal and real exchange rate depreciation.

3 The effects of capital controls in Malaysia

We now study the effects of introducing capital controls in the immediate aftermath of a financial panic. The capital controls are introduced as a tax on the net capital flows undertaken by the EMFs. Define capital outflows, \( \Xi_t \), as the difference between new debt and old debt plus interest:

\[
\Xi_t = D_t - (1 + r_{t-1}^{CC}) (1 + l_{t-1}) D_{t-1}
\]

We define the tax as a non-linear function of capital flows, in the following way:

\[
TAX_t = \frac{\vartheta}{2} (\Xi_t - \Xi)^2
\]

Under this specification, the effective tax is increasing in the volume of capital flows, and will be positive whether capital flows are positive or negative. The EMF's are owned
by risk neutral foreign investors, who will choose the level of capital flows to maximize returns net of the world opportunity cost of capital, and taxes:

$$E_0 \sum_{t=0}^{\infty} \left( \frac{1}{1 + r^W} \right)^t \left[ (1 + r_{t-1}^{CC})(1 + l_f t_{-1}) D_{t-1} - (1 + r^W)(1 + l_f t_{-1}) D_{t-1} - TAX_t \right]$$  \hspace{1cm} (1)$$

Here the variable $l_f$ represents a risk premium term. As we explained above, in the aftermath of a financial panic, domestic banks will be required to hold excess liquidity to ward off the occurrence of further bank runs. Foreign lenders believe that the possibility of another financial panic is sufficiently high that they will require borrowers to implement investment plans that avoid that likelihood. Theoretically, this is represented by EMFs and banks writing ‘run-preventing contracts’ as in Cooper and Ross [18]. The effective implication of this will be that the required return on loans to the domestic economy rises, relative to the world opportunity cost of capital. This is captured by the term $l_f$. The size of $l_f$ is determined in the model by the amount of excess liquid assets that domestic banks need to hold to eliminate the possibility of financial panic equilibrium. We then examine the manner in which capital controls can cushion the economy against the post-panic increase in risk-premia.

The optimal choice of $D$ undertaken by foreign lenders channeling funds through EMFs, chosen to maximize (1), results in the following relationship between onshore and offshore rates of return:

$$(1 + r_{t}^{CC}) = \frac{(1 + r^W)[1 - \frac{\theta}{(1 + l_f t_{-1})}(\Xi_t - \Xi)]}{E_t[1 - \theta(\Xi_{t+1} - \Xi)]}$$

Note that domestic and foreign rates of return differ for two reasons; the existence of the risk premium term, and the presence of capital taxes. We calibrate the post-crisis period as 10 consecutive periods when effective real interest rates rise by 300 annualized basis points. Our evidence for this comes from the US dollar debt of Petronas. After spiking at annualize rates 1200 basis points above US Treasuries right after the initial
financial crisis, benchmark US dollar debt issued by Petronas stayed at a rate close to 300 basis points above Treasuries at least through the 3rd quarter of 1999.

What is the relationship between our capital tax system and that actually imposed by Malaysia? The original regime of controls announced in September 1998 imposed a variety of restrictions on both Malaysian and foreign investors. These included a ban on repatriation of short-term investments in Malaysia by foreign investors and a requirement that Malaysian investors repatriate their own foreign investments. In February of 1999, the Malaysian government replaced its absolute ban on short-term capital repatriation with a capital gains tax on foreign investors. The standard capital gains tax would be 10%. However, investors repatriating capital invested post February 1999 and held in Malaysia for less than a year would pay a 30% capital gains tax. Investors repatriating capital held in Malaysia for less than a year and invest prior to February 1999 would pay a 30% tax rate on principle. In other words, the Malaysian capital controls could be thought to be represented by a tax scheme in which the marginal tax rate is increasing with the speed with which investors withdrew funds. We approximate this with a regime in which the marginal tax rate is smoothly increasing with the size of capital flows. The thinking behind this approximation is that at any time, capital repatriation would consist of a combination of outflows that faced the highest marginal tax rate and outflows that faced the lower rate. Since capital outflow taxes would discourage frequent repatriation of short-term capital flows, we assume that only a small share of outflows would usually be subject to the highest tax rate. However, when foreign investors want to repatriate a greater amount of funds than average, on the margin, more of those funds would be forced to come from short-term funds and the marginal tax rate would increase. A second aspect of our tax system is that it is symmetric. Taxes are placed on capital inflows as well as capital outflows. This is important since the simulation paths that we will examine will consist of a period characterized by net capital outflows followed by a period characterized by net capital inflows. Taxes on capital inflows were not part
of the regime of the Malaysian capital control regime. However, in mid 1990's, some capital controls had been imposed in order to prevent large scale inflows. We think it not an entirely irrational expectation on the part of foreign investors that at future period when capital inflows began occurring, the Malaysian government might re-impose such a regime. Thus, our specification might be thought of as capturing this aspect as well.

4 Simulation

In this section we examine the dynamic equilibrium response of a set of variables to a risk premium shock which sets \( f_t = 0.0075 \) for 10 periods under a variety of monetary policies and capital controls regimes. In Figure 1 and 2, we will show the response of some price and quantity variables under a policy of monetary targeting. In this case, monetary targeting will imply a fixed money supply, \( M_t = \bar{M} \). In Figure 3 and 4, we will show the response of some price and quantity variables under a policy of fixed exchange rates, \( E_t = \bar{E} \). For each monetary policy, we will describe the response to the risk premium shock under two regimes. In the first, designated FREE, the parameter \( \theta = 0 \), indicating no taxes on capital flows. In a second regime, designated CAPCON, the parameter will be set so that \( \theta = 0.3 \). Under this parameterization, the marginal tax rate faced on any additional capital outflows will be equal to 0.3% when the size of the capital outflows are equal to 3% of the initial debt. The reasoning for this parameterization is somewhat intricate. Under either monetary policy, the largest capital outflow in any given period is approximately 3% of the initial debt level when the parameter is set at 0.3. Thus, at that point, the economy is facing a tax rate equal to 0.3% of principal. Assuming that the marginal capital that is flowing out had been in Malaysia for just less than a year and given that capital was earning an annual capital gain of 10%, the marginal tax rate could then be thought of as 30% of capital gains. In February 1999, the Malaysian government imposed a capital repatriation tax with a maximum tax rate of 30% of capital gains. Thus, at capital outflows of the largest size, the investors in our
model were facing a tax rate which reasonably approximates the top tax rate imposed by the Malaysian government.

### 4.1 Constant Money Supply

In Figure 2 and 3, we show the dynamic response of some simulated economic aggregates to a rise in the risk premium under monetary targeting. First, examine the response of the effective real interest rate, \((1 + r_t^{CC}) \cdot (1 + lf_t)\). Under free capital controls, \(1 + r_t^{CC}\) will always be equal to the exogenous world interest rate, \(1 + r^W\). Thus, the effective interest rate will rise 1 for 1 with the liquid reserves shock for 10 periods as shown in Figure 2 (A). In Figure 2 (B) we show that the rise in the real interest of 300 annualized basis points leads to a rise in the domestic nominal interest rate by only 80 annual basis points. Since uncovered interest rate parity holds in this case, the nominal interest rate is cushioned by a sharp depreciation, followed by an expected appreciation of the currency. In Figure 2 (C), the currency falls by more than 6% in the period of the shock. In Figure 2 (D) we see that the real exchange rate rises 1-for-1 with the nominal exchange rate in the initial period of the shock. In subsequent periods, the real exchange rate converges more slowly than the nominal exchange rate. The reason for this is that the non-tradeable sector encounters deflation as lower demand reduces non-tradeables prices during the adjustment period.

The persistent rise in the risk premium results in a decline in aggregate investment of nearly 15%, and a fall in total absorption of more than 8% as shown in Figure. Given the rise in the effective interest rate, the economy has an incentive to repay debt to the rest of the world. As we see in Figure 3 (C), debt to the rest of the world shrinks rapidly under FREE capital markets dropping by 20% over 10 periods, before beginning to rise again as interest rates fall. In the same manner as the response to a financial panic, we find that a rise in the risk premium generates a combined internal transfer of resources from the non-traded to the traded sector, and a transfer of resources from the domestic
economy to the rest of the world. Because the fall in non-traded output exceeds the rise in traded goods output, overall GDP falls. Output declines by nearly 3% (see Figure 3 (D)).

The imposition of capital controls changes the response to the shock. Under the CAPCON regime, the risk premium shock leads to a rise in the effective real and nominal interest rate; a real and nominal exchange rate depreciation; a contraction of investment, absorption, and output; and contraction in foreign debt through capital outflows, just as in the FREE capital regime. However, in each case, the capital taxes ameliorate the effects of the shock. Examine the effect of capital controls on the dynamic response of the effective real interest rate to a risk premium shock. The rise in the risk premium leads to a drop in demand for foreign debt and to capital outflows. Foreign lenders would then face an increasing tax rate as they removed capital from the system. In order to avoid doing that and still earn a return on assets, they reduce the interest rate \( (1 + r_t^{CC}) \) below the world interest rate. In Figure 2 (A), we see that in the CAPCON case, the risk premium shock increases the effective interest rate, but not by as much as under free markets. As we see in Figure 2 (B) and (C), the rise in the real interest rate will translate into a rise in the nominal interest rate and an exchange rate depreciation under capital controls. In each case, these are less severe than under free markets for the very reason that the rise in the effective interest rate is less severe. This results in a milder real exchange rate depreciation and a milder non-tradeable deflation.

With the smaller increases in the effective interest rate under capital controls, there is a smaller decline in investment. In Figure 3 (A), we show that the equilibrium response of investment under the CAPCON regime is to fall by 8% compared to the 15% decline under capital controls. In Figure 3 (B), absorption drops by 4% under capital controls (compared to a drop of 8% under free capital markets). Under a capital controls regime, output falls by only 1.4% (compared to an output fall of 2.8% under free capital markets). The lower interest rate effects under capital controls reduce the need
to switch resources from the tradeable to the non-tradeable sector. This reduces the impact of adjustment costs on the real wage and reduces the drop in nominal demand in the non-tradeable sector. Both effects ameliorate the impact of the shock on output. Finally, unsurprisingly, the presence of capital controls reduces the magnitude of capital outflows caused by the risk premium shock.

4.2 Fixed Exchange Rates

A central aspect of the implementation of capital controls in Malaysia in 1998 was that they were combined with a rigidly pegged exchange rate. Exchange rate stability has clearly been the over-riding priority of the Malaysian authorities. Krugman (1998) argues that the imposition of capital controls in Malaysia offered a way to stimulate the economy without facing further weakening of the exchange rate. We now investigate the implications of our model when the central bank adopts a policy of fixing the exchange rate in the aftermath of the panic.

Figure 4 (A) and (B), shows the response of the effective real and nominal interest rates to the risk premium shock. Without movements in the exchange rate, they are equivalent, with and without capital controls. The presence of capital controls dramatically insulates the domestic economy from the risk premium shock. Comparing Figure 4 (A) with Figure 2, we see that the jump in the effective real interest rate is actually less under fixed exchange rates than under fixed money supply. The reasoning is that capital outflows will be larger under fixed exchange rates. Thus, marginal tax rates are higher and the domestic real interest rate is pushed lower. In the previous section, we saw that when the money supply remained constant in the face of a risk premium shock, the exchange rate depreciated substantially. To maintain the exchange rate peg therefore, Figure 4 (C) shows that the money supply must be reduced sharply.

While the nominal exchange rate is pegged, the real exchange rate gradually depreciates following the risk premium shock, as there is a deflation in non-traded goods
prices. But as we would anticipate, the real depreciation is significantly less under pegged exchange rates. Moreover, the simultaneous imposition of capital controls and a pegged exchange rate can keep the maximum depreciation of the real exchange rate to only about 1 percent, far lower than seen under the fixed money supply policy.

As shown in Figure 5, the monetary tightening required under fixed exchange rates will exacerbate the real effects of the risk premium shock, whether or not capital controls are in place. Under free capital markets, investment falls more than 30%; under a capital control regime, investment falls by close to 10% (see Figure 5). Under free capital markets, total absorption falls by more than 15%; under a capital control regime, absorption falls by more than 6%. The more dramatic effects of the risk premium shock on absorption under fixed exchange rates translate into more dramatic effects of the shock on foreign debt. In Figure 5, we show that foreign debt drops by more than 30% under a free capital market, but drops only about 10% with capital controls. The deflation required by fixed exchange rates also exacerbates the decline in output. Output drops by more than 8% under free capital markets. In the presence of capital controls, however, output drops only by about 2%.

There are a number of important points that we can get from these experiments. Two are clear; the third somewhat more subtle. First, the real effects of a risk premium shock are larger under a fixed exchange rate regime than under fixed monetary policy. Second, the real effects of the shock are larger under free capital markets than under a regime of taxation on rapid capital controls. The third point is that the extra destabilizing effects of fixed exchange rates are much more apparent under free capital markets than under a capital control regime. More deflation is required to keep exchange rates fixed in the face of rapid capital market movements when there is an effective rise in the real interest rate charged on foreign debt. Quantitatively, this impact is substantial. Under free capital markets, the difference between fixing money supply and fixing the exchange rate is the difference between a 2.7% decline and a 7.9% decline. Under the capital controls regime,
the difference between fixing the money supply and fixing the exchange rate is only the difference between a 1.4% contraction and a 2.8% contraction. This demonstrates that the extra instability incurred by switching to a fixed exchange regime can be ameliorated by taxing capital flows.

5 Expansionary Monetary Policy with Capital Controls

A corollary to this point is that monetary policy is more powerful under free capital markets than under a capital controls regime. In Figure 6, we show the response of absorption, GDP, nominal exchange rates and foreign debt to a 1% permanent increase in the money supply. At a fixed real interest rate, as in the free capital markets case, this leads to an increase in absorption which exceeds the increase in output. In Figure 6 (A) and (B), we show that a 1% money expansion leads to a 1.6% increase in absorption and a .9% increase in GDP under free capital markets. As shown in Figure 6 (C), this current account deficit would lead to an increase in foreign debt levels. Given the capital controls regime, however, foreign investors seeking to increase their holdings of domestic assets would face increasing marginal capital tax rates. The capital controls therefore generate an increase in the effective interest rate charged to domestic borrowers. As a result, the impact of the money shock on output would be reduced. Figure 6 (D), does show however, that the presence of capital controls does succeed in dramatically reducing the impact of an expansionary monetary policy on the exchange rate. While the presence of capital controls reduces the effectiveness of monetary expansion in increasing GDP only slightly; 0.9% without capital controls, and 0.7% with controls, the response of the nominal exchange rate is cut in half. To this extent, our model suggests that a policy maker putting a high priority on nominal exchange rate stability may employ capital controls, while still retaining significant ability to stabilize the domestic economy.
5.1 Discussion

Qualitatively, most of the above results are very intuitive, and would simply support the expectations of economists about how capital controls work in a small open economy. Quantitatively, however, we believe that the results show that the Malaysian capital controls in particular could be expected to have played a significant role in Malaysia, and perhaps in the recovery from the financial crisis. We find that under floating exchange rates (and a fixed money supply rule), capital controls of the size that Malaysia imposed would have cut in half the output costs of the post-shock risk premium that was imposed on Malaysia, while also cutting in half the implied real and nominal exchange rate depreciation. Malaysia chose however to eliminate all nominal exchange rate flexibility. In this case, we find extremely large quantitative benefits of capital controls. The capital controls as applied by Malaysia would cut the output losses by almost 75 percent, when the exchange rate is pegged. Although the pegged exchange rate necessarily, in our model, implies a higher output cost in face of an external risk premium shock, the difference between output losses under a floating and fixed exchange regime is relatively minor, in the presence of the capital controls. Moreover, capital controls under a pegged exchange rate regime succeed in dramatically reducing the response of the real exchange rate, the current account, and especially domestic real interest rates. Finally, our model suggests that capital controls, again measured against those imposed by Malaysia, would be an effective way to employ expansionary monetary policy, while reducing the real and nominal exchange rate consequences. While the output effects of monetary expansion are only slightly circumscribed under capital controls, the exchange rate depreciation is cut by more than 50 percent.
6 Empirical Analysis

6.1 A V-Shaped Recession?

The model suggests that output will initially contract due to the liquid reserves or interest risk premium shock. However, much of this contraction should be due to sectoral and price adjustment costs. If there were perfect flexibility in employment, capital, and prices, there would be much smaller impact of the risk premium shock on overall GDP. The model therefore implies that the impact of the high interest rates on output will dissipate as the economy adjusts. Our assumption that the Malaysian economy is approximately as flexible as the US economy, at least in these respects, implies a fairly rapid adjustment of output under a wide variety of monetary policies and capital control regimes. In Figure 1 (A) we show deviations of seasonally adjusted Malaysian real GDP from its long-term growth path. The long term growth path is identified by fitting a simple log-linear trend to quarterly Malaysian real GDP from 1991:1-2000:4. This implies a 6.4% annual GDP growth path. Figure 1 (A), implies that in early 1993 the Malaysian economy was very near the long term growth path. In subsequent periods, output growth rises above trend; in early 1997, output reaches a peak level 9% above trend. But in early 1998, Malaysian GDP rapidly reverses course and by the second quarter of 1998 is more than 9% below trend. However, this output reversal does indeed quickly dissipate. By the first quarter of 2001, Malaysian GDP is only 2.6% below its long term growth path.

The model also predicts that the recovery of expenditure is slower than the recovery of output. The rise in the effective real interest rate has a direct impact on both household consumption decisions and the investment decisions of firms. The persistent rise in the interest rate should cause a more persistent contraction in investment and consumption than on output. Figure 1 (B) and 1 (C) supports this prediction. These figures show the deviation of (seasonally adjusted) real private consumption expenditure
and gross fixed capital formation from their respective long run balanced growth paths. These paths are calculated as a constant share of the long-term output growth path. The constant share is set equal to consumption and investment's respective share of output in the second quarter of 1993 (when output itself had been near the long-term growth path). With the extraordinary capital inflows of 1994-1996, consumption and investment rise far above their long-term growth paths. Relative to their trend growth paths, consumption and investment rise much more than GDP. Following the financial collapse, they also experience sharper declines. This is unsurprising to the extent that, by definition, capital outflows require a sharper contraction in spending than in output. It is remarkable however to note the extent of the persistence of the decline in investment. After bottoming out at more than 15% below the balanced growth path, consumption recovers to a point approximately 7% lower than the balanced growth path. Investment, however, was more than 60% below the long term growth path at the bottom. Although there has been a substantial recovery in investment; it still remains more than 30% below the balanced growth path.

The implication of a rapid recovery of production and a persistent contraction in absorption is a persistent expansion of the trade balance. In Figure 1 (D) we show that net exports as a share of output declined as capital inflows took off in the mid-1990's. However, with the onset of rapid capital outflows in 1997, the trade deficit was transformed to a large surplus on the order of greater than 10% of GDP. This trade surplus continues at level greater than 10% of GDP up to and including the most recent period. In terms of allocating capital between Malaysia and the rest of the world, the East Asian crisis seems far from over.

6.2 A Sectoral Shift?

It is a priori clear that a rise in interest rates would lead to a contraction in output. For example, in the classic Mundell-Fleming model, a rise in the interest premium leads
to an expansion in output with a constant money supply. The theory outlined in the
previous section suggests that the output contraction is due to the difficulty of shifting
resources to export industries without driving up the overall marginal cost of produc-
tion. This is exacerbated by the drop in nominal demand for those industries whose high
market power allow for less flexible prices. Is this a plausible explanation for the decline
in GDP in Malaysia during the East Asian crisis? We examine the sectoral effects of the
movements of GDP by looking at three categories: Tradable goods, Non-tradable goods
and the special case of Fabricated Metals and Electrical Machinery manufacturing. The
Malaysian Bureau of Statistics, in constructing a set of industrial production indices, di-
vides manufacturing industries into domestically oriented and export oriented categories.
At the two digit SIC level, domestically oriented manufacturing industries include Food
Processing, Industrial Chemicals, Plastics and Products, and Basic Metal manufactur-
ing; export oriented industries include Textiles and Apparel and Wood/Paper products.
We define Non-tradable goods as the sum of real value-added in Construction, Trans-
port, Storage and Communication, Electricity, Gas and Water, Retail and Wholesale
Trade, Finance, Insurance, Real Estate and Business Services, and Other Services sec-
tors in addition to the domestically oriented manufacturing sectors. We define Tradable
goods as the value-added in Agriculture, Mining and Quarrying and export oriented
manufacturing sectors. The remaining 2 digit category Fabricated Metals and Electrical
Machinery manufacturing is a combination of the value added of the Fabricated Metals
sector which is categorized as domestically oriented and the Machinery and Electrical
machinery sector which is categorized as export oriented.

In Figure 7, we examine the sectoral price and output responses of the various cat-
egories of GDP by industry. Figure 7 (A) displays the results of a sectoral growth
accounting exercise. We calculate the growth rates of the three sectors for each time
period, as well as a time varying weight which for each sector would be the ratio of the
real GDP of that sector to the sum of the real GDP of all sectors. Figure 7 (A) shows
the product of the sectoral growth rate and the sectoral weight. The sum of all of these series approximates the growth rate of the aggregate real GDP. We can then think of these series as the share of growth in each period which could be attributed to each series. In Figure 7 (A), we see that the chief contraction occurs in the first quarter of 1998. Negative private sector output growth in that period is lower than -6%. In the subsequent periods of 1998, output continues to contract at a rate of approximately -2% per quarter. In the initial period of contraction, all three sectors contract. In the tradeable sector, the contraction is small and cannot with certainty be attributed to the East Asian crisis; the output contraction attributed to the tradeable sector is less than 1% in the first quarter of 1998. After that, output growth in the tradeable sector is near zero or positive. The contraction in output growth attributable to the non-tradeable sector is approximately 2% per period. These sectoral responses to the crisis seem consistent with the theory.

We might further examine the response of prices in the tradeable sector and the non-tradeable sector. The theory suggests that the effective interest rate will lead to a large exchange rate depreciation and thus a large increase in the price of those goods which are sold competitively on international markets. The fall in demand for non-tradeable goods, combined with the fall in marginal cost in that sector, should lead to a gradual fall in prices in the non-tradeable sector, relative to the trend inflation rate in that sector. In Figure 7 (B), we show the response of prices in the tradeable and non-tradeable sector relative to their pre-crisis growth paths. The price series are implicit price deflators for the two sectors calculated from Malaysian NIPA. In each case, the pre-crisis growth path is determined as the fitted value from a log-linear regression of the implicit price deflator on trend using data from 1991:1 to 1997:2. Prior to the crisis, non-tradeable inflation was approximately 3.2% per year. Contrary to the Belassa-Samuelson hypothesis, pre-crisis tradeable inflation was approximately 4% per year. As exchange rates depreciated in the third quarter of 1997 by nearly 40%, so did the price of tradeable, reaching a point
nearly 20% above the pre-crisis path in the first period of 1998. In subsequent periods, the price of tradable goods moved back toward the pre-crisis path, at least in part because the trend price level had been rising. By contrast, the price of non-tradeable displays virtually no extra inflation during the first part of 1998. Subsequently, deflation begins to occur in the non-tradeable sector as prices of that good begin to fall. This dramatic rise in the prices of tradable goods and slow disinflation in the non-tradeable sector also tends to support the model.

Somewhat more confusing is the final Fabricated Metals and Machinery sector. Part of this sector is export oriented, especially the semiconductor industry. Another part produces fabricated metal products for the domestic industrial sector. Yet another part produces cars and other transportation equipment for the domestic market. In the first quarter of 1998, the lion's share of the contraction can be attributed to this sector. Fully 3% of the 6% output contraction is attributable to the Machinery sector. This is somewhat puzzling in light of the theory since this sector might be typically thought of as a tradable sector. However, a more disaggregated examination shows that the crisis generated a substantial sectoral shift even within this sector. Though National Income and Product Accounts do not report more disaggregated data than approximately 1 digit SIC code, industrial production measures at more disaggregated levels exist. In Figure 8 (A) and 8 (B), we report the behavior of sectoral disaggregates from the Fabricated Metals and Machinery sector. All indexes are reported as percentage deviations from their 1997:2 level to distinguish sectors for which the crisis had an expansionary effect from those in which the crisis had a contractionary effect.

The dynamic response of disaggregated production in this sector can be easily divided into two groups. The first set of industries which includes the sectors which produces Office Equipment, Radio and TV Equipment, Electrical Appliances, Scientific and Professional Equipment and Semiconductors experienced mild contractions and expansions during 1998 neither of which could be definitively attributed to the crisis. However, in
1999, these sectors almost universally exploded, with expansions in output of 30-70%. Conversely, other sub-sectors experienced a dramatic decline in output. In particular, those sectors including the Exhaust and Ventilation machinery, Transport Equipment, Fabricated Metals and Cable and Wires sector all experienced contractions between 40% and 100% of pre-crisis levels during 1998. All sectors experienced dramatic recoveries during 1999 though virtually all end the period at lower levels of production than prior to the crisis. The response of the Transport sector is especially stark. In 1998, the sector that produces cars, motorcycles or other transport equipment fell by nearly 90% from the pre-crisis level within the space of two quarters before substantially recovering. One interpretation of these disaggregated figures is that during the crisis, Malaysia transferred resources away from uncompetitive export substitution industries such as the auto industry toward sectors which could produce more hard currency earnings such as the semiconductor industry. However, it is notable that even in those sectors which ultimately experience large expansions, there is a substantial delay before output begins to grow. This seems to fit with the idea that adjustment costs prevent the rapid expansion in these sectors.

6.3 Capital Inflows: When and Where?

The model predicts that in the period in which Malaysian capital controls were in effect, essentially September 1998 to September 1999, Malaysia would experience lower effective foreign currency risk premiums than would otherwise occur. In Figure 9, we show the average cost for a Malaysian customer to borrow US dollars from Maybank. Maybank, a major Malaysian commercial bank, of course lends to domestic customers in Ringgit. Assuming a customer borrows ringgit at the prime rate, the effective (currency) risk-free dollar rate could be derived as the product of the prime interest rate and the buy spot rate divided by the forward sell rate offered by Maybank. We calculate this using daily data on Maybank base lending rates, spot rates and 3 month forward contracts. We
then take monthly averages of these daily values which are reported (as an annualized basis point premium over the US Federal Funds rate) in Figure 9. As a control, we also calculate the cost of effectively borrowing US dollars for a customer of Bangkok Bank in Thailand. Data on Maybank forward currency rates are available only from September 1997. Examining this series we see that the premium paid by Malaysian customers rises dramatically to 500 basis points in the final month of 1997. The risk premium stays at this level for approximately 8 months until August 1998, whence it falls to approximately 350 basis points. In September of 1998, the Malaysian government imposed controls on the repatriation of capital by foreigners. During the subsequent months, the risk premium continued to decline and reached a bottom at approximately 230 basis points above the Fed Funds rate. In February of 1999, the Malaysian government eased their strict restriction on short-term capital repatriation with a set of increasing tax rates on capital gains taxes. During the first half of 1999, the risk premium stayed between 300 and 350 basis points. In June of 1999, the risk premium once again rose to a level above 500 basis points. Following that peak, the risk premium slowly eased, staying above 400 basis points as late as August of 2000. Certainly it would be incorrect to use this one interest rate as a sufficient statistic defining the state of capital markets in post-crisis Malaysia, especially since many argue that banks often use non-interest rate measures to ration credit. Nevertheless, we interpret this series to be roughly consistent with some aspects of our model. First, we see a strong and persistent increase in the Malaysia specific cost of borrowing US dollars. This persistent increase is interrupted by a period when these borrowing costs are significantly ameliorated. This period basically coincides with the period of capital controls though the amelioration of borrowing costs itself dissipates before the capital controls were fully lifted.

Now compare this with the effective cost of borrowing dollars in Thailand during the same period. The effective dollar interest rate in Thailand begins rising in mid-1997 consistent with the conventional wisdom that the East Asian crisis affected Thailand
first. The initial rise in the interest rate in Thailand was somewhat lower than the initial rise in the effective dollar rate interest in Malaysia some 6 months later. It is worth pointing out, as Edison and Reinhart [23] did, that Thailand themselves imposed some constraints on capital movements over the second half of 1997. After September 1997, the Bangkok Bank's effective dollar rate displays substantial volatility. After a drop in the risk premium to approximately 1%, the risk premium rapidly rises in late 1997 through 1998. During the period that Malaysian capital controls were in effect and the Malaysian risk premium was in the area of 300 basis points, the Thai risk premium had reached a point above 600 basis points. Interestingly, the rise in the Thai effective dollar rate was less persistent. Through the year 2000, the risk premium falls to near zero, rising only near the end of the year.

In Figure 10, we examine the dynamics of some types of international capital flows into and out of Asia. Malaysia is distinguished by the large share of capital in the form of foreign direct investment. However, we focus on some more volatile elements of international capital flows; in particular portfolio and equity flows and loans from foreign bank. Figure 10 shows the dynamics of net portfolio inflows (including Malaysian government securities, money market instruments, corporate securities and equity) and changes in the net liabilities of Malaysian firms, financial intermediaries, and individuals to banks in the OECD countries plus some money center economies such as Singapore and Hong Kong. Figure 10 (A) and (B) show the dynamics of these series over the period 1992:1-1996:4. At the quarterly frequency, both types of capital flows demonstrate substantial volatility. For Malaysia, we can see that during this period of net capital inflows, portfolio inflows were a more important source of foreign capital than external bank debt. The average portfolio inflows per quarter were $1.4 billion; the average debt flows per quarter were closer to .8 billion. Overall bank debt flows were slightly more volatile. In particular, there is a particularly sharp inflow of capital that occurs in late1996. In Figure 10 (C) and (D), we show the dynamics of these series during
the period of capital outflows, 1997:1-2000:4. The continued strong inflows of bank loans continued through the first half of 1997. However, as early as the second quarter of 1997 there was a sudden net outflow of portfolio investment. During the second quarter of 1997, portfolio outflows were more than compensated by lending from foreign banks. However, in the 3rd quarter of 1997, the massive portfolio outflows (equivalent to US$5 billion in one quarter) were not matched by compensating foreign bank loans and net outflows rose dramatically. During the fourth quarter of 1997, portfolio outflows continued but were then joined by a massive cancellation of foreign bank loans continuing through the 1st quarter of 1998. Over most of 1998, there was a steady outflow of capital through both channels. In the fourth quarter of 1998, portfolio capital outflows essentially stop and become somewhat positive in some periods of 1999. By contrast, foreign bank debt continues to contract through most of 1999. This period covering the fourth quarter of 1998 and the first 3 quarters of 1999 are of special interest as they coincide with the period in which capital controls were in place. It should be noted that virtually all of the liabilities to foreign banks were offshore and denominated in hard currency assets and thus would not have been subject to repatriation restrictions or capital outflow taxes. The contrasting behavior of portfolio outflows bank loan outflows during this period may indicate that capital controls did effectively keep capital within Malaysia, though as there are other differences between portfolio flows and bank loans which might suggest alternative explanations.

7 Conclusion

1. The East Asian Crisis, as a maturity mismatch crisis, would have manifested itself primarily as a rise in the effective interest charged on capital inflows. In a previous paper, we consider an analytical model of a financial panic. The panic would occur in two stages. First, a financial crisis would cause a dramatic contraction in funds available for lending to an economy. This scarcity would be rationed by a rise in the
intertemporal interest rate. However, this dramatic rise in the interest rate would be transient. In the subsequent stage of the panic, the ability of lenders to impose new loan conditions on short term debt should prevent further panics. However, the steps necessary to avoid future panics would require more holdings of liquid assets by intermediaries importing capital from abroad. This would effectively increase the interest rate costs of financing spending in the economy for as long as the possibility of repeated episodes of panic was sufficiently high.

2. A repeat panic in the immediate aftermath of a crisis is unlikely to occur as the new loan conditions would likely prevent a crisis

The model suggests that the macroeconomic effects of the financial panic quickly dissipate in the periods following the panic. An aspect of a maturity mismatch panic is that it is likely to be short-lived. This statement goes beyond the argument that the emotional state of markets that might lead to a panic is likely to be transitory. Rather this statement is based on the nature of short-term debt. Although short-term debt may be subject to rapid movement, it does offer the advantage that debt contracts can be rapidly renegotiated in light of changing conditions. When the probability of a panic is subjectively believed to be small, creditors and debtors may write debt contracts that may generate the conditions that would support a contract. However, if panic is believed to be a real probability then debtors and creditors will arrange their debt contracts in such away to make lending arrangements that are not subject to panics. Cooper and Ross [18] show that the optimal way to do this is to require debtors to keep a certain percentage of their debt as liquid reserves. As suggested in this paper, this may make international financial intermediation slightly less efficient and more costly for the developing economy. However, the effective rise in the interest rate in the periods following the panic are inherently likely to be lower than in the period when the panic is first realized. This line of thinking would also argue that repeated waves
of maturity-mismatch based financial panics are unlikely. Kaplan and Rodrik [27] argue that in lieu of capital controls Malaysia in the 3rd quarter of 1998 was comparable to Thailand or Indonesia in the 3rd quarter of 1997. However, by the 3rd quarter of 1998 any extant short-term debt would have been issued after the crisis had occurred and with the possibility of panic firmly in mind. For a repeat of the 1997 crisis to have occurred, the short-term lending to under-capitalized banks that Sachs and Radelet [?] have documented occurring in 1995 and 1996 would have had to have continued in 1997 and 1998 after the original crisis occurred.

3. A persistent rise in the interest rate would likely induce a persistent contraction in absorption and a sharp, but much less persistent contraction in output. Standard intertemporal thinking would imply that a rise in the effective real interest rate would lead to a contraction in consumption and investment. Given standard estimates of capital adjustment costs and intertemporal elasticities of substitution, a persistent increase in interest rates will lead to a persistent decrease in consumption and investment. The effects of rise in interest rates on output are likely to be more transitory regardless of the persistence of the interest rates. A rise in the interest rate will likely generate a persistent sectoral shift in resources toward the production of goods that will generate hard currency overseas. Adjustment costs would generate high temporary costs of increasing production in those sectors. Further, sticky prices may exacerbate the increase the collapse in demand for non-tradable goods. Since both of these factors are temporary barriers to adjustment, the output response is also likely to be temporary even in the case of persistent shocks.

4. Capital controls, if effective, could significantly ameliorate the rise in the effective interest rate that occurs from a foreign risk premium shock. A small economy facing a rise in its interest rate would respond by exporting capital. Controls or taxes would prevent that shift, keeping capital in the small economy, and artificially low-
erating interest rates. Given that the chief macroeconomic effects of an international financial panic are caused by an increase in the interest premium, capital controls could substantially ameliorate the real effects of the panic.

5. *Capital controls may have the most significant impact on the macroeconomic effects of a financial panic under fixed exchange rates.* Monetary policy has important real impacts because of nominal price stickiness. In the face of interest rate shocks, maintaining a peg requires a monetary contraction which reduces nominal aggregate demand. This should exacerbate the macroeconomic effects of the panic. Conversely, capital controls under fixed exchange rate reduce the size of the aggregate demand contraction necessary to maintain the peg. Thus, capital controls ameliorate both the direct impacts of the panic on real output and absorption and the indirect impacts of monetary contraction.

8 Appendices

8.0.1 Data Appendix

The data on the stock of outstanding bank debt are drawn from the Joint BIS-IMF-OECD-World Bank statistics on high frequency external debt. The remainder of the data are from the CEIC database. All seasonal adjustment is done with X-12.

8.1 Model Appendix

8.1.1 Representative Agent

The representative agent in our small open economy is a net debtor, owing an initial debt to foreign banks of $D_{t-1}$. In certain periods, the possibility of a financial panic is deemed sufficiently high that local borrowers are required to keep some of the borrowed funds in a liquid form unavailable for productive use. This "over-borrowing" beyond insures against the possibility that solvent firms might find themselves to be illiquid and
face a maturity mismatch based run of the sort emphasized by Diamond and Dybvig [21], Chang and Velasco [11], Radelet and Sachs [?] and other authors. Thus, when panic is in the air, the representative agent will pay interest on funds larger than the stock of actual borrowed funds. Describe the overborrowing that must be held as a constant share of total debt, $lf_t$. In a “normal” period, $lf_t = 0$; when “panic is in the air”, $lf_t = \varsigma$. Thus, the effects of a potential panic lead to an effective rise in the risk premium paid on debt.

The demand side of the domestic economy is represented by an infinitely lived representative agent. The agent maximizes utility from a stream of consumption and real balances and disutility from labor:\footnote{In our analysis of a capital market crisis, we will wish to examine the impact of a switch by banks to a run-preventing contract. This implies a persistent change in borrowing costs facing the small economy. From a technical viewpoint, highly persistent interest rate changes cannot be easily handled in the standard model with a time-additive utility function for the representative agent. A reasonable alternative is the Epstein-Uzawa preference system, which allows for a stationary level of consumption for arbitrary interest rate realizations.}

$$
\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1 - \sigma} [X_t]^{1-\sigma} \quad X_t = \left( aC_t^{\psi} + (1 - a) \left( \frac{M_t}{P_t} \right)^{\psi_0} \right)^{\frac{1}{\gamma}} - \frac{\Gamma}{1 + \psi} H_t^{1+\psi} \quad (2)
$$

where $C_t$ is consumption, $H_t$ is labor, $M_t$ represents the domestic money supply and $P_t$ is an domestic price index of tradeable and non-tradeable prices, $P_t^T$ and $P_t^{NT}$

$$
P_t = \left[ b \cdot (P_t^T)^{1-\gamma} + (1 - b) \cdot (P_t^{NT})^{1-\gamma} \right]^{\frac{1}{1-\gamma}}
$$

The representative agents earn income, $INC_t$, from renting labor and tradable and non-tradeable capital, $K_t^T$ and $K_t^{NT}$, capital to domestic production firms plus lump sum profits, $\Pi_t^{NT}$ and $\Pi_t^T$.

$$
INC_t = W_t H_t + R_t^T K_t^T + R_t^{NT} K_t^{NT} + \Pi_t^{NT} + \Pi_t^T
$$

where $W_t$ is the nominal wage rate, $R_t^T$ is the rental price of tradeable capital and $R_t^{NT}$ is the rental price of non-tradeable capital. This income can be used for purchases of
non-tradable and tradable goods, $A_t^{NT}$ and $A_t^T$; the accumulation of domestic money balances and the pay-off of outstanding debt to banks, $D_{t-1}$. The representative agent demand for foreign funds is given by:

$$S_t D_t = (1 + r_{t-1}^{CC}) S_t (1 + f_{t-1}) D_{t-1} + P_t^{NT} A_t^{NT} + P_t^T A_t^T - IN C_t + [M_t - M_{t-1}] - T_t$$  \hspace{1cm} (3)

where $S_t$ is the nominal exchange rate, $P_t$ is domestic consumer prices, $W_t$ is the nominal wage rate, $R_t^T$ is the rental price of tradeable capital and $R_t^{NT}$ is the rental price of non-tradeable capital. The government collects a lump-sum tax from the representative agents to finance government spending, $P_t G_t$, and pays a transfer payment of new money, $T_t$, from the central bank. The representative agent accumulates tradeable capital, $K_t^T$, through investment, $I_t^T$; and accumulates non-tradeable capital, $K_t^{NT}$, through investment, $I_t^{NT}$.

$$K_{t+1}^T = (1 - \delta) K_t^T + I_t^T - \frac{\zeta}{2} \left( \frac{I_t^T}{K_t^T} - \delta \right)^2 K_t^T \hspace{1cm} (4)$$

$$K_{t+1}^{NT} = (1 - \delta) K_t^{NT} + I_t^{NT} - \frac{\zeta}{2} \left( \frac{I_t^{NT}}{K_t^{NT}} - \delta \right)^2 K_t^{NT} \hspace{1cm} (5)$$

Consumption, investment and government goods are a combination of tradable and non-tradeable goods

$$[C_t + G_t + I_t^T + I_t^{NT}] = A_t = \left[ b^\frac{1}{\gamma} \cdot (A_t^T)^{1-\frac{1}{\gamma}} + (1 - b)^\frac{1}{\gamma} \cdot (A_t^{NT})^{1-\frac{1}{\gamma}} \right] \gamma^{-1}$$

Events within the small open economy do not affect the interest rate charged within the world economy $r^W$. However, there is a wedge between the interest paid on the foreign currency debt $r_t^{CC}$ and the exogenous off-shore interest rate $r^W$ because the government charges a tax on loans to the domestic market.

The first order conditions for the representative consumer’s problem are:

$$P_t \cdot b \cdot \left( \frac{A_t^T}{A_t} \right)^{\gamma -1} = P_t^T \hspace{1cm} P_t \cdot (1 - b) \cdot \left( \frac{A_t^{NT}}{A_t} \right)^{\gamma -1} = P_t^{NT} \hspace{1cm} (6)$$
\[ X_t^{-\sigma} \cdot aC_t^{v_{t-1}} \cdot \left( aC_t^{v_{t}} + (1 - a) \frac{M_t^{v_{t}}}{P_t} \right)^{\frac{1}{1 - v_{t}}} = P_t \cdot \Omega_t \]

\[ X_t^{-\sigma} \Gamma H_t^v = W_t \Omega_t \]  \hspace{1cm} (7)

\[ (1 - a) \cdot \left( \frac{M_t}{P_t} \right)^{v_{t-1}} = a \cdot \frac{C_t^{v_{t-1}}}{(1 - d_t)} \]

\[ d_t \equiv \frac{1}{1 + i_t} \equiv E_t[\beta \frac{\Omega_{t+1}}{\Omega_t}] \hspace{1cm} 1 = E_t[\beta \cdot (1 + r_t^{CC}) \cdot (1 + l_{t-1}) \cdot \frac{S_{t+1} \Omega_{t+1}}{S_t \Omega_t}] \]  \hspace{1cm} (8)

\[ q_t^T = (1 - \zeta (\frac{I_t^T}{K_t^T} - \delta))^{-1} \hspace{1cm} q_t^T = E_t[\beta \frac{\Omega_{t+1}}{\Omega_t} (1 - \delta + \frac{I_t^T}{K_t^T} \zeta (\frac{I_t^T}{K_t^T} - \delta)) P_{t+1} q_{t+1}^T + Q_{t+1}^T] \]  \hspace{1cm} (9)

\[ q_t^{NT} = (1 - \zeta (\frac{I_{t+1}^T}{K_{t+1}^{NT}} - \delta))^{-1} \hspace{1cm} q_t^{NT} = E_t[\beta \frac{\Omega_{t+1}}{\Omega_t} (1 - \delta + \frac{I_{t+1}^T}{K_{t+1}^{NT}} \zeta (\frac{I_{t+1}^T}{K_{t+1}^{NT}} - \delta)) P_{t+1} q_{t+1}^{NT} + Q_{t+1}^{NT}] \]  \hspace{1cm} (10)

Define \( \Omega_t \) as the current shadow value of a unit of domestic currency at time \( t \). The first order conditions in (7) represent the consumption demand equation, the labor supply equation, and the money demand equation respectively. The equations in (8) define \( d_t \) as the inverse of the domestic nominal interest rate; and the Euler equation indicating uncovered interest parity. The equations in (9) and (10) define Tobin’s (marginal) \( q \) in each sector and equate the returns (net of adjustment costs) in that sector to the nominal interest rate.

### 8.1.2 Foreign Lenders

Assume that foreign banks borrow dollars at the world interest rate, \( 1 + r^{W} \) which is equal to the discount rate. This tax is endogenous to the size of capital flows. Define a capital outflow, \( \Xi_t \) as the difference between new debt and old debt plus interest:

\[ \Xi_t = D_t - (1 + r_{t-1}^{CC}) (1 + l_{t-1}) D_{t-1} \hspace{1cm} TAX_t = \frac{\vartheta}{2} (\Xi_t - \Xi)^2 \]
The foreign banks are owned by risk neutral foreign investors, the objective function of the foreign investors is:

\[
E_0 \sum_{t=0}^{\infty} \left( \frac{1}{1 + r^W} \right)^t \left[ (1 + r^{CC}_t)(1 + I_{t-1})D_{t-1} - (1 + r^W)(1 + I_{t-1})D_{t-1} - TAX_t \right]
\]

implying a relationship between the onshore and offshore rate

\[
(1 + r^{CC}_t) = \frac{(1 + r^W)[1 - \frac{\phi}{(1 + I_{t-1})(\Xi_t - \Xi)]}{E_t[1 - \phi(\Xi_{t+1} - \Xi)]}
\]

8.1.3 Tradable Goods

 Tradable goods, \(Y^T_t\), are produced with capital and labor. Tradable goods firms are price takers and face adjustment costs of changing both their labor force and their capital stock. Net output of the tradeable goods firm is:

\[
Y^T_t = X^t \cdot (K^T_t)^\theta \cdot (H^T_t)^{1-\theta} - \frac{\varphi}{2} \left( \frac{H^T_t}{H^T_{t-1}} - 1 \right)^2 H^T_t
\]  

(11)

tradeable firms accumulates capital \(K^T_t\) through investment \(I^T_t\) subject to:
The tradeable managers maximize

\[
\max E_0 \sum_{t=0}^{\infty} \beta^t \cdot \Omega_t \cdot \Pi^T_t \quad \Pi^T_t = P^T_t \cdot Y^T_t - W_t \cdot H^T_t - R^T_t \cdot K^T_t
\]

(12)

The first order conditions describing capital and labor demand in the tradeable sector are:

\[
R^T_t \equiv \theta \cdot \frac{P^T_t \cdot Y^T_t}{K^T_t}
\]

\[
\Omega_t \left[ W_t H^T_t + \frac{H^T_t}{H^T_{t-1}} \left( \frac{H^T_t}{H^T_{t-1}} - 1 \right) - (1 - \theta) \cdot P^T_t Y^T_t \right] = \beta \Omega_{t+1} \varphi \left( \frac{H^T_{t+1}}{H^T_t} \right)^2 \left( \frac{H^T_{t+1}}{H^T_t} - 1 \right)
\]
8.1.4 Non-Traded Goods

Non-tradable goods are produced with a constant returns to scale Cobb-Douglas production function:

\[ Y_{t}^{NT} = (K_{t}^{NT})^x \cdot (H_{t}^{NT})^{1-x} \]

Cost minimization implies:

\[ W_t = (1 - \chi) \cdot \frac{MC_t^{NT} \cdot Y_t^{NT}}{H_t^{NT}} \quad \rho_t^{NT} \equiv \chi \cdot \frac{MC_t^{NT} \cdot Y_t^{NT}}{K_t^{NT}} \]

where \( MC_t^{NT} \) is marginal cost at the cost minimizing capital labor ratio. There exists a unit measure of monopolistically competitive non-traded goods firms (indexed by \( i \)) each producing a differentiated good \( a_{i,t}^{NT} \). The total absorption of non-tradable goods is a combination of each of these unique non-tradable goods

\[ A_t^{NT} = \left[ \int_0^1 \left( a_{i,t}^{NT} \right)^{\phi} d_i \right]^{\frac{1}{\phi}} \tag{13} \]

the price, \( p_t^{NT} \), of good \( i \), is given by the inverse demand curve:

\[ \frac{p_t^{NT}}{p_t^{NT}} = \left( \frac{a_{i,t}^{NT}}{A_t^{NT}} \right)^{\phi-1} \]

where the effective aggregate non-tradeable price is an index of non-tradeable prices:

\[ P_t^{NT} = \left[ \int_0^1 \left( p_{i,t}^{NT} \right)^{\frac{\phi}{1-\phi}} d_i \right]^{\frac{1-\phi}{\phi}} \]

Non-tradeable output is produced with the constant returns to scale technology. The profit of firm \( i \) is cost minimizing marginal cost faced by non-traded goods firms is \( MC_t^{NT} \). Non-tradeable firms maximize the value of their profit stream to their owners:

\[ \max E_0 \sum_{t=0}^{\infty} \beta^t \Omega_t \cdot \pi_{i,t}^{NT} \quad \pi_{i,t}^{NT} = (p_{i,t}^{NT} - MC_t^{NT}) \cdot a_{i,t}^{NT} \]
In our Benchmark model, non-tradable firms have sticky prices as in Calvo [7] or Yun [44]. In each period \( t \), a fraction of the firms \( 1 - \kappa \) are able to reset their prices. Prices of the remaining firms is fixed. Define \( P_{t}^{NT} \) as the price chosen by price setters. Prices evolve according to:

\[
P_{t}^{NT} \frac{\phi}{\phi + 1} = \kappa \cdot (P_{t-1}^{NT}) \frac{\phi}{\phi + 1} + (1 - \kappa) \cdot (P_{t}^{NT}) \frac{\phi}{\phi + 1}
\]

(14)

Define \( Z_{t} = \Omega_{t}^{1/\phi} P_{t}^{NT} \frac{\phi}{\phi + 1} Y_{t}^{NT} \), then the optimal price chosen is:

\[
P_{t}^{NT} = \frac{1}{\phi} \frac{E_{t-1} \sum_{j=t}^{\infty} \beta^{j} \cdot \kappa^{j-t} \cdot Z_{j} \cdot MC_{j}^{NT}}{E_{t-1} \sum_{j=t}^{\infty} \beta^{j} \cdot \kappa^{j-t} \cdot Z_{j}}
\]

(15)

In our FLEX model, prices are flexible so prices are a constant markup over marginal cost.

\[
P_{t}^{NT} = \frac{1}{\phi} \cdot MC_{t}^{NT}
\]

In aggregate,

\[
\int_{0}^{1} a_{t}^{NT} \, di = Y_{t}^{NT} \quad \int_{0}^{1} \pi_{t}^{NT} \, di = \Pi_{t}^{NT}
\]

8.1.5 Equilibrium

Define information sets \( \Psi_{t} \) as the history of all shocks up to time \( t \) along with a money supply rule. An equilibrium is a set of quantity functions \( C_{t} (\Psi_{t}) \), \( I_{t}^{T} (\Psi_{t}) \), \( I_{t}^{NT} (\Psi_{t}) \), \( A_{t}^{T} (\Psi_{t}) \), \( A_{t}^{NT} (\Psi_{t}) \), \( Y_{t}^{T} (\Psi_{t}) \), \( Y_{t}^{NT} (\Psi_{t}) \), \( H_{t}^{T} (\Psi_{t}) \), \( H_{t}^{NT} (\Psi_{t}) \), \( K_{t+1}^{T} (\Psi_{t}) \), \( K_{t+1}^{NT} (\Psi_{t}) \), \( D_{t} (\Psi_{t}) \) and price functions \( P_{t}^{T} (\Psi_{t}) \), \( P_{t}^{NT} (\Psi_{t}) \), \( P_{t}^{D} (\Psi_{t}) \), \( W_{t} (\Psi_{t}) \), \( R_{t}^{T} (\Psi_{t}) \), \( R_{t}^{NT} (\Psi_{t}) \), \( d_{t} (\Psi_{t}) \), \( S_{t} (\Psi_{t}) \), \( r_{t}^{CC} (\Psi_{t}) \) that (1) solve the firm, household and foreign banks optimization problems (i.e. are consistent with the first order conditions); (2) supply of non-tradeables must equal demand, \( \int_{0}^{1} a_{t}^{NT} \, di = Y_{t}^{NT} \); (3) the Law of One Price holds for tradable goods
Let us denote the foreign nominal price of the traded good by \( P_t^F \), and let \( \frac{P_t^F}{S_t} \) be the foreign real price of the traded good. Then, the demand for labor in period \( t \) is given by \( n_t = H_t \frac{P_t^F}{S_t} \), where \( H_t \) is the labor supply. The demand for labor equals the labor supply, so that \( H_t = H_t^T + H_t^{NT} \).

In our model, the only source of uncertainty will come from the possibility that in some periods the debtor country will be forced to overborrow in order to maintain an available pool of liquid assets. Conceptually, we think of such an outcome as occurring in the immediate aftermath of a financial panic. In the aftermath of a maturity mismatch related panic we will assume that foreign lenders will believe that the possibility of another financial panic is sufficiently high that they will require borrowers to implement investment plans which avoid that likelihood. As Cooper and Ross [18] demonstrate, an optimal way of implementing a panic preventing plan that would require the debtor to hold some funds in liquid non-interest earning assets. As such, we model the aftermath as a period of time when our liquid funds shock is positive. We assume then that \( \beta \) takes on values equal to either 0 or 1, the minimum share of liquid funds necessary to prevent further capital panics. Funds implement the panic preventing plans for \( N \) periods following the emergence of the possibility of panic.

### 8.1.6 Calibration

We solve a numerical approximation to this problem, near a steady state, using techniques outlined in Sims [40] and King and Watson [28]. A number of parameters are calibrated according to standard values from the dynamic, stochastic computable general equilibrium literature while others are calibrated according to Malaysian data. The real world interest rate is assumed to be 4% per year; the time discount rate is its inverse. The coefficient of risk aversion, \( \sigma \), is set at 2, as in Backus, Kydland and Kehoe [1]. As regards labor supply, we use the parameterization of Christiano, Eichenbaum and Evans [15] that \( \psi = 1 \); we set \( \Gamma \) such that steady state hours are normalized to 1. The average depreciation rate of capital is assumed to be 10% per year (\( \delta = .025 \)). A financial panic in this model will induce a large sectoral switch of resources from the
tradable to the non-tradable sector. A key determinant of the real effects of the financial crisis is the speed with which capital stocks, labor supply, and prices respond to shocks. This will be governed primarily by the size of the adjustment costs of these variables. Since specific estimates are not available for these series for Malaysia, we use a general rule of calibrating these parameters on the basis of studies of the United States. Cogley and Nason [16], use a labor adjustment cost implying a 1% increase in the labor force costs .36% of real output following estimates by Shapiro. For the US, Gali and Gertler [24] estimate $\kappa = .8$, consistent with prices changing on average every 5 quarters. Following Bernanke, Gertler and Gilchrist [3], we set capital adjustment costs such that the elasticity of investment with respect to Tobin's $q$ is 4. Zimmerman [45] reports that elasticities of substitution in computable general equilibrium aggregators are typically set between .5 and 1.5; we assume the elasticity of substitution between tradeable and non-tradeable is .5. We normalize the steady state real exchange rate to be equal to 1.

Other parameters are estimated directly from Malaysian data. On average, Malaysian output can be roughly split into equal shares of tradable and non-tradable goods. We set to approximate this split in steady state. We assume that the steady state foreign debt is approximately equal to quarterly GDP; this reflects the size of Malaysian debt to banks from Bank for International Settlements data. We set $1 - \theta_T = .31$, reflecting labor’s average share of income in Malaysian manufacturing as recorded by UNIDO Industrial Statistics [43]. We set $\theta_{NT}$ so that labor’s share of total income is 50%. We base our estimates of estimate the consumption and income elasticities of money demand directly from an M2 money demand regression for Malaysian data. We set $a$ such that the consumption velocity of M2 is 1.73, the mean observed in Malaysia. We assume that Malaysian government spending is equivalent to 10% of GDP in steady state.

We calibrate the post-crisis period as 10 consecutive periods when effective real interest rates rise by 300 basis points. This calibration reflects the idea that in the immediate periods following a crisis, when panic is still in the air, remaining debt would
be restructured in such a way that it would be immune to a liquidity crisis. One way this immunity could be achieved would be by requiring debtors to keep some of their funds in high liquidity low return assets, reducing the net return that could be obtained and effectively raising the cost of capital in Malaysia. Indeed, after spiking at annualize rates 1200 basis points above Treasuries, benchmark US dollar debt issued by Petronas stayed at a rate close to 300 basis points above Treasuries at least through the 3rd quarter of 1999. This would imply that \( I^f = .0075 \) and \( N = 10 \).

References


[29] Krugman, Paul “Balance Sheets, the Transfer Problem, and Financial Crises,” Mimeo. MIT.


Figure 1: The Dynamics of Detrended Malaysian GDP and Expenditure.

Figure 2: Response of Prices to a Liquid Reserves Shock Under Fixed Money Supply
Figure 3: Response of Quantities to Liquid Reserves Shock under Fixed Money Supply

Figure 4: Response of Prices to a Liquid Reserves Shock under Fixed Exchange Rates.
Figure 5: Response of Quantities to a Liquid Reserves Shocks Under Fixed Exchanges Rates

Figure 6: Response to a Permanent Increase in the Money Supply
Figure 7: The Dynamics of Sectoral Production and Nominal Prices over the East Asian Crisis
Figure 8: Dynamics of Industrial Production in Certain Sectors Over the Asian Crisis

Figure 9: Dynamics of Effective US Dollar Rates
Figure 10: Dynamics of Certain Capital Flows in Pre- and Post-Crisis Malaysia