Monetary Policy in Illiquid Markets: Options for a Small Open Economy

Edda Claus[+], Mardi Dungey[%+], and Renée Fry[+%*]
[+]Centre for Applied Macroeconomic Analysis,
The Australian National University
Canberra, ACT 0200, Australia

[%]Cambridge Endowment for Research in Finance,
University of Cambridge
Cambridge CB2 1 AG, UK

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Abstract

Two impediments to effective monetary policy operation include illiquidity in bond markets and the move towards the zero bound of interest rates. Either or both of these scenarios have been evident in many countries in the last decade, raising the suggestion that alternative means of enacting monetary policy may be required. This paper empirically explores policy options implemented through equity and currency markets that will generate similar inflation responses at a short (2 year) and a long (10 year) time frame as those obtained under current arrangements. The results show that current monetary policy arrangements are least costly in terms of the output loss from achieving lower inflation outcomes. However, if this option ceases to be available the next best alternative is to use the equity market option provided a longer run focus is maintained. Focus on short horizons increases the longer term output costs of the policy in all cases.

Key words: monetary policy alternatives, illiquid markets, liquidity trap, zero bound interest rates, latent factors, structural VAR

JEL Classification: E52, C51

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[*]Corresponding Author: Edda Claus: email edda.claus@anu.edu.au. Dungey and Fry acknowledge funding from ARC grant DP0343418.

1 Introduction

Macroeconomic stabilization through monetary policy may be compromised as interest rates approach their lower bound or if there is illiquidity in bond markets. In recent history several countries have found themselves in one or both of these positions, including the US, the UK, Australia and Canada. A lack of supply of new sovereign paper following debt paydowns associated with budget surpluses around the turn of the century prompted a first wave of research. Although this issue abated post 2001, it was quickly followed by concern about the ability to provide sufficiently stimulatory monetary policy in a low nominal interest rate, low inflation rate environment. As nominal interest rates in some countries approach the zero bound, and with real interest rates also falling, there is some unease that liquidity constraints as experienced by Japan in the last decade may be realised in other countries. There is general agreement that alternative assets could be used to implement monetary policy decisions (although it is acknowledged that there may be technical impediments to overcome). Most of the literature has thus far focussed on the US and Japan. This paper examines the empirical implications of using alternative asset channels to enact monetary policy focussing particularly on the issues facing small open economies. The alternative asset markets considered are equity and currency markets.

Appropriate means of providing effective monetary policy when faced with potential liquidity constraints centre around whether open market operations are able to provide sufficient stimulation to the economy; see for example King (1999), and for analysis of the difficulties of macroeconomic stabilisation in a low interest rate environment see Reifschneider and Williams (2000) and Sims (2005). Some authors and policy makers argue that alternative mechanisms for implementing monetary policy are needed, and suggest the use of markets such as long term Government bonds, increased asset bases for repurchase agreements and increased trade in Government Sponsored Enterprise (GSE) markets; see Greenspan (2003), Federal Reserve Board (2003), McGough et al (2005), Reinhart and Sack (2000), Ambrose and King (2002), and Bernanke (2000) for examples.[1] Other authors argue against such ideas, as in Woodford (2005) and indeed argue that open market operations will continue to be effective even in a liquidity constrained environment; Auerbach and Obstfeld (2004, 2005). Most of this research is based around a closed economy model, and given the Japanese experience, open economy suggestions to alleviate the problem such as intervention in currency markets,

[1] In addressing Congress Greenspan (2003:p6) stated that "[T]he Federal Reserve has been studying how to provide policy stimulus should our primary tool of adjusting the target federal funds rate no longer be available".

and the potential for purchases of non-domestic currency denominated assets have been put forward; see Svensson (2003), Bernanke and Reinhart (2004), Coenen and Weiland (2003), Meltzer (2001), McCallum (2000, 2001), and Krugman (2000) and for an instance, the use of foreign exchange swaps described by Edey and Ellis (2002).

The problems with implementing monetary policy in a thinning bond market include potential instability in the macroeconomic environment; see Schreft and Smith (2002). To effectively implement policy, a central bank must have access to a liquid and deep asset market. Open market operations must be feasible without creating liquidity shortages or oversupply in the market; see Board of Governors of the Federal Reserve System (2005). Further a central bank needs access to a market whose assets can provide an anchor for other financial prices. This is generally domestic government bonds, but an international financial instrument could potentially fulfill this role. The depth and liquidity of the market should be such that the central bank can operate without distorting credit allocation decisions rather than just influencing decisions as is the case with traditional implementation of monetary policy. Kohn (2002) suggests that in thinking of alternative assets, opinion is divided between those who would prefer to maintain the liquidity feature and those who stress the importance of not perturbating credit allocation. Eggertsson and Woodford (2004) maintain that the credit allocation distortion is likely to be "tiny". Reinhart and Sack (2000) argue that trading in equity markets may meet these requirements.

From an operational viewpoint, neither the instrument through which monetary policy is enacted nor the portfolio the central bank holds is relevant (BIS, 2001, and Broaddus and Goodfriend, 2001), and the problem may be that there are many alternatives rather than too few; Kohn (2002). The discussions of alternative assets are often hampered by implementation and regulatory issues. These are particularly pronounced for the Federal Reserve System; see Small and Clouse (2004). Other countries exploring these issues may not face such restrictions or may be able to repeal them.

The problems outlined here affect a number of small open developed economies. Australia, Canada, Denmark, New Zealand, and Sweden, for example, have all experienced issues associated with budget surpluses used to reduce government debt equity and periods of low nominal interest rates. This paper investigates potential scenarios for enacting policies to control inflation through alternative asset markets for a small open economy. The issue is illustrated using an empirical structural vector autoregression (SVAR) model of the Australian economy. The Australian economy is experiencing both conditions of sustained budget surpluses and low interest rates, whereby if current trends continue, alternatives to traditional monetary policy may need to be considered.

Australian policy makers have focussed on both of these issues; see the Commonwealth Treasury (2002) about operating monetary policy through the declining government debt market, and MacFarlane (2002) for returning monetary policy settings to a higher nominal ('neutral') interest rate. In addition, Australia faces the problems of many small open economies that whilst there is a developed and relatively liquid sovereign government debt market, the GSE equivalent and corporate debt markets are still relatively small, but the equity market has greater liquidity.

The analysis is conducted through simulations of macroeconomic outcomes of using alternative asset markets to implement inflation control policies, and are similar in intent to those recently carried out in the Pesaran, Smith and Smith (2005) VAR based investigation of output and inflation outcomes under the scenario that the UK had joined the Euro. The small open economy nature of the model means that it is important to control for international financial conditions, as domestic monetary policy can only be effective on the component of domestic financial markets not driven by outside conditions. For this reason indicators of international financial conditions are constructed and incorporated into the model. These indicators are extracted from a variety of international financial series, namely short term interest rates and real equity indices, and control for the common effects of international financial conditions.

This paper proceeds as follows: Section 2 outlines an empirical model of monetary policy in a small open economy. This section specifies the domestic and international components of the model and outlines the tools through which the analysis is conducted. Section 3 provides three options through which monetary policy can be conducted; the interest rate channel, the equity market channel and the currency market channel. Initially the analysis focusses on current outcomes for inflation and gross domestic product (GDP) under the status quo of operating monetary policy through the interest rate. This model is referred to as the benchmark model. Sections 3.2 to 3.4 provide the results of the simulation experiments. The results indicate that the equity market operation of monetary policy is the least costly alternative to the economy if a long run focus is taken. Concluding comments are provided in Section 4.

2 An Empirical Model of Monetary Policy in a Small Open Economy

The core of the empirical model to examine alternative options for monetary policy in the small open economy of Australia draws on the SVAR and Kalman filter methodologies. The model is conceptually separated into the two components of a domestic and an international sector. Although the focus here is not specifically to examine the international dimensions of the problem, the small open economy nature of Australia requires that this sector be rigorously modelled, particularly since the alternative asset markets considered for monetary policy are affected by international conditions.

The domestic model is drawn from Dungey and Pagan (2000) which has proved to generate stable results for estimations of the Australian economy since its inception in 1997. Recently, this model has been shown to have a direct analog with the theoretical structure of a New Keynesian dynamic stochastic general equilibrium model, see Dungey and Pagan (2006). The model comprises 6 domestic economy variables, the Australian ASX200 equity index deflated by the consumer price index (CPI) which is referred to as domestic investment conditions (AUQ), gross national expenditure (GNE), gross domestic product (GDP), quarterly consumer price inflation (INF), the short term interest rate (CASH) and the real trade weighted exchange rate (TWI); the inclusion of both GNE and GDP allows specific incorporation of balance of payments effects.[2] In Dungey and Pagan (2000) a small SVAR of the US economy represented the international sector. Here the international sector is represented by US GDP (USGDP), Australian exports (EXP), an indicator of global monetary conditions, F^R, and an indicator of global investment conditions, (F^Q). The construction of F^R and F^Q is through the use of the Kalman filter and builds on Fry (2004) who uses similar techniques to construct indicators of international aggregate demand and liquidity as conditioning information in a SVAR. Issues surrounding the financial market indicators and what they may represent are discussed in Section 2.1 below. Structural changes and data frequency in the Australian economy make the appropriate estimation period cover from 1979Q1 to 2004Q3 using quarterly data. Each of the variables except the inflation rate are detrended and US GDP, exports, domestic investment conditions, GNE, GDP and the trade weighted exchange rate are in logs; plots of the data are presented in Appendix A.

The structural form of the SVAR of order two is specified as

$$B_0 Z_t = B_1 Z_{t-1} + B_2 Z_{t-2} + \varepsilon_t, \tag{1}$$

[2]The data sources are as detailed in Dungey and Pagan (2000) with the exception that in the original application the AUQ variable was constructed with the Australian All Ordinaries index, which has now been superseded by the ASX200 index. Additionally, the Australian consumer price index series has been adjusted for the effects of the introduction of the Goods and Services Tax in June 2000 using the figures calculated by Econtech which are available from the Business Council for Tax Reform (BCTR) at (http://www.bctr.com.au).

where Z_t is the vector of variables

$$Z_t = \left[F_t^R, F_t^Q, USGDP_t, EXP_t, AUQ_t, GNE_t, GDP_t, INF_t, CASH_t, TWI_t\right]'. \qquad (2)$$

The parameters are contained in the matrices B_i, $i = 0, 1, 2$ and the structural error term is given by ε_t where $\varepsilon_t \sim N(0, D)$. The model is overidentified, using the standard Wold ordering of the contemporaneous variables with additional restrictions imposed on the contemporaneous and lagged relationships between the endogenous variables following Dungey and Pagan (2000). Within the domestic component of the model restrictions are imposed to represent the lagged effects of monetary policy changes on GNE, GDP and inflation, and to restrict the interest rate reaction function to resemble an open economy Taylor rule. These restrictions translate into zero elements in the three coefficients matrices, B_0, B_1, and B_2. Table (1) summarises the restrictions imposed on these matrices.

The three international variables are exogenous to the domestic system in accordance with the small open economy assumption, and they are also exogenous amongst themselves. USGDP follows an AR(2) process while the international financial conditions indicators evolve as AR(1) processes, reflecting the lower lag structure of financial variables, as well as the optimal structure of the indicators as explored in the next section. The model in equation (1) was estimated by ordinary least squares in Gauss version 5.0. The results of the estimation of the SVAR model are discussed in Section 3 in terms of the impulse responses of the system.

2.1 International Financial Conditions Indicators

Domestic variables in a small open economy are a function of both international and domestic conditions. The small open economy assumption implies that monetary policy can only affect domestic conditions. To separate domestic and international influences, indicators of common international financial market movements are constructed for inclusion in the SVAR model. The global monetary conditions indicator is extracted from short term interest rates of a selection of major financial markets, while the global investment conditions index is extracted from consumer price deflated equity indices for the same markets. This can be interpreted as a form of Tobin's Q.

The major financial markets are those of the US, the UK and the Euro area. Japanese conditions are arguably important, but experimentation revealed them to make no substantive difference to the results reported here. The data comprise three month interest rates for each region, and the S&P500, FTSE100 and DAX30 equity

Table 1: SVAR contemporaneous and lagged relationships

Depend. variables	explanatory variables									
	international sector			domestic sector						
	F^R	F^Q	$USGDP$	EXP	AUQ	GNE	GDP	INF	$CASH$	TWI
				contemporaneous structure						
F^R	1									
F^Q		1								
$USGDP$			1							
EXP	$\bullet$	$\bullet$	$\bullet$	1						
AUQ	$\bullet$	$\bullet$	$\bullet$		1					
GNE					$\bullet$	1				
GDP	$\bullet$	$\bullet$	$\bullet$		$\bullet$	$\bullet$	1			
INF						$\bullet$		1		
$CASH$						$\bullet$		$\bullet$	1	
TWI	$\bullet$	$\bullet$	$\bullet$		$\bullet$	$\bullet$	$\bullet$	$\bullet$	$\bullet$	1
				lag structure						
F^R	$\star$									
F^Q		$\star$								
$USGDP$			$\circ$							
EXP	$\circ$	$\circ$	$\circ$	$\circ$						
AUQ	$\circ$	$\circ$	$\circ$		$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$
GNE					$\circ$	$\circ$	$\circ$	$\circ$	$\ddagger$	$\circ$
GDP	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\ddagger$	$\circ$
INF						$\circ$		$\circ$		$\circ$
$CASH$						$\circ$		$\circ$	$\circ$	$\circ$
TWI	$\circ$	$\circ$	$\circ$		$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$

A $\bullet$ represents the inclusion of an explanatory variable in the contemporaneous structure. A $\star$ represents the inclusion of lag 1 only, a $\circ$ represents the inclusion of lags 1 and 2, while a $\ddagger$ represents the inclusion of just lag 2 in the lag structure of the model.

market indices deflated by the relevant CPI. The use of the German DAX30 as representative of the Euro area is supported by research into representing Euro area financial variables with German data by Brüggemann and Lütkepohl (2004, 2005).[3]

The Kalman filter is applied to extract the two financial market indicators, F_t^R and F_t^Q. The state-space representation with a first order autoregressive state equation for international interest rates is given by

$$Y_t^R = \lambda^R F_t^R + \eta_t^R \tag{3}$$

and

$$F_{t+1}^R = \phi^R F_t^R + \varpi_{t+1}^R, \tag{4}$$

where $Y_t^R = \left[Y_t^{R,US}, Y_t^{R,UK}, Y_t^{R,EU}\right]'$ is a vector containing short term interest rates of the US, the UK, and the EU while the vector λ^R contains the factor loadings.[4] ϕ^R is the autoregressive parameter loading, and η_t^R and ϖ_t^R are error terms with standard properties.

A similar structure is used to extract the international equity investment indicator, F^Q, where $Y_t^Q = \left[Y_t^{Q,US}, Y_t^{Q,UK}, Y_t^{Q,EU}\right]'$ is a vector containing real equity indices of the US, the UK, and the euro zone and the vector λ^Q and ϕ^Q contain the factor and the autoregressive parameter loadings. Maximum likelihood estimation is undertaken using the MAXLIK procedure implemented via the BFGS algorithm in Gauss version 5.0.

Figure (1a) plots the extracted factor F_t^R, denoted the global monetary policy indicator over the sample period. Five major economic periods emerge. The first is a period of global stagflation with low output growth combined with high inflation following the oil price crisis, ending in the figure in 1987Q3. This period was challenging for monetary policy as revealed by the frequent and often large swings in global monetary policy conditions.

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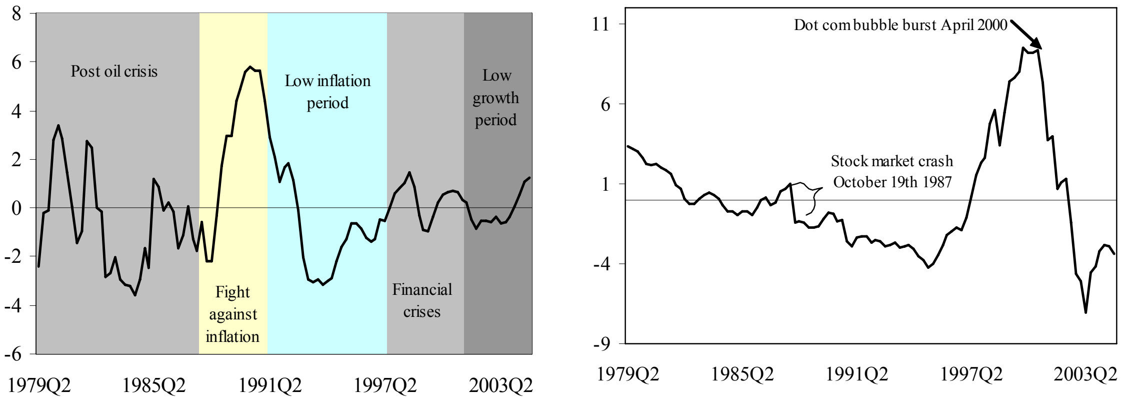
[3] The short-term interest rates are represented by the 3-month Treasury bill rates from the US and the UK and 3 month interbank rates for the Euro area from the EABCN database detailed in Fagan, Henry and Mestre (2005). The equity market indices are the S&P500 deflated by the US consumer price index, the UK FTSE100 deflated by the UK consumer price index, and the DAX30 deflated by the German consumer price index. The series used in construction of the global investment factor are from the IFS database.

[4] Specification tests on estimating the state space equations separately for each global factor revealed a preferred autoregressive structure of 2 lags for the global monetary policy proxy and 1 for the global investment conditions indicator. When estimated, jointly, however, the model was unstable with 2 lags, with the instability mainly coming from the global investment conditions factor. This suggests joint estimation at 1 lag as appropriate. Additionally the univariate properties of financial data support a relatively short autocorrelation structure, for further details see Claus (2006).

Figure 1: Global monetary policy and investment conditions

a) Monetary policy b) Investment



The second period in the figure runs from 1987Q4 to 1991Q1 and reflects the global fight against inflation by central banks. Generally high interest rates prevailed as reflected in the indicator. Once high inflation was eradicated in developed nations, global monetary conditions were looser as shown in the third period of the figure. The low inflation period runs from 1991Q2 to 1997Q2. It encompasses the rebound of the world economy from the early 1990s slow-down and ends in the quarter prior to the onset of the Asian financial crisis in July 1997. Despite robust growth of the world economy, monetary policy conditions were loose for most of the period.

The fourth period is one of financial crises, namely the Asian crisis beginning in the third quarter 1997, the Russian crisis starting in the second quarter of 1998, and the bursting of the dot-com bubble in April 2000. The period runs to 2001Q2. Global monetary conditions somewhat tightened in part of this period. As the US dollar started appreciating strongly in the immediate aftermath of the crises, concerns arose that low domestic currency values would translate into higher domestic prices. The somewhat tighter global monetary policy conditions may also reflect the lack of liquidity which was characteristic of this period. As global growth slowed and inflation remained subdued, conditions were loose or neutral.

The fifth major economic period is characterized by low global growth. Global growth remained subdued following the crises period and is reflected by neutral monetary policy conditions. However, the rebound of economic activity and some concerns about inflation toward the end of the sample can be seen in the figure by the tightening in monetary policy conditions.

Figure (1b) plots the extracted factor F_t^Q, denoted the global investment indicator.

The figure suggests two distinctively different periods for global investment conditions. In the first period from the late 1970s to the mid 1990s, global investment conditions were soft and declining throughout most of those years. The second period from the mid 1990s to the early 2000s, is marked by a boom followed by an equally large decline after the turn of the millennium. The figure also highlights the equity market crash of 19 October 1987 when the New York equity exchange experienced its largest percentage fall on record and the dramatic bursting of the dot-com bubble in 2000.

2.2 Tools for Assessing Monetary Policy Options

As alluded to in the introduction, three alternative asset markets are proposed as candidate alternatives to implement monetary policy. Section 3 examines the relative merits of each of these markets, namely the bond (cash rate), the equity market and the currency market. To assess the relative merits of these markets, four tools are utilised. These are impulse response functions, historical decompositions, pure effects measures and simulation techniques.

2.2.1 Impulse Responses and Historical Decompositions

Impulse response functions can be used to represent the composition of the effects of shocks to a particular observed variable, and is one of the main tools used in the analysis to follow. Using the standard moving average representation of the reduced form of equation (1), any variable $z_t^h \in Z_t$ can be constructed from the weighted errors of the system, where the weights are given by the impulse response functions. Here $c_{k,j}$ identifies the j^{th} impulse response to the k^{th} innovation, $e_{k,t}$ such that

$$z_t^h = \text{initial conditions} + \sum_{j=0}^{t-1} \sum_{k=1}^{10} c_{k,j} e_{k,t-j} \ . \tag{5}$$

The (small) initial condition is usually ignored in the analysis. A useful analytical tool is a further rearrangement of the moving average representation to form a historical decomposition. The historical decomposition utilises the information from the impulse response functions to report the contribution of the shocks in each equation to the composition of the observed final outcome for a particular endogenous variable.

2.2.2 Extracting pure effects

Traditional impulse response analysis takes into account not only the impact of the original shocks, but also feedback responses from other variables given the initial shocks.

To extract a measure of the impact of pure shocks which are purged of feedback effects, the SVAR can be simulated whilst suppressing these effects. The advantage of this technique is that the historical contribution of the pure impacts from the key monetary policy candidate variables to GDP can be considered.

The parameter estimates from equation (1) are used to simulate the system, but the estimates in the equation for the variables to be suppressed are set equal to zero, apart from their own autoregressive coefficients (as estimated from the SVAR). The pure effect of each variable z_t^h on the relevant endogenous variable in the system can be determined by evaluating the difference between the impulse responses for the original system (given by $c_{k,j}$) and the system with suppressed feedback effects (given by $d_{k,j}$), and then adding the own effects of the shocked variable, $d_{h,j}$. This expression denoted IX_t^h is as follows,

$$IX_t^h = \sum_{j=0}^{t-1} d_{h,j} e_{h,t-j} + \sum_{j=0}^{t-1} \sum_{\substack{k=1 \\ k \neq h}}^{10} \left(c_{k,j} - d_{k,j} \right) e_{k,t-j}. \tag{6}$$

In Section 3 the pure effects on GDP (IX_t^h) are calculated for each of $h =$ CASH, TWI and AUQ. Each simulation is undertaken separately. Dungey and Pagan (2000) call IX^{CASH} the Monetary Policy Indicator.

2.2.3 Simulation techniques

To assess the relative merits of alternative asset markets for monetary policy implementation, simulations are conducted where a shock to an alternative asset is imposed such that it produces a similar inflation profile to that observed in the model under standard monetary policy. In intent the method is similar to that of the Pesaran, Smith and Smith (2005) global VAR model where the SVAR is simulated to produce outcomes for a range of variables under the maintained hypothesis that the UK adopts the Euro as its currency. The observed values of the Euro exchange rate are maintained in the simulations and interest lies in the deviations of other variables in the system which would allow this path to be observed. In the experiments here the interest lies in obtaining similar inflationary outcomes to those observed from monetary policy conducted via the cash rate in the estimated model.

Two styles of experiment are conducted. The first style constructs a policy tightening in an alternative asset that produces a profile for inflation similar to that of a tightening of the cash rate in the short term (the first eight quarters). The second experiment considers a tightening via an alternative asset market which produces a similar cumulative inflationary impact.

To implement the experiments, the monetary policy reaction function is suppressed as in equation (6) and the shock to the alternative monetary policy variable is calibrated so that it has a similar impact on domestic CPI inflation as a one unit shock to the cash rate equation in the original system. An integer α is chosen so that the response to an α shock to the alternative financial variable is broadly similar to a one unit shock to the cash rate equation such that

$$\frac{\partial z_{INF,t+s}}{\alpha \partial e'_{Z_t^h}} \approx \frac{\partial z_{INF,t+s}}{\partial e'_{CASH,t}}, \tag{7}$$

for $s = 1, ...8$. This set of experiments is labelled the short run experiments. Corresponding long run experiments are conducted via

$$\sum \frac{\partial z_{INF,t+s}}{\alpha \partial e'_{Z_t^h,t}} \approx \sum \frac{\partial z_{INF,t+s}}{\partial e'_{CASH,t}}, \tag{8}$$

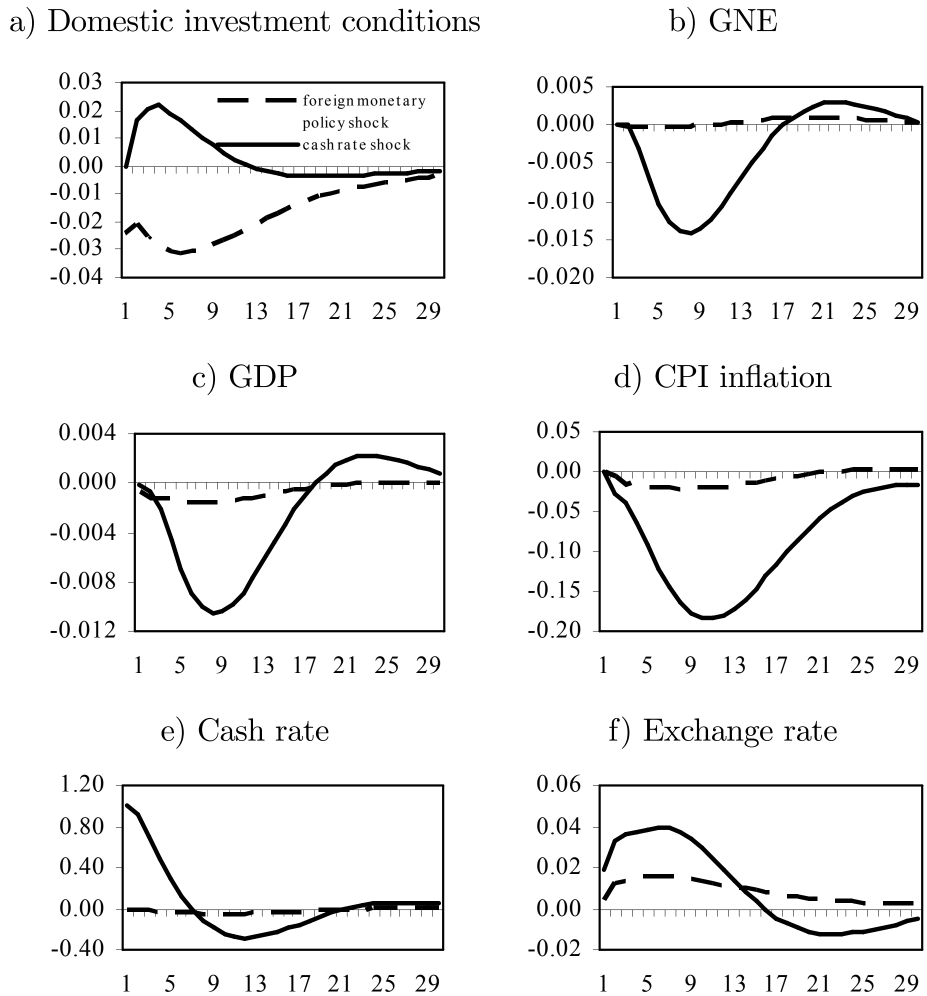
for $s = 1, ...40$, where s is the period over which the calibration is conducted, and Z_t^h is the variable through which the alternative policy shock is enacted. Here the choices for Z_t^h are domestic investment conditions (AUQ) and the exchange rate (TWI).

3 Options for Monetary Policy

3.1 Option 1: Cash Rate (Benchmark)

Before assessing the alternative options for the implementation of monetary policy, the impulse response functions for key shocks are analysed to demonstrate that the model provides a sensible representation of the Australian economy. Particular attention is devoted to analysing the impulse responses to a cash rate shock, as this provides the benchmark for comparing the outcomes from alternative monetary policy options. The benchmark domestic monetary policy shocks are interpreted to be shocks to the cash rate, although there is some debate about the efficacy of this representation; see the debate between Rudebusch (1998) and Sims (1998) on this identification. Historical decompositions are also contemplated to determine the relative impacts of shocks in each variable to outcomes for GDP over the sample period. A similar examination of the pure effects of each shock is also considered. The examination of GDP is important as it provides an effective measure of welfare by which to evaluate the overall impacts of each policy in a comparative sense.

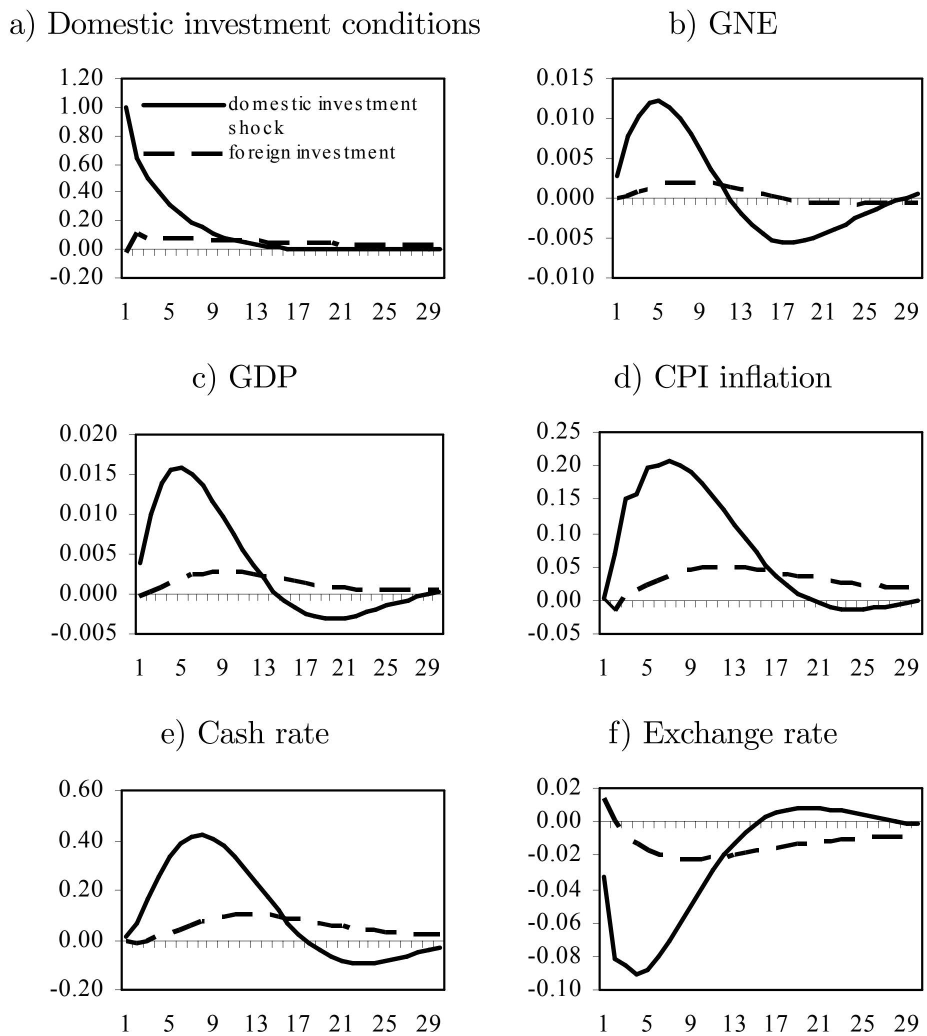
Figure 2: Impulse responses to a domestic and global monetary policy shock



3.1.1 Impulse Responses

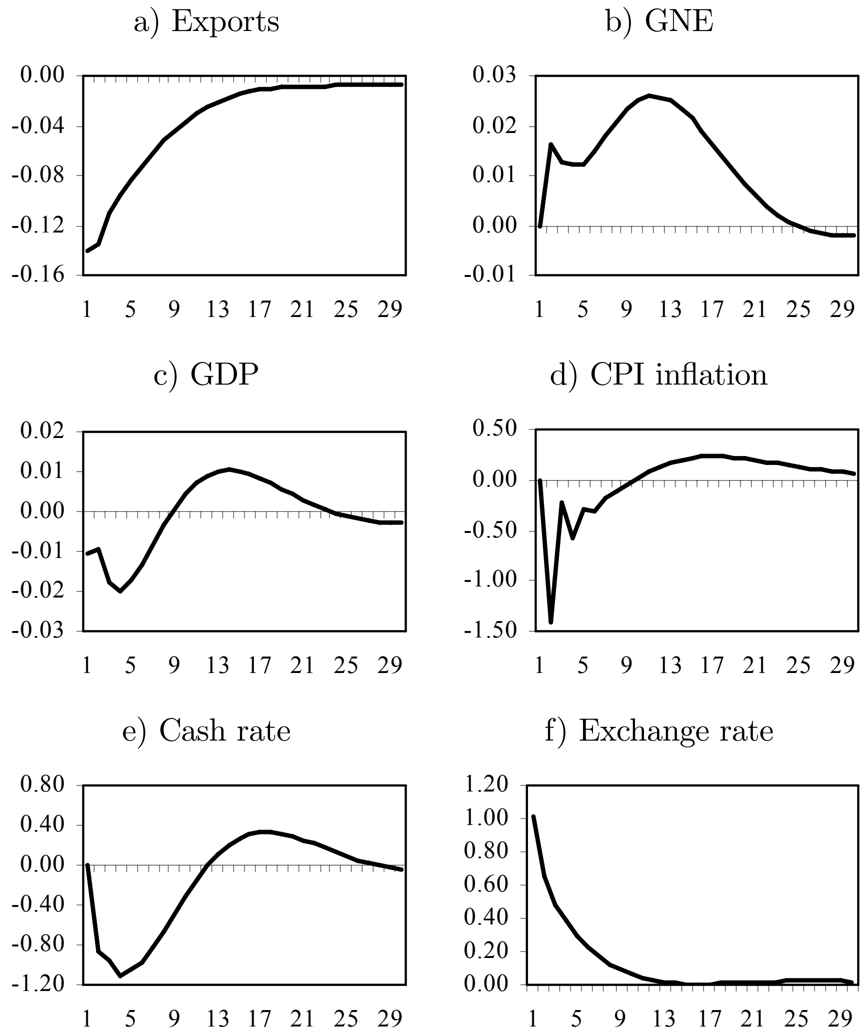
These responses of the domestic economy to the cash rate shock are presented by the solid line in Figure (2). The (benchmark) monetary policy tightening results in lower GNE, GDP and inflation conforming with stylised facts about the effect of tighter monetary policy. There is no evidence of the price puzzle in the model. Domestic investment conditions (AUSQ), expressed in real terms, rise sharply before returning to longer run levels, which is likely due to the fall in inflation generated by the tighter monetary policy. For comparison, the dashed line in the figure presents the equivalent domestic economy responses to a unit global monetary policy shock. The global monetary policy shock is modelled by a positive shock to the error of the F_t^R equation. The relative magnitudes of the impulses show that the Australian economy is primarily responsive to domestic economic conditions. However, the global monetary policy shock tends to put downward pressure on domestic investment conditions, GDP, inflation and the cash rate, and causes an appreciation of the Australian dollar. The key point is that of the Australian variables, domestic investment conditions are most affected by the global shock, and in a negative way. This result emphasizes the importance of controlling for global monetary policy shocks when considering the equity market as an alternative means of operating monetary policy.

Figure 3: Impulse responses to a domestic and global investment conditions shock



Given that one of the options for alternative monetary policy is through the equity market, Figure (3) shows the responses of the domestic economy to unit shocks in the domestic and global investment conditions equations. Responses to the domestic shock are as anticipated, with GNE and GDP responding positively to the more buoy-

Figure 4: Impulse responses to an exchange rate shock



ant conditions. The resulting increase in inflation leads to a tightening of the cash rate. However in real terms, the interest rate falls and the Australian dollar depreciates. The comparative global investment shock in Figure (3) also prompts rises in domestic investment conditions, namely AUQ, GNE, and GDP. Inflation and the cash rate also rise after an initial (almost certainly insignificant) fall; the policy tightening in subsequent quarters reflects the above longer run levels of expenditure, output and inflation. About 10 percent of the shock to global investment conditions spills into the Australian equity market. Assuming a symmetric response for rises and falls, this means that the non-diversifiable equity market risk in Australia is of about this dimension. The depreciation of the Australian dollar reflects higher domestic inflation, and the relative increase in expected output via better investment conditions in the international economy. Again, domestic responses are stronger to the domestic shocks than to the international shocks. The global investment conditions shock appears to have more of an impact on the domestic economy than the global monetary policy shock, which is in line with larger quarterly foreign equity compared to foreign debt flows.[5] the premise that central banks respond only to the domestic economy so there should be little correspondence between global and domestic monetary policy.

Figure (4) shows the responses of variables in the system to a real exchange rate shock. The appreciation leads to a decrease in exports and a decrease in the recorded inflation rate shown in panels (a) and (e) respectively. The higher GNE and lower GDP shown in panels (b) and (c) are consistent with substitution of cheaper imported goods for domestic production. The cash rate is lowered in response to the lower GDP and inflationary outcomes.

3.1.2 Outcomes for GDP

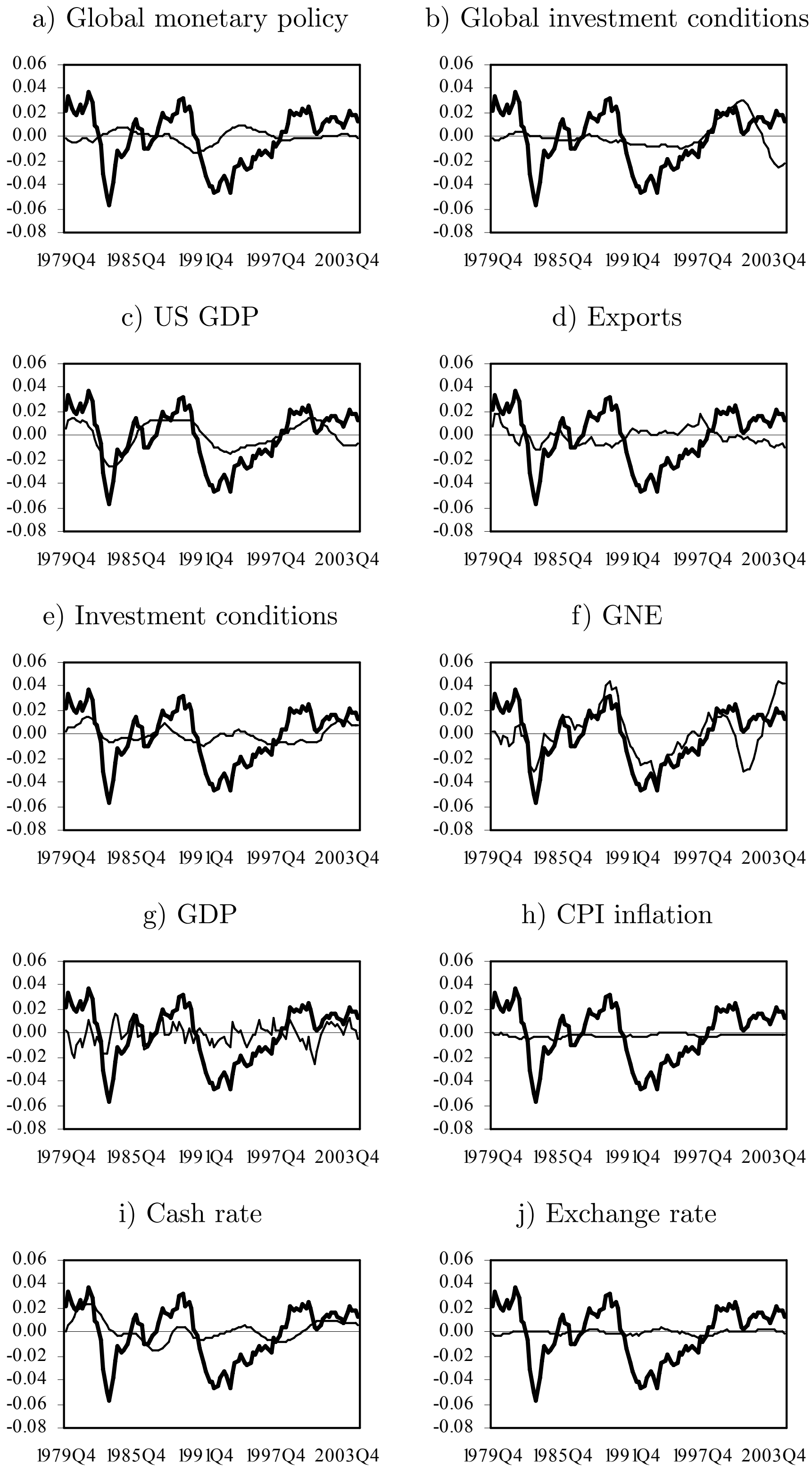
Historical decompositions Historical decompositions reveal the relative importance of financial market developments for the Australian economy over the estimation period. The charts in Figure (5) show the historical decomposition of Australian GDP between 1979Q3 and 2004Q3. The thick line shows Australian GDP while the thin line indicates the contribution of shocks in a nominated variable to GDP. As GDP is expressed in its trend adjusted form, positive values indicate output above longer run levels and negative values indicate below longer run levels of output.

Figure (5) reveals that historically the contribution of the three candidate monetary policy variables to GDP is least for the exchange rate. The contribution of the cash rate and domestic investment conditions is large at various points in time, particularly during the early periods of the sample. Cash rate shocks to GDP outcomes reveals a generally countercyclical contribution, with exceptions around the early 1990s recession (as also reflected in the global monetary policy indicator in Section 2.1) and the late part of the sample where the relatively lower cash rate added to the above average GDP outcomes.

Examination of the three international variables reveals the integration of Australia in the global economy, although domestic demand (GNE) remains the largest contributor to GDP outcomes. US GDP is the biggest contributor of the three foreign variables to domestic GDP except toward the end of the sample when it becomes pro-cyclical.

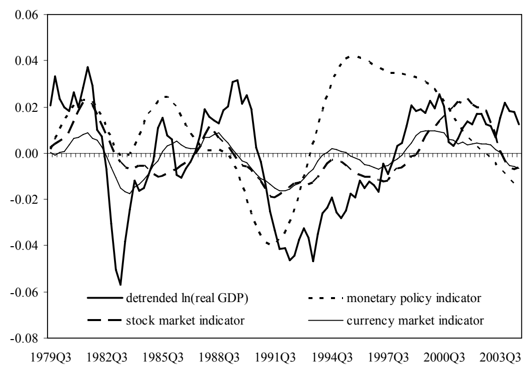
[5] Though the stock of net foreign debt is larger than that of net foreign equity, quarterly foreign equity transactions outweigh foreign debt transactions on average.
Source: Australian Bureau of Statistics (2006).

Figure 5: Historical decomposition of Australian GDP. Thick line - Australian GDP. Thin line - contribution of shocks in variable.



A similar story emerges when comparing global and domestic investment conditions. The contribution of domestic investment conditions is larger than that of global conditions during the 1980s and early 1990s, but the opposite is true for the remainder of the sample. Shocks to global investment conditions are particularly important in the late 1990s and early 2000s. This result provides further evidence for the importance of controlling for global conditions in the model.

Figure 6: Monetary policy, equity market and exchange rate effects



Pure Effects The relative contributions of each variable to GDP in Figure (5) also includes the feedback effects from other variables in the system as discussed in Section 5. The pure reflection of monetary policy is extracted by suppressing feedback effects using the method of equation (6). The thick line in Figure (6) shows Australian GDP. The dashed line shows the effects of cash rate monetary policy on GDP, the dotted line shows the effect of the changes in equity prices and the thin line shows the effects of changes in the exchange rate.

Positive values for the dotted line show periods when monetary policy has added to GDP growth indicating a loose policy stance to boost activity and negative values show the opposite. Values close to the abscissa indicate neutral monetary policy. The pure effects of monetary policy can be classified into four distinct periods and in general is countercyclical. Monetary policy supported growth between 1979 and 1989 and between 1993 and 2003, and detracted from growth between 1989 and 1993, and from 2004 until the end of the sample. However, confirming the historical decomposition analysis, monetary policy detracted from growth between 1990Q3 and 1993Q3, when actual GDP growth was at or below longer run rates.

Figure (5) also shows the pure effects of shocks in domestic investment conditions and the exchange rate on GDP, purged of feedback. The interesting feature of the figure is the detraction from growth of the equity market over most of the 1990s. The effects only became stimulative in 1999Q2 and remained supportive for four years. The stimulative effects reached a peak in 2001Q4 more than a year following the burst of the dot-com bubble. This may be a reflection of the structure of the Australian economy as pointed out by Dungey et al (2004). While the relatively small information and communication technology sector in Australia was seen as a negative in the 1990s, see DeLong (2000), it shielded Australian equity markets and domestic activity from some of the negative effects of the bursting of the dot-com bubble in April 2000. Edison and Sløck (2001) find a higher marginal propensity to consume out of changes in valuation in new economy equities compared to old economy equities.

The figure shows that in general the equity market effects were smaller than those of monetary policy while pure exchange rate effects are less important to GDP than the other shocks. This result is consistent with Goodhart and Hofmann (2000) for Canada, another small open economy.

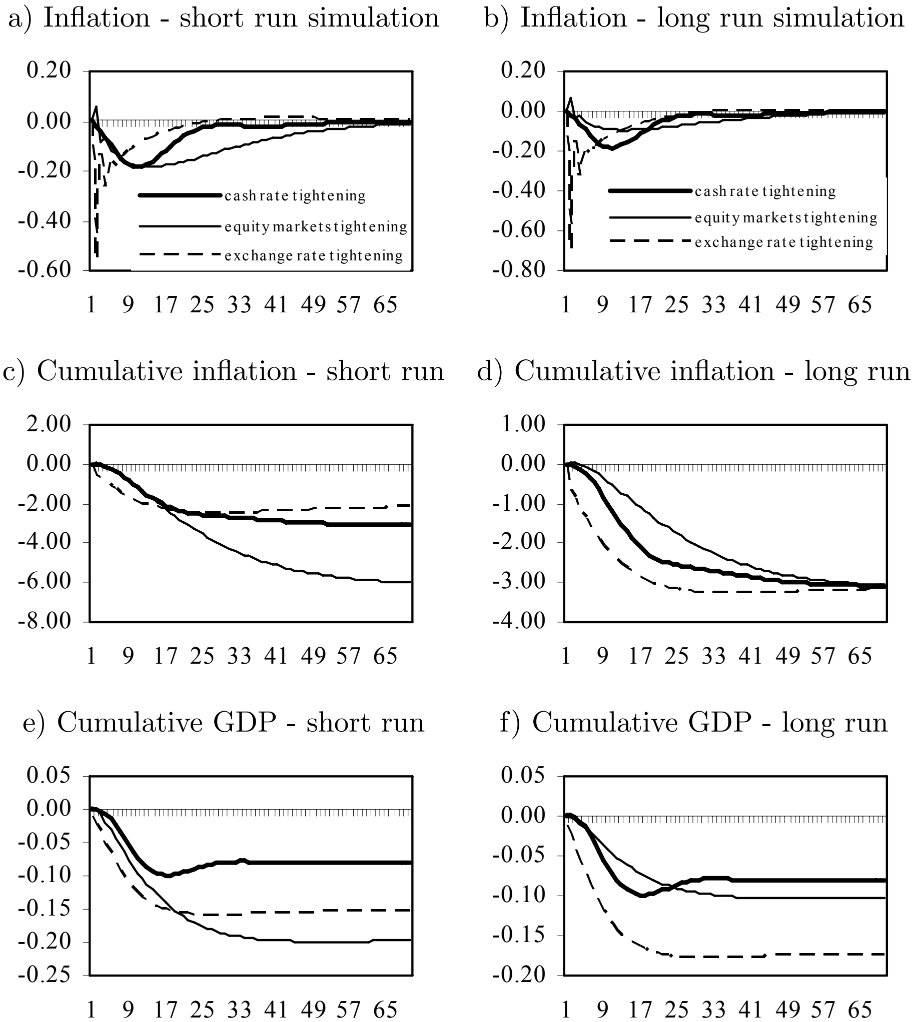
3.2 Option 2: Equity Market

Figure (7) contains the results from the simulations of monetary policy alternatives as outlined in Section 2.2.3. The first column of the figure presents the results for the simulations where inflation scenarios are matched in the short run (that is, the shocks over the first 8 quarters are calibrated so that the responses of inflation are equivalent), and the second column presents the results for the simulations where inflation scenarios are calibrated in the long run (that is over 40 quarters). The first row represents the responses of inflation to the alternative shocks, the second row represents the cumulated responses of inflation (the price level) to the alternative shocks, and the third row represents the cumulated responses of Australian GDP to the alternative shocks. Examination of outcomes for GDP provides a measure of comparative welfare under the alternative scenarios. In all cases, the thick solid line represents the benchmark impulse response function (that is, the responses to a unit cash rate shock), the thin solid line represents the responses to an equity market tightening, and the dashed line represents responses to a currency market tightening.

3.2.1 Short Run

Panel a) of Figure (7) shows that to achieve the same inflation result at 8 quarters as through traditional monetary policy using equity markets as a monetary policy tool, the shock in the equity market has to be about 6 per cent stronger than a shock to the cash rate (that is $\alpha = -1.064$). The thin solid line clearly shows that the response

Figure 7: Impulse responses of inflation, cumulative inflation and cumulative GDP to alternative monetary policy shocks



of inflation to a monetary policy tightening through the equity market is more volatile than that to a tightening through the cash rate in the first year following the change in policy. Inflation rises in the first quarter following the shock. This rise is largely driven by the contemporaneous response of GNE to a change in domestic investment conditions. Such price puzzle effects are often observed in VARs analysing monetary policy and are the subject of much research to overcome them; see, for example, Sims (1992), Hanson (2004) and Giordani (2004).

In cumulative terms (see Figure (7c)) the response of CPI inflation to the equity market and cash rate based tightening is almost identical for the first 15 quarters, then diverges for about 6 years before the difference stabilizes. The difference stabilizes because inflation returns to its longer run level faster following a tightening through the cash rate than a tightening through the equity market. This means that once the economy has returned to equilibrium, the price level following the tightening through the equity market is lower than that following a tightening through the cash rate.

3.2.2 Long Run

The second simulation in Figure (7b) generates a monetary policy tightening through the equity market that has a similar long run effect on consumer price inflation as a cash rate tightening. The results show that to achieve the same long run response, the shock in the equity market has to be about 35 per cent weaker than a shock to the cash rate. This is evident by the thin solid line in Figure (7b) which is generated by a 0.65 unit decrease in the real equity market index ($\alpha = -0.65$). Cumulatively, the effect on CPI inflation is stronger under the cash rate scenario than under the equity scenario, particularly in the short term (see panel d of Figure (7)). However, in the long run the cumulative responses are the same under both scenarios.

3.3 Option 3: Currency Market

3.3.1 Short Run

The inflation response to the short run currency market option for monetary policy as shown by the dashed line in Figure (7a) is much more volatile than the equity and cash rate scenarios. Although after 8 quarters inflation is at the same level across the three experiments, in the initial periods after the currency market shock, the fall in inflation is relatively more dramatic. The value of α generating this response is $\alpha = 0.4$. Potentially the reason for the variability in outcomes for inflation under this scenario is that the equation specifying the exchange rate is the least well specified. In other applications of a SVAR with an underlying structure comparable to Dungey and Pagan (2000), similar difficulties are encountered in effectively modelling the exchange rate; see Dungey and Fry (2003), Fry (2004), and Dungey and Pagan (2006). The other reason for this variability may be that it is in fact more difficult for a central bank to implement policy in such a market which is not only responsive to domestic conditions, but also international conditions.

Cumulating the inflation responses under the short run currency market simulation (Figure 7c) shows that the impact on the price level is initially lower than the other two policy alternatives. However, the cumulated series levels out more quickly, but remains at a higher price level compared with the other asset markets.

3.3.2 Long Run

The simulation where the long run inflation outcomes are calibrated under the currency market option are shown in panel d of Figure (7). To generate this response $\alpha = 0.5$ for the currency market. In the long run simulation, the inflation response to the currency market shock levels out to the equilibrium and remains stable and comparable for the rest of the time over which the impulse response function is plotted.

3.4 Comparison of Options

3.4.1 Outcomes for GDP

The third row of Figure (7) shows the impact of the three alternative tightening scenarios on the cumulated GDP variable, for the short and long run experiments. Under the short run simulations in Figure (7e), the loss in GDP is most pronounced under the currency market option in the first instance, but in the long run the loss is greatest for the equity market option. Eight periods after the initial shock the fall in GDP due to the equity market option is 1.47 times larger than under the cash rate. This fall increases to 1.59 times larger than the cash rate option after 40 periods. Similarly, under the currency market simulation, the fall in GDP is 1.96 times larger than the cash rate option after eight periods, but after 40 periods reduces to 1.25 times more than the cash rate option. The figure clearly shows that over time, the cumulated loss to output is greatest under the equity market option under the short run experiments.

The simulations for GDP in which the long run inflation profile is calibrated is presented in Figure (7f). Under these simulations, the cash rate remains the best option in terms of cumulated losses in GDP. However, the equity market alternative outcomes are better than those under the currency market. After the first 8 periods, the GDP loss due to the equity market is actually better than the cash rate response by a factor of 0.69. However, in the long term (after 40 periods), the scenario is reversed with the loss in GDP due to the equity market being 1.27 percent more than compared to the cash rate option. The loss due to the currency market is again much greater in magnitude than the cash rate response (3.60 and 1.74 times greater than the equivalent cash rate scenario at periods 8 and 40). It is likely that these impulses are statistically indistinguishable when surrounded by their appropriate error bands.[6]

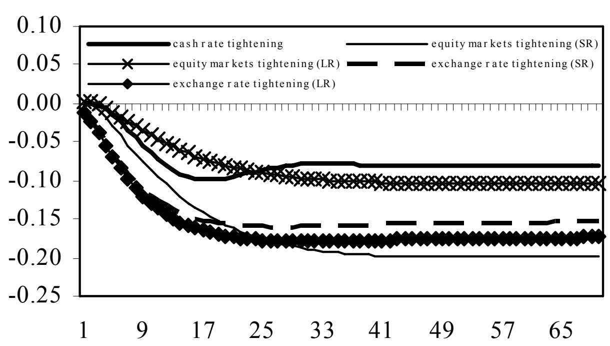
[6] Generating confidence intervals for the impulse responses led to unsatisfactory results. This is not unique to the the SVAR estimated here. Kilian and Chang (2000) demonstrate poor confidence bands for three typical VAR studies and conclude that "the accuracy of confidence intervals for large-dimensional VARs is questionable [...] and [...] that even the best current practise of constructing confidence intervals for impulse responses cannot be considered reliable for large-dimensional VAR

Figure (8) shows the outcomes for cumulated GDP from the set of short and long run experiments together. Over all experiments, the option where equity markets are used to control long run inflationary outcomes is the best alternative strategy in which to operate monetary policy. The impulse responses for the cumulated GDP are relatively close to those as a result of cash rate monetary policy, and is even less recessionary in the shorter term. The three other scenarios appear to follow similar dynamics, with the equity market option targeted at short term inflation the worst performing.

3.4.2 Outcomes for Equity and Currency Markets

To round off the analysis, Figure (9) presents the impulse responses for the alternative monetary policy options in their own market for their own experiments. The figures show that as expected, the cash rate monetary policy shock has the least impact on the equity and currency market. Of the equity market experiments, the impulse response function generated by matching the long term, rather than the short term inflation profile is the least distortionary, although this is only marginal. Despite the marginal nature of the differences between the impulses, this result provides more evidence that operating monetary policy through equity markets with a long term perspective is a better outcome than the other options. In the case of the currency market shown in panel b, the opposite is true, with the impulse response function generated by matching short term, rather than the long term inflationary profile least distortionary.

Figure 8: Cumulative impulses of GDP - all experiments



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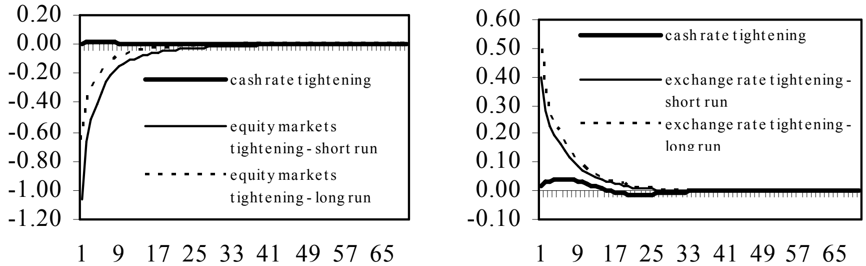
models"; pp. 305-306.

Figure 9: Responses of equity and exchange rate markets to alternative policy shocks.

a) Equity market responses b) Exchange rate responses



4 Conclusion

Reduced issuance of new sovereign debt and low interest rate, low inflation rate environments in many developed economies have provoked interest in alternative assets through which domestic monetary policy aims could be enacted. Although in the US there is a relatively deep secondary market for local and semi-government authorities debt as well as a corporate bond market, this is not the case for many small open economies. A number of options have been proposed in the literature, including operations in domestic equity markets and currency markets. This paper considers the empirical implications of using the equity market or currency market to influence inflationary outcomes compared with the current bond market based approach. The scenarios described are based on a baseline SVAR model of Australia, an economy facing all of these issues. The analysis is in the spirit of the type of VAR based counterfactual analysis recently considered by Pesaran, Smith and Smith (2005) in considering paths of output and inflation if the UK had joined the euro.

The scenario results are based on attempting to achieve the observed decline in inflation at different horizons obtained using a cash rate shock by acting alternatively in the equity market or currency market. The two horizons are relatively short, at 2 years, and long, at 10 years. The outcomes show that in each case the long run cumulated output loss from any alternative is least using the current cash rate arrangements. The next most attractive alternative is the use of equity markets aiming at the long run inflationary outcome. At the 2 year horizon policy enacted through the equity markets aiming at the long run inflationary outcome produces the least output loss for the given inflation outcome. Cash rate based policy is the next least costly. These two policies are clearly the most attractive outcomes considered here in terms of achieving a given reduction in inflation for least output cost. The other options considered, using a shorter target horizon with equity markets or using currency markets produce clearly higher output costs.

The results of this investigation are to conclude that, under the presumption that the operational issues of central bank operations in alternative asset markets can be overcome, the least costly means of achieving a given inflationary outcome such as possible using the cash market is to operate in the equity market based on achieving a longer run inflationary target. Short horizons increase the longer term output costs of the policy in all cases.

References

[1] Ambrose, B.W. and King, T-H. D. (2002), "GSE Debt and the Decline in the Treasury Debt Market", *Journal of Money, Credit and Banking*, 34, 812-839.

[2] Auerbach, A.J. and Obstfeld, M. (2004), "Policies to Deal with Deflation: Monetary and Fiscal Remedies for Deflation", *AEA Papers and Proceedings*, 94, 71-75.

[3] Auerbach, A.J. and Obstfeld, M. (2005), "The Case for Open-Market Purchases in a Liquidity Trap", *The American Economic Review*, 95(1), 110-137.

[4] Australian Bureau of Statistics (2006), *Balance of Payments and International Investment Position*, Catalogue number 5302.0, March 2006.

[5] Bernanke, B. (2000), "Japanese Monetary Policy: A Case of Self-Induced Paralysis?" in R. Mikitani and A. S. Posen, eds., *Japan's Financial Crisis and Its Parallels to U.S. Experience*, Washington: IIE, 149-166.

[6] Bernanke, B. and Reinhart, V. (2004), "Conducting Monetary Policy at Very Low Short Term Interest Rates", *American Economic Review: Papers and Proceedings*, 94(2), 85-90.

[7] BIS (2001), *The Changing Shape of Fixed Income Markets: A Collection of Studies by Central Bank Economists,* BIS papers no. 5, Basle.

[8] Board of Governors of the Federal Reserve System (2005), *Federal Reserve System Purposes and Functions*, 9th edn, Board of Governors of the Federal Reserve System, Washington, DC.

[9] Broaddus, J. and Goodfriend, M. (2001), "What Assets Should the Federal Reserve Buy?", *Federal Reserve Bank of Richmond Economic Quarterly*, 87(1), 7-22.

[10] Brüggemann, R. and Lütkepohl, H. (2004), "A Small Monetary System for the Euro Area Based on German Data", European University Institute, *mimeo.*

[11] Brüggemann, R. and Lütkepohl, H. (2005), "Uncovered Interest Rate Parity and the Expectations Hypothesis of the Term Structure: Empirical Results for the US and Europe", *SFB 649 Discussion Paper,* 2005-035.

[12] Claus, E. (2006) *Monetary Policy in an Inflation Targeting World: Evidence from the Antipodes*, unpublished PhD thesis, Australian National University.

[13] Coenen, G. and Weiland, V. (2003), "The Zero-Interest-Rate-Bound and the Role of the Exchange Rate for Monetary Policy in Japan", *Journal of Monetary Economics*, 50(5), 1071-1101.

[14] Commonwealth Treasury (2002), "Review of the Commonwealth Government Securities Market", *Discussion Paper* October 2002.

[15] DeLong, B. J., (2000), "What Went Right in the 1990s? Sources of American and Prospects of World Economic Growth, *in*, D. Gruen and S. Shrestha, eds, 'Proceedings of a Conference held at the H.C. Coombs Centre for Financial Studies, Kirribilli on 24/25 July 2000 *The Australian Economy in the 1990s*, Reserve Bank of Australia, Sydney, 8-23.

[16] Dungey, M. and Fry, R.A. (2003), "International Shocks on Australia – The Japanese Effect", *Australian Economic Papers*, 42, 158-182.

[17] Dungey, M., Fry, R.A. and Martin, V.L. (2004), "Identification of Common and Idiosyncratic Shocks in Real Equity Prices: Australia 1982 to 2002", *Global Finance Journal*, 15(1), 81-102.

[18] Dungey, M. and Pagan, A.R. (2000), "A Structural VAR Model of the Australian Economy", *Economic Record*, 76, 321-342.

[19] Dungey, M. and Pagan, A.R. (2006), "Revisiting an SVAR Model of the Australian Economy", *mimeo.*

[20] Edey, M. and Ellis, L. (2002), "Implications of Declining Government Debt for Financial Markets and Monetary Operations in Australia", in *Market Functioning and Central Bank Policy*, BIS papers no.12, 25-42.

[21] Edison, H. and Slϕck, T. (2001), "Wealth Effects in the New Economy", *International Monetary Fund Working Paper*, WP/01/77.

[22] Eggertsson, G.B. and Woodford, M. (2004), "Policy Options in a Liquidity Trap", *American Economic Review*, 94(2), 76-79.

[23] Fagan, G., Henry, J. and Mestre, R. (2005), "An Area Wide Model (AWM) for the Euro Area", *Economic Modelling*, 22(1), 39-59.

[24] Federal Reserve Board (2003), FOMC Minutes June 24-25, 2003.

[25] Fry, R. (2004), "International Demand and Liquidity Shocks in a SVAR Model of the Australian Economy", *Applied Economics*, 36(8), 849-864.

[26] Giordani, P. (2004), "An Alternative Explanation of the Price Puzzle" , *Journal of Monetary Economics,* 51, 1271-1296.

[27] Goodhart, C. and Hofmann, B. (2000), "Asset Prices and the Conduct of Monetary Policy", Royal Economic Society, *mimeo.*

[28] Greenspan, A. (2003), Testimony Before the Committee on Financial Services the US House of Representatives, July 15, 2003, available from http://www.federalreserve.gov.

[29] Hanson, M.S. (2004), "The "Price Puzzle" Reconsidered", *The Journal of Monetary Economics,* 51, 1385-1413.

[30] Kilian, L. and Chang, P.L. (2000), "How Accurate are Confidence Intervals for Impulse Responses in Large VAR Models", *Economics Letters*, 69(3), 299-307.

[31] King, M. (1999), "Challenges for Monetary Policy: New and Old", in Proceedings from a Symposium held at Jackson Hole, Wyoming, August 26-28, *New Challenges for Monetary Policy*, Federal Reserve Bank of Kansas City, 11-57.

[32] Kohn, D. L. (2002), "Panel: Implications of Declining Treasury Debt: What Should the Federal Reserve Do as Treasury Debt is Repaid?", *Journal of Money, Credit and Banking*, 34 (3, Part 2), 941-945.

[33] Krugman, P. (2000), "Thinking about the Liquidity Trap", *Journal of the Japanese and International Economies*, 14, 221-237.

[34] MacFarlane, I. (2002), "House of Representatives: Standing Committee on Economics, Finance and Public Administration", *House Committee Proceedings.* Hansard, 31 May 2002: http://parlinfoweb.aph.gov.au/piweb/Repository/Committee/Commrep/Linked/1738-3.pdf.

[35] McCallum, B.T. (2000), "Theoretical Analysis Regarding a Zero Lower Bound on Nominal Interest Rates", *Journal of Money, Credit and Banking,* 32, 870-904.

[36] McCallum, B.T. (2001), "Inflation Targeting and the Liquidity Trap" paper presented at the conference *Asset Prices, Exchange Rates, and Monetary Policy*, 2-3 March, Federal Reserve Bank of San Francisco, San Francisco.

[37] McGough, B., Rudebusch, G. and Williams, J. (2005) "Using a Long-Term Interest Rate as the Monetary Policy Instrument", *Journal of Monetary Economics*, 52, 855-879.

[38] Meltzer, A.H. (2001), "Monetary Transmission at Low Inflation: Some Clues from Japan in the 1990s", *Monetary and Economic Studies*, 19 (S-1), 13-34.

[39] Pesaran, H., Smith, R. and Smith, V. (2005), "What if the UK had Joined the Euro in 1999? An Empirical Evaluation using a Global VAR", *CESIFO Working Paper.* No. 1477.

[40] Reifschneider, D. and Williams, J.C. (2000), "Three Lessons for Monetary Policy in a Low-Inflation Era", *Journal of Money, Credit and Banking*, 32(4), 936-966.

[41] Reinhart, V. and Sack, B. (2000), "The Economic Consequences of Disappearing Government Debt", *Brookings Papers on Economic Activity*, 2, 163-220.

[42] Rudebusch, G. (1998), "Do Measures of Monetary Policy in a VAR Make Sense?", *International Economic Review*, 39, 907-931.

[43] Schreft, S.L. and Smith, B.D. (2002), "The Conduct of Monetary Policy with a Shrinking Stock of Government Debt", *Journal of Money Credit and Banking*, 34 (3) pt 2, 848-882.

[44] Sims, C.A. (1992), "Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy", *The European Economic Review*, 36, 975-1011.

[45] Sims, C.A. (1998), "Comments on Glenn Rudebusch's "Do Measures of Monetary Policy in a VAR Makes Sense?"", *International Economic Review*, 39, 933-941.

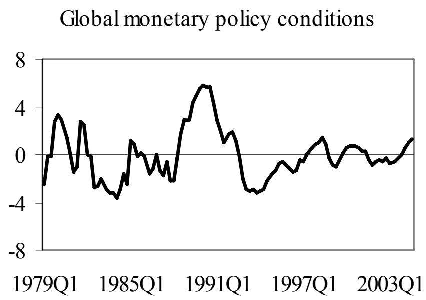
[46] Sims, C.A. (2005), "Limits to Inflation Targeting", in B.S. Bernanke and M. Woodford eds., *The Inflation Targeting Debate*, *NBER studies in Business Cycles,* 32, 283-310.

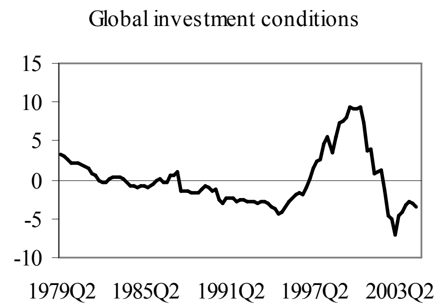
[47] Small, D. and Clouse, J.A. (2004), "The Scope of Monetary Policy Actions Authorized under the Monetary Policy Act", *Board of Governors, Finance and Economics Discussion Paper* 2004-40.

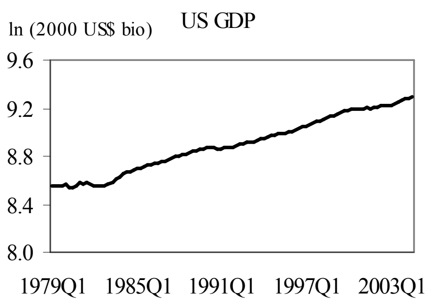
[48] Svensson, L. (2003), "Monetary Policy and Real Stabilization", *NBER Working Paper* 9486.

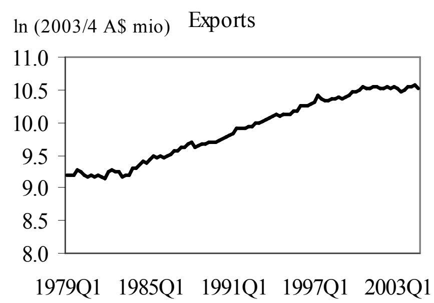
[49] Woodford, M. (2005), "Comment on Using a Long-Term Interest Rate as the Monetary Policy Instrument'", *Journal of Monetary Economics*, 52, 881-887.

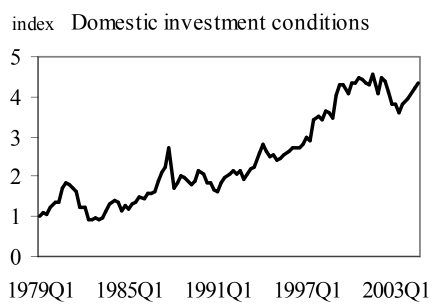
A Appendix – Data

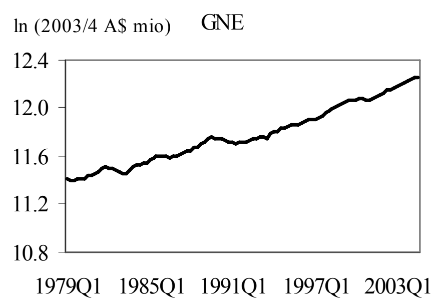












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