Do monetary shocks cause regional prices to go bananas?

An empirical investigation into the asymmetric effects of monetary policy shocks on regional prices within Fiji.

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Abstract

This thesis intends to investigate the asymmetric effects of monetary policy on regional prices within Fiji. The monetary policy shocks are generated by removing any systemic response to future economic conditions from the actual policy rate that is set by the Reserve Bank of Fiji (RBF). This method of generating shocks involves utilizing the data and forecasts that the Reserve Bank of Fiji (RBF) employs when implementing monetary policy, thus ensuring that any systematic response to future economic conditions by the RBF is controlled for. Regional prices are then subjected to monetary shocks to gauge whether these regional prices respond asymmetrically to a common monetary shock. The results reveal that regional prices do respond asymmetrically within the first eighteen months after the initial monetary shock. However the effects of the monetary shocks generally did not have any long term effects. Furthermore, the resulting regional inflation differentials, which varied in the short run, tended to dissipate within the first twelve months after the initial monetary shock. These results bode well for policy makers as the welfare consequences associated with long term regional inflation differentials are negligible.

Table of Contents

Table of Figures

List of Tables

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Any errors and omissions are solely the author's.

Introduction

This study aims to ascertain the effects of monetary policy shocks on regional prices within Fiji. Fiji is a republic in the South Pacific, 2000 kilometers northwest of New Zealand. Outside Australia and New Zealand, Fiji has the largest economy in the South Pacific. Its economy is mainly driven by tourism, sugar production and other light manufacturing. Over the last twenty years, monetary policy in the Pacific, and in particular Fiji, has evolved quite dramatically. The Reserve Bank of Fiji has adopted the use of market based instruments to achieve its monetary policy objectives. Waqabaca and Morling (1999) outline the conduct of monetary policy in Fiji.

The effects of monetary shocks on aggregate output, prices and other economic variables for each country as well as across countries are well documented in the literature (Sims, 1980, Christiano et al., 1999, Kuttner, 2001). However, only a few studies have actually investigated the asymmetries that these monetary shocks cause **within** a country. Carlino and DeFina (1998) investigated the asymmetric response of regional output to monetary shocks in the US, while Fielding and Shields (2007) investigated the asymmetric effects of monetary shocks on intercity price levels in the US. There are very few studies that have ventured into the topic of monetary policy in Fiji. Waqabaca and Morling (1999), Ali and Jayaraman (2001) and Rao and Singh (2006) have looked at the relationship and issues between monetary policy and economic variables, while Katafono (2000) and Jayaraman and Choong (2009) appear to be the only studies that have tried to formally quantify the effects of monetary disturbances on aggregate output and inflation. However, these studies have been applied in an aggregate context and therefore the regional effects of these shocks and their potential asymmetries have not been investigated.

This project aims to fill this void in the literature, by first generating monetary shocks using aspects of the *narrative* approach by Romer and Romer (2004), and then subsequently applying these to aggregate regional prices to ascertain the effects of these shocks. More interestingly however, is whether regional prices respond asymmetrically to monetary shocks. We also intend to look at the effects of monetary shocks on the disaggregated components in regional aggregate prices, to gauge if these components explain the responses of the aggregate regional prices. We also investigate the potential regional inflation differentials that arise after a monetary shock. The analysis is carried out on monthly data from January 2005 to December 2009.

The first chapter contains the details and issues surrounding monetary shocks, in addition to the measures and methods we have used to generate these shocks. The second chapter will apply these generated monetary shocks to the regional prices and investigate whether there are regional asymmetries associated with monetary shocks. This will be followed by the conclusions we have drawn from the two chapters.

Chapter 1

1.1 Introduction

This chapter will look to formulate monetary shocks that have occurred in Fiji between January 2004 and December 2009. These shocks will then be applied to the regional prices in the next chapter.

There are very few studies that have tried to simulate and analyze the effects of monetary shocks in Fiji. There are various studies which have investigated the relationship between monetary policy and various economic variables (Waqabaca and Morling, 1999, Ali and Jayaraman, 2001, Rao and Singh, 2006). However, a study by Katafono (2000) and Jayaraman and Choong (2009) appear to be the only studies that have modeled monetary shocks and their subsequent transmission to economic variables. These studies use the vector autoregressive approach to simulate and analyze the effects of monetary shocks. [1]

This study will simulate monetary shocks using aspects of the *narrative technique* by Romer and Romer (2004). It will also conduct a review into the various other methods of creating and simulating monetary shocks. This is to be followed by a brief insight into how monetary policy in Fiji is conducted, followed by the methodology used to simulate our monetary shocks. The results and a brief discussion of the results round off the chapter.

[1] This method has potential pitfalls, which will be discussed in the following literature review.

1.2 Literature review

This section intends to review the literature on the various methods of generating monetary shocks. There are broadly three conventional methods by which this can be done; vector auto regressions (VAR), forward contracts and the narrative technique. The VAR approach can be applied in a variety of ways which stem from the different theories and assumptions that one places on the interactions of the variables concerned. These assumptions and theories often have dramatic consequences on the results. The forward contracts and narrative methodologies on the other hand have slight variants within them, but are generally found to give more consistent results.

This literature review will first examine the literature on VARs and their variants followed by a review of forward contracts and conclude with a look into the literature on narrative methodology.

1.2.1 Vector auto regressions

Monetary policy shocks can be modeled in a number of ways. The first of these is via vector auto regressions (VAR), where equations which represent the endogenous and exogenous variables in an economy are put into a system without any over identifying restrictions. Prior to this, economic models had 'incredible identification restrictions' and restricted dynamics which translated to large and at times obscene assumptions in a structural model of the economy.

The variables in a VAR are only dependent on the other contemporaneous variables and on lagged values of the other variables and itself. There are no restrictions placed on the model and the 'data is allowed to do the talking'. Sims (1980) first advocated this methodology when modeling multiple equations with endogenous and exogenous variables, as it allows the changes and associated dynamics in the data to come through, both in the long and short run, without imposing a theoretical a priori on the model. An additional advantage of using the VAR framework is the amount of information that could be extracted from a relatively small number of variables. Most VARs are estimated in their reduced form as opposed to their structural form, as illustrated below:

Take a two variable case:

$$y_t = b_{10} - b_{12}z_t + c_{11}y_{t-1} + c_{12}z_{t-1} + \varepsilon_{yt} \quad \textbf{(1)}$$

$$z_t = b_{20} - b_{21}y_t + c_{21}y_{t-1} + c_{22}z_{t-1} + \varepsilon_{zt} \quad \textbf{(2)}$$

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Below is the structural representation of the model above, or structural vector auto-regression (SVAR)

$$\beta X_t = C + \alpha X_{t-1} + \varepsilon_t \qquad \textbf{(3)}$$

β is the contemporaneous relationship between the variables in the model

C is a vector of constants

α is the coefficients on the autoregressive terms

ε_t is the random error term ~ (0,1)

This can also be rewritten in reduced form, which involves isolating X_t. This leads to:

$$X_t = \beta^{-1}C + \beta^{-1}\alpha X_{t-1} + \beta^{-1}\varepsilon_t$$

$$X_t = \gamma + \lambda X_{t-1} + e_t \qquad \textbf{(4)}$$

γ is the vector of constants

λ is the vector of reduced form coefficients

X_t and X_{t-1} represent the endogenous variables in the model

e_t represents the reduced form residuals

It is the reduced form equations, (equation 4) that are estimated. Notice however, that the errors in equation 4 are no longer independent but are related by the matrix β^{-1}. This has implications when trying to observe and justify economic shocks to the system via variance decompositions and impulse response functions. The matrix β (the structural matrix) dictates the contemporaneous effects of the various shocks on the variables in the system. However, β is not easily estimated and one has to apply economic theory in justifying the restrictions that are put onto the matrix. This is crucial as it is the structural shocks which are of great interest; reduced form shocks seldom have any economic significance.

Table 1. Summary of VAR papers

Cholesky	Short run restrictions	GIRF	Long run restrictions
Bernanke and Blinder (1992)	Cushman and Zha (1997)	Evans and Wells (1983)	Blanchard and Quah (1989)
Sims (1992)	Kim and Roubini (2000)	Pesaran and Shin (1998)	Monticelli and Tristani (1999)
Bernanke and Gertler (1995)	Uhlig (2004)	Hoffmaister (2001)	Ehrmann (2000)
Eichenbaum and Evans (1995)	Haug and Smith (2007)	Fung (2002)	Wehinger (2000)
Jayaraman and Choong (2000)	Dungey and Fry (2009)	Fielding et al. (2004)	Fielding and Shields (2001)
Katafono (2000)	Fry and Pagan (2010)	Kim (2009)	Van Aarle, et al. (2003)
Giordani (2004)			

Cholesky ordering and other short run restrictions

There are various ways in which the variables can be ordered so that shocks to the system (via the error terms) can be traced out and the contemporaneous and lagged effects on these variables observed. This method of analyzing shocks is known as the "recursive approach".

The first one of these recursive methods is the *Cholesky ordering*. It uses the Cholesky decomposition method to try and trace out the effects of shocks to the system. This method orders the variables based on the assumptions that some of them are contemporaneously, weakly exogenous from the other variables within the VAR, and therefore it becomes possible to configure the β^{-1} matrix. [2] This makes estimation of the β^{-1}, matrix and consequently the impulse response functions (IRFs), less daunting. However, a caveat of using the Cholesky method is the sensitivity of the results to the ordering of variables within the VAR.

This section is concerned with monetary shocks, which are derived from shocks to the monetary policy instrument.[3] The choice of monetary instruments has evolved over the years, from controlling the money supply to the currently accepted practice of targeting the policy interest rate. The money supply methodology was abandoned because most countries found their money

[2] If a variable is contemporaneously weakly exogenous to the other variables then, any change to the other variables does not have a contemporaneous effect on said variable. For more detail on the Cholesky method refer to Sims (1980).

[3] Normally the monetary instrument is represented by a policy rate that central banks use to achieve their monetary objectives.

demand functions were not stable (Rao and Kumar, 2007). Therefore, to ensure effective monetary policy, central banks started to target the interest rate as their primary monetary policy instrument.

The ordering of variables is crucial in determining the effects of these monetary shocks on the economy. Take for example a VAR that has the nominal interest rate *(i),* price level data (*p*) and GDP (*y*), which are ordered in the way they are mentioned. The Cholesky ordering imposes one of two possible orderings, *the upper* or *lower triangle*, on the corresponding B^{-1} matrix. The following matrix is a representation of the corresponding B^{-1} matrix with the commonly used *lower triangle* assumption.[4]

$$\begin{bmatrix} c_{ii} & 0 & 0 \\ c_{pi} & c_{pp} & 0 \\ c_{yi} & c_{yp} & c_{yy} \end{bmatrix} = B^{-1} \qquad \textbf{(5)}$$

The ordering of variables in a VAR is based on the different economic theories that govern the interaction of the variables within the VAR. The ordering of *i*, *p* and *y* in the above matrix implies that the interest rate is contemporaneously, weakly exogenous from the price level and the level of output, while the price level is assumed to be contemporaneously, weakly exogenous from the level of output. If the variables had been ordered differently, the IRFs would also differ. Consequently an ordering problem arises (Liitkepohl, 1991).

Numerous papers have adopted this way of analyzing monetary shocks in the economy. Those such as Bernanke and Blinder (1992), Eichenbaum and Evans (1995) and Bernanke and Gertler (1995) have all adopted the Cholesky approach. I elaborate on Sims (1992) as an example of how these authors have generally applied this approach to their research. Sims looked into the effects of monetary policy shocks on aggregate economic variables, across the five most developed countries, the UK, the US, Japan, France and Germany. He tried to reconcile Monetarist, Keynesian and Real Business Cycle (RBC) arguments from the data in a VAR framework. He used a six- variable VAR which contained the following: the interest rate (R), index of the foreign exchange value of domestic currency (XR), a commodity price index (PC), a monetary aggregate (M), a consumer price index (P) and an industrial production index (Y), all at a monthly frequency.[5] The Cholesky ordering was applied according to how the variables appear above. This ordering would imply that shocks to the variables after the interest rate, would not have any contemporaneous effect on monetary

[4] The lower triangle ordering as opposed to the upper triangle ordering is commonly used in economic applications.

policy. The monetary shocks were represented by a one standard deviation disturbance, to the interest rate equation. Sims has not checked the robustness of his results to the various possible orderings.

Sims has assumed that monetary shocks had a contemporaneous effect on the economy while being unaffected by contemporaneous shocks to other economic variables. On the other hand Bernanke and Blinder (1992), Bernanke and Gertler (1995) and Eichenbaum and Evans (1995), all employ different orderings based on their own assumptions of which variables in the VAR are contemporaneously weakly exogenous. Therefore, there is no one standard *ordering* in the literature and hence results and their interpretations are susceptible to the different orderings in the Cholesky framework. This has resulted in confusion and debate as to which variables are contemporaneously weakly exogenous, as various orderings have obvious implications for the IRFs.

Through the IRF for each of the countries, Sims found that output and the money stock reacted negatively to a negative monetary shock.[6] Prices appeared to have an initial positive response followed by the orthodox negative response in all cases except Japan and France, where prices continued to move in a positive fashion.[7] A negative monetary shock also resulted in persistent negative output across all countries. The exchange rates of Japan, the US and the UK appeared to appreciate as expected, while the French and German currencies depreciated, which was most peculiar.

The initial positive response of prices and the depreciation of German and French currencies from a negative monetary shock, does not bode well for existing theory. However, Sims offers a possible explanation that monetary policy may be endogenous and that central banks have information about inflationary pressures (better than those in his model) and act accordingly. He therefore advocates the inclusion of a commodity index, as it is a beacon for future inflation. This is a potential short coming of this study as Sims does not actually use the data that central banks are privy to when setting monetary policy.

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[5] Sims also used a four variable VAR that excluded index of the foreign exchange value of domestic currency and a commodity price index.

[6] By negative monetary shock I mean, a positive shock to the interest equation that results in an increase to the interest rate.

[7] The persistent positive response of the price level to contractory monetary policy is known as the price puzzle. Sims noted that the inclusion of the commodity price index helped resolve the price puzzle in the UK four variable VAR, but did not remedy the problem in Japan or France.

This raises another problem with the VAR methodology in general. What variables and data do we include in the VAR, and what are the effects or the consequences of misspecification?

Giordani (2004) is adamant that Sims' explanation about the price puzzle and his subsequent remedy are dubious. He cites previous studies by Hanson (2004) and Barth and Ramey (2001), which found little correlation between the commodity price index and future inflation. Instead Giordani suggests that omitting the output gap from the VAR analysis of the economy could be a possible explanation for the price puzzle. He further argues that this omission causes the inflation equation to be incorrectly specified, as the interest rate now proxies the output gap, as they are positively related. Therefore an increase in inflation would see the increase in the output gap and hence its proxy, the interest rate. As a result, he advocates the inclusion of the output gap as a possible remedy to the price puzzle.

Giordani supports his hypothesis by using the capacity utilization index (as a proxy for the *output gap), the rate of inflation* and *the interest rate* in his VAR of the US economy. He argues that the traditional VAR model, which comprises *output, inflation* and *the interest rate*, is mis-specified, even with the inclusion of a commodity index. He assumes the VAR contained in Svensson (1997) as the true data generating process and compares this to the *"traditional VAR*". He finds that the traditional VAR leads to spurious results or price puzzles in its IRF. Giordani employs a recursive Cholesky ordering based on the theory that monetary policy shocks do not have a contemporaneous effect on either the output gap (or output), or inflation.

Giordani also applies the above ordering to his hypothesized VAR where he has substituted *output* for the *output gap*. Consequently, he assumes that the output gap is contemporaneously weakly exogenous from inflation and monetary policy, and inflation is contemporaneously weakly exogenous from monetary policy. His findings reveal a price puzzle in the IRFs of the traditional VAR but not in the VAR with the output gap. He also notices that monetary shocks are shorter lived in his VAR vis-à-vis the traditional approach. In general he finds that his VAR, with the output gap, has given results that are free from price puzzles and consistent with economic theory. This is not always the case in the traditional approach.

In the Fijian context, Katafono (2000) analyzed the relationship between monetary aggregates, aggregate output and aggregate inflation. She tried various orderings of the variables and noted the sensitivity of the results to the different orderings. Ultimately, she found that none of the monetary aggregates had a significant impact on aggregate inflation or aggregate output. However, while

Katafono has tried to test the robustness of the various orderings, she has not provided an economic rationale for the different orderings. Although econometrically valid, the economic rationale could have identified which ordering, and subsequently which set of results, were valid.

Jayaraman and Choong (2009) analyzed the effects of monetary shocks and the transmission of these shocks on the Fijian economy using the interest rate, broad money (M2), credit to private sector, the nominal exchange rate, real GDP and the aggregate price level. The variables in their VAR were ordered in the same way they appear above. The authors found that shocks transmitted via the money channel had the greatest effect on prices and real output.

However, the ordering of the above variables would suggest that monetary policy is not contemporaneously affected by shocks to the nominal exchange rate, real GDP or aggregate prices. Therefore one could assume that the central bank correctly preempts shocks to economic variables when formulating policy, although it appears that the authors did not try alternative orderings to gauge the robustness of their results.

A major concern of the above studies and others that have employed the Cholesky ordering is the way these models are interpreted. Many claim to base their orderings on solid theoretical grounds. However, if the variance decomposition and impulse response profiles "fit the picture" then they are assumed to be good models, while if they are not consistent, they are either thrown out or assumed to have a " *puzzle*" attached to them. The ordering of variables in Giordani raises some questions as it assumes that central banks always act with a one quarter delay and that they never preempt shocks or changes in the economic outlook. Many would view this with obvious cynicism as central banks around the world (particularly since the majority of these studies were carried out on large developed economies with vast resources) often spend vast resources on forecasts as well as adjusting monetary policy to encompass forecasted economic conditions.

The studies above disagree on which variables should be included within the VAR. They are also at odds as to how these variables should be ordered.[8] Consequently, the ambiguities that are associated with the Cholesky approach would warrant a different approach to modeling monetary shocks.

[8] The ordering of variables within a VAR is based on the different economic theories that govern the interaction of the variables within the VAR.

Structural VAR

The ordering of variables within the Cholesky framework governs their interaction. In contrast, structural VARs impose direct restrictions on the β matrix, which consequently governs the contemporaneous interaction of the variables. These restrictions are normally derived from various economic theories and assumptions. This is known as a structural vector auto regression (SVAR). SVARs have become increasingly popular in the literature Cushman and Zha (1997) Kim and Roubini (2000) Haug and Smith (2007) and Dungey and Fry (2009), have all used structural VARs in their analysis.

However, while SVARs may seem like the ideal alternative to the Cholesky framework, deriving the necessary number of restrictions from economic theory is not always straightforward or plausible.

Sign restrictions

Studies have also tried to impose sign restrictions on short run variables. Uhlig (2005) investigates the effects of monetary policy on output in the US. He places restrictions on the direction/sign that a negative monetary policy shock has on the price level, non-borrowed reserves and the federal funds rate, however no restriction is placed on real output. He cites the literature and convention as the primary reasons for placing these assumptions in his VAR. Others such as Haug and Smith (2007) impose restrictions on short run variables when trying to model the effects of disturbances on a small open economy. However, like the majority of empirical studies in economics, assumptions have to be made and these may be open to debate. For a further critique on sign restrictions see Fry and Pagan (2010). The assumptions regarding sign restrictions are usually carried out on the consensus of other works. Since there is a limited literature on the effects of monetary policy in Fiji, deriving sign restrictions based on the consensus of solid empirical foundations would be difficult.

General impulse response functions

To avoid the ordering issues associated with the Cholesky method, the general impulse response function (GIRF) is used. Evans and Wells (1983) first proposed a method of analyzing shocks that were invariant to the way variables were ordered in a VAR. Unlike the Cholesky method, which generally imposes a lower triangle assumption on the structural matrix, Evans and Wells allow the covariance terms (which would normally be assumed zero in the Cholesky method) to be some value *k.* Therefore when one of the variables is shocked, all the other variables respond contemporaneously as determined by the covariance structure. Consequently, IRFs generated under the general impulse response function would generally differ from those of the Cholesky ordering (except for the IRF from the variable ordered first in the Cholesky ordering). Take the following as an illustration of the above:

A VAR which has the following definition:

$X_{t}.= [x_{1t}, x_{2t} \ldots\ldots\ldots x_{it}]$

Now the IRF for the variable ordered first in the Cholesky framework (x_1) would correspond to the GIRF $\varphi^{G}_{x_1}(n) = \hat{\varphi}^{o}_{x_1}(n)$

$$\varphi^{G}_{x_i}(n) \neq \hat{\varphi}^{o}_{x_i}(n) \text{ with } i \neq 1 \text{ and } i=2,3\ldots\ldots\ldots h \qquad \textbf{(6)}$$

$\varphi^{G}_{x_1}$ is the general impulse response function

$\hat{\varphi}^{o}_{x_1}$ is the Cholesky impulse response function, with x_1 first in the ordering

n is the forecast horizon of the impulse response function

Evan and Wells investigated the effects of shocks to the New Zealand economy via a nine variable VAR, in first differences.[9] They note however that their methodology had issues with the interpretation of shocks in the system as they were not necessarily individual structural shocks with any economic interpretation. Following on from Evans and Wells, Pesaran and Shin (1998) adopted the GIRF methodology but also showed how it could be applied to non-stationary variables within a cointegrated framework.

Hoffmaister (2001) conducted an empirical investigation of inflation in Korea, to help shed light on the proposed introduction of an inflation targeting regime by the Korean central bank (BOK). He used the GIRF to trace out the effects of the external shocks on the aggregate CPI and its major components. Results aside, he singled out the GIRF's immunity to the ordering issues, inherent in the "standard" recursive approaches, as the main advantage of the GIRF.

Fung (2002), in his investigation of inflation targeting in Mexico and Chile, also employed the GIRF to trace out the effects of shocks to the economies of these countries. He cites the robustness of the GIRF to different orderings, as an advantage over the Cholesky approach.

[9] Taking first differences has meant that their analysis was carried out on stationary variables.

However, while Hoffmaister and Fung have outlined the GIRF's robustness to different orderings of variables in the VAR, one must also consider the interpretation of economic shocks inherent in the GIRF methodology. Unlike the Cholesky ordering, the sources of the shocks that affect the system cannot be identified and consequently do not necessarily have an economic interpretation. Since this study is only interested in the effects of monetary shocks, the GIRF may not be able to isolate the effects of monetary policy on the price level. Instead the GIRF would be useful if we were trying to evaluate the effects of various shocks on the price level.

Kim (2009) suggests that the GIRF is equivalent to an amalgamation of IRFs generated under a first order Cholesky ordering for each of the variables as seen below:

Consider the following VAR:

X_{t}.= [x_{1t},x_{2t}………x_{it}]

Therefore the GIRF impulse response function is equivalent to the following:

$\varphi_{x_1}^{G}(n) = \hat{\varphi}_{x_1}^{o}(n)$, $\varphi_{x_2}^{G}(n) = \hat{\varphi}_{x_2}^{o}(n)$,…………., $\varphi_{x_i}^{G}(n) = \hat{\varphi}_{x_i}^{o}(n)$

where $\hat{\varphi}_{x_n}^{o}(n)$ refers to the nth variable being ordered first in the VAR and consequently in the Cholesky ordering. This consequently renders the following GIRF:

$$\varphi_{x}^{G}(n) = \{\varphi_{x_1}^{o}(n)\ , \varphi_{x_2}^{o}(n) \ldots\ldots\ldots\ldots\ \varphi_{x_i}^{o}(n)\} \quad \textbf{(7)}$$

Kim further states that these extreme assumptions can lead to dubious inferences. Though he has not explicitly stated that these shocks have no economic meaning, he has provided an empirical example to help support this statement.

However, there are instances when the GIRF is plausible, if for example none of the variables in the VAR are contemporaneously related, or if there is a variable that is exogenously determined and is therefore first in the ordering.[10] Fielding et al. (2004) when trying to model a West African currency union in a VAR framework, assumed the interest rate to be exogenously determined and therefore shocks to the interest rate were not correlated to any of the other shocks. As such, their monetary shocks had an economic interpretation. The policy rate (PIR) to be determined in my study is not

[10] Therefore the covariance matrix (β^{-1} from above) should be just a diagonal matrix with zero off diagonal elements, in which case a structural estimation is unnecessary and the reduced form shocks would suffice. Consequently, the structural and reduced models are identical.

exogenous. Therefore "monetary shocks" generated under the GIRF approach would render results that were not economically interpretable.

Nevertheless the restrictions imposed on both recursive identification schemes are rather extreme and are often controversial. Consequently others have tried other identification procedures which are weaker vis-à-vis the recursive ordering. The following classes of models impose structural assumptions within the VAR.

Long run restrictions

There are rare instances when the contemporaneous interaction amongst variables is known and therefore direct restrictions can be imposed on the structural matrix (B^{-1}). These restrictions are sought from generally accepted theory or common sense. However, theory does not always render restrictions on the contemporaneous interaction between variables. Thankfully theory does often offer some insight into the **long run** interaction between variables. Blanchard and Quah (1989) investigated the effects of aggregate demand and supply disturbances on output in the US. They proposed imposing long run restrictions on the coefficients in the VAR, their rationale being that demand shocks have a temporary effect on output, while supply shocks have a more permanent effect. In addition, they also assumed that both demand and supply shocks had no long run effect on unemployment.[11] Blanchard and Quah then proceeded to fit a VAR to unemployment and output with the above long run restrictions. To help make sense of how they imposed these long run restrictions take the following example.

Using Equations 1 and 2 earlier, assume shocks to equation 1 (ε_{yt}) have no permanent or long run effects on z. The following shows how the corresponding long run restriction(s) are imposed on the VAR.

$\beta X_t = C + \alpha X_{t-1} + \varepsilon_t$

(Assume for now that C does not exist to make things less cumbersome.)

$X_t = \beta^{-1}\alpha X_{t-1} + \beta^{-1}\varepsilon_t$

However equations 1 and 2 contain variables lagged one period, the general form would have *q lags*

This leads to the more general form

[11] Blanchard and Quah justify their restrictions by solving a system of equations that represent the economy.

$X_t = \beta^{-1}\alpha(L)X_{t-L}+\beta^{-1}\varepsilon_t$

$X_t = A(L)X_{t-L}+e_t$

Where $e_t = \beta^{-1}\varepsilon_t$ and $A(L) = \beta^{-1}\alpha(L)$

$[I\text{-}A(L)]X_t=e_t=\beta^{-1}\varepsilon_t$

$X_t=[I\text{-}A(L)]^{-1}\beta^{-1}\varepsilon_t$

$$X_t=G(L)\,\varepsilon_t \tag{8}$$

where $[I\text{-}A(L)]^{-1}\beta^{-1}=G(L)$

Equation 8 will help trace out the effect of a shock into *t* periods into the future therefore a shock that is only transitory should have no effect in the long run. Since we only impose a structure with one lag on the VAR this would yield:

$X_t=G(1)\,\varepsilon_t$

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Therefore as ε_{yt} has no long run effects on z_t we can set $g_{21}=0$.[12] This would yield:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} \\ 0 & g_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} \tag{9}$$

Using the above long run assumptions, the other coefficients in the model can be calculated.

[12] We assume that the structural shocks are uncorrelated which would aid in imposing restrictions in the variance covariance matrix.

Numerous studies have applied the Blanchard and Quah methodology to analyzing the effects of monetary policy shocks on the rest of the economy. Fielding and Shields (2001) imposed long run restrictions on their VAR when they investigated the impact of shocks to output and prices to member countries of the African CFA currency union as a tool for gauging the potential costs (in terms of having a common currency and by extension a common monetary policy) for members in the currency union. Numerous studies have also applied the Blanchard and Quah or slight variants of the methodology in the European context. Monticelli and Tristani (1999) investigated the effects on monetary policy for a single euro area VAR which encompassed output, interest rates and inflation (aggregated for the regions within the euro area). Ehrmann (2000) looked into the transmission mechanisms of monetary policy shocks across thirteen European countries in the VAR framework, while Van Aarle et al. (2003) used long run restrictions in a VAR framework to investigate the effects of monetary and fiscal policy on the economies of the Euro area. In addition, others such as Wehinger (2000) have used long run restrictions to compare inflation and price stability between the euro area, the US and Japan. Wehinger hypothesized that shocks to energy prices, aggregate supply, aggregate demand and the exchange rate, as well as monetary policy shocks and wage setting, in some way or the other had effects on inflation in the period from the late eighties to the late nineties. Overall, he found that monetary policy had a strong effect on inflation across all the regions.

Proponents of this methodology argue that economic theory reveals how these variables should behave or what coefficients they should have in the long run. This may help negate price puzzles because even though there are no restrictions in the short run, the long run restrictions ensure that impulse response functions behave according to theory. The studies above use different economic theories from prior studies which dictate the derivation of equations that subsequently represent the economy. These equations are then solved to provide the long run restrictions imposed on the VAR. While this methodology is proving increasingly popular, there has not been extensive work done on monetary policy disturbances in Fiji. Apart from Singh (2008) there are few papers that have tried to set up detailed economic models for Fiji, from which these long run restrictions can be derived and proved. Therefore, unlike the US or Europe imposing long run restrictions on coefficients that are not based on the consensus of other works would be naive. Secondly, the number of shocks that are able to be identified are restricted by the number of equations or endogenous variables that are present in the VAR. As a result one is usually unable to recover individual disturbances using this method. This was an issue that Blanchard and Quah (1989) had identified in regard to aggregate demand shocks as they could not isolate them further.

The ordering problems and ambiguities associated with the Cholesky method, the amalgam of shocks using the general impulse response functions (which make no economic sense) and the lack of reliable studies that have investigated the effects of monetary policy in Fiji (which in turn affects the restrictions I could impose on long run coefficients or the sign of the coefficients), in addition to the potential for misspecification inherent in all monetary policy shocks formulated within a VAR, would make it dubious to formulate, analyze and interpret monetary policy shocks within a VAR framework.

1.2.2 Futures markets

Moving away from the VAR framework others have tried to generate monetary shocks using the financial markets, namely the futures contracts on the policy rate. The rationale behind this is that expectations that markets form encompass all available quantitative information at the time, therefore any deviation from these expectations by policy makers is viewed as a shock.

FFF_{t-1} is the federal funds futures contract for time *t*

FF_t is the actual federal funds rate at time *t*

t: is what agents expect Federal Funds rate to be at time *t*

Shock is equivalent to FF_t-FFF_{t-1}

Rudebusch (1998) critiques the VAR methodology of creating monetary policy shocks. He generally arrives at the same conclusions as we have, about monetary shocks generated within a VAR. He further stipulates that VARs seldom have the same monetary shocks as a consequence of the data and variables included, as well as the identification assumptions imposed on the different VARs. Subsequently, he advocates the use of the futures markets (in his study the federal funds futures (FFF) contracts) for reasons outlined above. Others such as Faust, Rogers et al. (2003) also advocate the use of FFF contracts and in doing so claim to negate any *price puzzle* that is sometimes apparent in recursive orderings.

While this would seem the ideal way to generate monetary policy shocks, there are caveats to consider. Firstly the actual Federal Funds Rate is determined by factors outside the Fed and monetary policy. Therefore expected changes that determine the Federal Funds Futures contracts may embody expectations that are not related to expected movements in monetary policy. This could be problematic when one is trying to ascertain monetary shocks that are a result of unexpected monetary policy changes.

Furthermore this method of generating monetary policy shocks is not applicable to Fiji because they do not have a futures market on their policy indicator rate. Even if the central banks introduced the futures contracts, the under-developed capital markets, lack of market participants and asymmetric information that is present in small Pacific Island developing countries, would suggest that the futures policy indicator rate would not necessarily or correctly reflect the rate that is expected by the central bank. Consequently it would not reveal monetary shocks to the economy.

One could argue that the concepts of covered and uncovered interest rate parity could be used as an indicator of the interest rate, using the exchange rate. The covered interest rate parity (CIP) model is used in the calculation of the forward exchange rates. If the spot and forward rates are known, as in the case of a fixed exchange rate, then one could easily reverse engineer the equation to derive the local interest rate. However there are a few caveats to consider. Fiji's exchange rate is semi-fixed rather than fixed, as it is pegged to a basket of currencies and not one currency. Consequently there is scope for movement. This makes calculating the forward exchange rate difficult, particularly when trying to deduce the Fijian interest rate.

Secondly and most importantly, CIP relies on arbitrage to maintain this relationship thus allowing arbitragers to modify their portfolio composition to exploit arbitrage opportunities and thus keep CIP. However, given the stringent capital controls in Fiji, particularly on outgoing capital, acting on arbitrage opportunities would not always be possible. Therefore the interest rate on assets, and consequently the exchange rates, are not free to respond to arbitrage and the CIP relationship may not hold.

The simple uncovered interest parity model (UIP) states that the interest differential between two countries (r^h-r^f) is equivalent to the expected exchange rate depreciation (appreciation) $\left(E\left[\frac{der}{dt}\right]\right)$ between the two countries at time *t*.[13]

$$E\left[\frac{der}{dt}\right] = r^h - r^f \tag{10}$$

Therefore any deviation from UIP should see a change in the interest rate differential between the two countries, a change in the expected exchange rate depreciation between the two countries or

[13] For a greater discussion refer to Pilbeam (1992).

both. However, gauging market expectations of what they expect the exchange rate to be can be difficult, particularly since the Fijian currency is not one that speculators choose to dabble in. Furthermore, UIP assumes that capital is perfectly mobile. However, given Fiji's strict capital controls, it is unlikely that UIP would hold. In addition, UIP assumes that investors have the same risk premium across countries. This idea may seem farfetched, given the political instability that Fiji has experienced. Consequently it would be naive to assume that Fijian bonds are held in the same esteem as Australian or US bonds. As a result using the exchange rate or the nonexistent futures policy rate is not a feasible option for generating monetary shocks.

1.2.3 Narrative

There is however the *narrative method* of formulating monetary shocks, as developed by Romer and Romer (2004). I have decided to adopt part of their methodology in trying to model and formulate monetary shocks for Fiji. Their novel technique of formulating monetary shocks is based on the forecasts that the Federal Reserve (Fed) in the US uses in formulating their policy rate at each board meeting. The inclusion of such forecasts helps control for the endogeneity problems associated with other measures of monetary policy disturbances. Endogeneity problems occur because econometricians normally disregard the fact that central banks exhaust vast resources on forecasts. Central banks incorporate these forecasts into their policy decisions and hence try to pre-empt and act according to future economic conditions. Therefore disregarding this can result in the incorrect identification of monetary shocks. Romer and Romer argue that the Fed sets the policy rate (FFR) based on their forecasts of the economy, which are usually the best available. This is generally the case in most countries, especially in small developing economies. Hence the Reserve Bank of Fiji is likely the only institution with adequate resources to make reliable economic forecasts of the Fijian economy.

However, the Fed does not publish the FFR. To account for this Romer and Romer have derived an intended Federal Funds rate from the *Weekly Report of the Manager of Open Market Operations* as well as the detailed minutes from each board meeting. The Reserve Bank of Fiji however, publishes their policy rate and therefore unlike Romer and Romer we do not have to derive the policy rate.

Romer and Romer put the following variables in their regression:

- The intended Federal Funds rate
- The previous period and forecasted inflation

- The previous period and forecasted growth
- Forecast revisions of inflation and growth
- The federal funds rate of the previous meeting.

However, Bluedorn and Bowdler (2006) in addition to the above, also include a capacity utilization index to help account for deviations from potential output. They note that this is not available to policy makers at the time and therefore its inclusion can be met with some cynicism. Nevertheless they justify its inclusion, citing Giordani (2004) and the higher R^2 they obtain in their regressions. Quoting higher R^2 as a justification for including variables seems dubious as the R^2 increases as the number of variables included in a regression increase. However, this does not necessarily mean the variable(s) are able to explain the dependent variable accurately.

Bluedorn and Bowdler as well as Romer and Romer both assume that the forecasts of the above variables are exogenous to the policy rate that is set by the board of the Federal Reserve. Shocks are formulated based on the actual policy rate that is set at each board meeting, which may differ from what is expected. If this is the case then a monetary policy shock is said to have occurred. In essence, I would be comparing the policy rate which should be set based on the forecasts of inflation and growth (as well as last period's inflation and growth, coupled with the policy rate from the previous meeting) and what the Reserve Bank of Fiji actually sets. The difference, if any, is said to be a monetary shock.

This brings the discussion to another important aspect of the *narrative* methodology, the time intervals. Romer and Romer and Bluedorn and Bowdler formulate monetary shocks on a meeting by meeting basis, which does not necessarily occur at symmetric time intervals. Sometimes there are two meetings in a month and sometimes there are none. Consequently these shocks have to be transformed into the required time intervals, be it quarterly or monthly time bins. Romer and Romer use a crude method of aggregating and converting their shocks into monthly intervals. If there was no meeting in that month, it would simply have a zero for its shock value and if there were two meetings in a month, the resulting shocks would be aggregated. As Bluedorn and Bowdler pointed out, this method of aggregation would not take into account the "*dynamic and contemporaneous"* effects of monetary policy on variables in the economy. Instead they propose an aggregation method that has shocks from the meetings weighted according to when they occur within the month.

Romer and Romer have taken their shocks and applied it to a VAR that represents the US economy. They found that the new measure of monetary policy shocks have large and significant effects on inflation and the real output in the US economy. They also found that real output and inflation behave in accordance with conventional economic theory, that is inflation and real output decrease with a contractionary monetary shock. Consequently, the price puzzle that has often plagued the literature has been negated. The authors also found that real output generally responded a lot more rapidly than prices did, to a contractionary monetary shock. This suggests that prices behave in a Keynesian paradigm and are therefore *"sticky"*.

Bluedorn and Bowdler assess the open economy consequences of their monetary shocks formulated for the US economy. They investigate the effects of US monetary shocks on the exchange rate with the foreign countries (G7 countries excluding the US), the foreign and US price levels and output. They found that after a contractionary monetary shock, the US exchange rate appreciates and foreign output decreases. They also concur with the Romer and Romer findings of the domestic US economy, but cite that the effects of the monetary shocks are smaller in their study, owing to the increased number of conditioning variables.

Overall Romer and Romer and Bluedorn and Bowdler all agree that their narrative approach to formulating monetary shocks is robust and gives sensible interpretable results when applied to economic variables.

1.3 A brief review of monetary policy in Fiji

This section provides a succinct review of monetary policy and the exchange rate regime in Fiji. Unlike the policy target agreement (PTA) in New Zealand, the Reserve Bank of Fiji (RBF) does not have a legislated target for inflation. Instead it tries to keep inflation within 2-3% (Waqabaca and Morling 1999). It also tries to ensure that Fiji has sufficent foreign reserves to meet its import payemnts (RBF monetary policy statement 2008).

Since 1989, the RBF has had a market-based approach to the conduct of monetary policy. Monetary policy objectives are signaled through the policy indicator rate (PIR) and are achieved via open market operations. Open market operations (OMO) are carried out using short term debt paper which have various maturities. These are known as RBF notes. Therefore, once the RBF board has signaled its policy intentions via the PIR, OMO is carried out on the RBF notes, to achieve the required policy rate. Consequently, when the rates on the RBF notes are not in line with the policy rate, the RBF intervenes in the market to bring these rates back in line with RBF targets. These short term interest rates then affect the rates at which commercial banks and other financial institutions are able to borrow from the RBF. Therefore a tighter monetary stance would result in an increase in the PIR, which would lead to an increase in the short term lending rates that commercial banks and other financial intermediaries face from the RBF. This would then flow onto other agents within the economy, which consequently influence aggregate demand and hence economic activity.

For a more detailed account of the transmission of monetary policy in Fiji, refer to Waqabaca and Morling (1999), Ali and Jayaraman(2001) and Jayaraman and Choong (2009).

1.3.1 Fiji's exchange rate regime

The Fijian dollar is pegged to a basket of major currencies: the Greenback, the Australian dollar, the New Zealand dollar, the Yen and the Euro in a semi fixed exchange rate regime. The currencies in the basket are weighted according to a three year moving average, of the level of trade Fiji has with each of its trading partners (Jayaraman and Choong 2009). The resultant exchange rate from the basket of currencies is commonly referred to as the Nominal Effective Exchange Rate (NEER). Unfortunately the RBF does not publish the weights used in the NEER.

Due to the semi fixed exchange rate, the Fijian dollar is allowed to float against the individual currencies. However, the NEER is kept within a prescribed band, if it deviates outside this band then the RBF would intervene in the foreign exchange market by selling and buying reserves, to bring it back in line with RBF targets. In this way the RBF has control over the exchange rate.

Conventional text book theory would stipulate that a fixed exchange rate and monetary policy cannot coexist as any change in monetary policy is usually undone via the exchange rate mechanism. However, the strict capital controls particularly on the outflow of capital helps Fiji maintain control over its monetary policy as interest rate differentials cannot always be exploited by investors, foreign and domestic. Furthermore, the movement of the NEER within a prescribed band does mean that this not a traditional fixed exchange rate as there is scope for bilateral exchange rate movements.

1.4 A formulation of monetary policy shocks based on RBF board meetings

The main objective of this chapter is to purge the policy target rate from the forecasts of growth and inflation. Once this is done, the resulting variable is considered the monetary shock. Monetary shocks will be calculated from January 2004 to December 2009.

The Greenbook forecasts that the Federal Reserve uses in the US are only available to the public six years after they are initially published. This may be met with a degree of cynicism especially if private sector forecasts are reliant on the Fed forecasts, which are only released after a six year lapse. In the case of a small economy like Fiji, the Reserve Bank of Fiji (RBF) is most likely the only entity that performs sophisticated forecasts of economic conditions. However, unlike the Greenbook forecasts, which are only released to the public after a six year period, the RBF are generally more open about their forecasts.

In some instances, the data that the central banks use at the time they set monetary policy may differ from what is historically available now. The data and forecasts that central banks use may embody errors which have since been corrected. Therefore to accurately capture the actions and expectations of central banks, Romer and Romer (2004) advocate using data contained in the Greenbook forecasts, which in this study are equivalent to the Monthly and Quarterly economic reviews. The following scenario may help clarify differences and the implications of forecast and what is now historic data. Suppose year end inflation for June 2004 is measured at five percent in August. However, in December of that year, inflation in June was revised to four percent. In the months post June till December, the RBF would have used 5%, as opposed to 4%, when calculating the policy rate.

The majority of the monthly data used in this study was sourced from the Reserve Bank of Fiji (RBF) website, in particular the economic review which publishes vital statistics and a monthly commentary about the Fijian economy. The sampling period was taken from the 1 Jan 2004 to 31 December 2009. The time interval was motivated by the availability of data. Since the monetary reforms of the late 80s, the RBF has increased the amount of information it releases to the public, particularly post 2004.

In the spirit of the Romer and Romer methodology, this paper uses similar variables in its calculation of the expected policy rate. We also assume that the variables and in particular the forecasts used in equation 11 are not a function of the change in the PIR as this would cause endogeneity issues, which would require estimation within a VAR framework as opposed to the single equation method outlined below. This assumption is plausible given that the forecasts are used by the board when setting monetary policy. The RBF have acknowledged that the PIR and SDR are decided upon **at** the board meeting and not beforehand thereby ruling out any endogeneity issues.

The regression equation used to formulate the monetary shocks (ε_m), that are free from Reserve Bank expectations is as follows:

$$\Delta PIR_m = \propto + \gamma PIR_{m-1} + \sum_{i=-1}^{0} \rho_i \pi_{m,i} + \sum_{i=-1}^{2} \sigma_i g_{m,i} + \beta \; reserves_{m-1} + \omega \; outputgap_m + \sum_{i=-1}^{2} \theta_i (g_m - g_{m-1}) + \sum_{i=-1}^{2} \tau_i (\pi_m - \pi_{m-1}) + \varepsilon_m \tag{11}$$

Romer and Romer estimate the above equation using OLS. The frequency of their data was not in symmetric time intervals but in meeting dates of the board. Therefore *m* in their regression would have represented meeting dates. Like the meeting dates of the Fed, the RBF board meetings do not necessarily occur at symmetric time intervals. However, we are using weighted least squares (WLS) to estimate Equation 11. WLS was seen as a better estimation technique compared to the traditional ordinary least squares (OLS), as we could still use symmetric time intervals but use weights to accommodate for the months where there were no meetings.[14] Consequently *m* in equation 11 represents a monthly frequency. In the months where there were no meetings, the values of the variables in equation 11 took on the values from the earliest month where there was a meeting. However, the weights in the WLS regression ensure that no emphasis is placed on these observations.

ΔPIR represents the change in the nominal policy indicator rate (PIR) which is the difference between the PIR from the previous month (m-1) and the PIR from the current month (m) when the RBF board meets. The nominal policy indicator rate is sourced from the economic review, the statistical annex of the RBF and clarified by a senior member of the RBF. This is the main monetary policy instrument that the RBF has direct control over. It is comparable to the Federal Funds Rate in the US and the OCR in Australia and New Zealand. The PIR_{m-1} refers to the policy indicator rate that

[14] We had to construct a series that weighted months according to when the RBF board met. If a month had a RBF board meeting, it was given a weighting of a 1000. If a month had no board meetings it was given a weight of 0. The series was called WGT.

was set in the previous month.[15] This is included because the RBF board may want the PIR to take a *smooth* path and it also helps control for any mean reverting tendencies the board may take, as mentioned by Romer and Romer. As stated earlier, movements in the PIR occur at the sole discretion of the RBF, therefore unlike Romer and Romer, this study is able to use the actual PIR.[16]

π refers to the level of inflation while the subscript *i* refers to the forecast horizon relative to *m*. Inflation in this study differs somewhat from those inflation rates used in the Romer and Romer and Bluedorn and Bowdler papers, which have inflation calculated on a monthly basis, while data from the economic reviews have inflation calculated as "year on year "inflation. Therefore inflation for August 2004 is in fact inflation from September 2003 to August 2004.

Inflation for the current time period is calculated with a one month delay; consequently it is not available when the board decides on the PIR. However, the board does have access to the forecasted year end level of inflation. This encompasses inflation from January to December of the current year. However, the forecasts of year end inflation can change within the year and therefore could vary at subsequent meetings. In light of this, the variable *current inflation* ($\pi_{m,0}$) is a forecast that signals current month and future inflation. This differs from the Fed which forecasts monthly inflation for up two months ahead of each meeting. The inflation rate for the previous month and the forecasted inflation rate are published in the monthly economic review

Previous, current and forecasted levels of Growth *(g)* are also included in the regression. The growth forecasts represent the **year end** forecast of growth and are normally formed for up to two years out. This is in contrast to the monthly growth forecasts used in the Romer and Romer paper. However, the forecasted growth rates could change within the year and subsequently vary at subsequent months. Growth and its forecasts are available from the monthly economic reviews, half yearly monetary policy release statements and annual reports of the RBF.

The RBF board may also take into account any revisions in its forecasts between the current month (m) and the previous month (m-1) when setting the PIR. Hence, the changes in the growth and inflation forecast are included in the regression.

This study has also included a measure of the output gap appropriately represented by *GAP* in the above regression. Bluedorn and Bowdler use the capacity Utilization index produced by the Federal

[15] This is equivalent to the PIR set at the previous meeting, for reasons mentioned earlier.

[16] Movements in the Federal funds rate often occur for reasons outside the Fed's control. Therefore a change in the FFR does not necessarily reflect a change in monetary policy.

Reserve, as a proxy for the deviations of the US economy from potential output. The RBF publishes no such measure, but has a working paper that has tried various methods of computing the output gap and potential output for Fiji[17]. It is important to stress that the board are not privy to this information in real time, but this measure has been included to capture board members perceptions on the cyclical path of the Fijian economy.

Monthly electricity generation has been used as a proxy for output in Fiji.[18] The Hedrick Prescott (HP) filter was then applied to the electricity series to ascertain a trend.[19] The output gap is then calculated as the deviation of the actual series from the calculated trend. St-Amant and Van Norden (1997), Gounder and Steven (2000), Rennison (2003) and similar studies have used the HP filter as a starting point when trying to measure the output gap. However, there are many shortcomings of the HP filter, particularly the arbitrary choice of the smoothing parameter λ. The HP filter also produces dubious estimates when applied to a non-stationary series. For a greater discussion into the pitfalls of the HP methodology refer to Coe and McDermott (1997), St-Amant and Van Norden (1997) and Guay and St.-Amant (2005). Other possible measures of the output gap could be considered namely the structured vector autoregressive models, such as those contained in DeSerres, Guay et al. (1995), St-Amant and Van Norden (1997), Gounder and Steven (2000) and Rennison (2003). These studies have used the long run restrictions derived from the Blanchard and Quah (1989) methodology, to separate the transitory from permanent shocks. The long run shocks are then used to derive potential output, while the transitory shocks are used to derive deviations from potential output or the output gap. The choice of variables differs amongst the various studies surveyed, but all contain some proxy for economic activity and selection of employment, unemployment, the interest rate, capacity utilization index or inflation. The HP filter was seen as an appropriate measure of the output gap given that we are simply trying to account for any cyclical behavior that the board may have when setting the policy rate. The other methods required more data, time and the benefits they brought did not warrant the required resources.

The Romer and Romer and Bluedorn and Bowdler papers were written in context of the US which is a large economy with a floating exchange rate. However, as mentioned earlier Fiji is a small open

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[17]Gounder and Stevens (2000) "Measures of potential output in Fiji." RBF working paper.

[18] Narayan (2007) found that electricity consumption is a significant and reliable proxy for economic growth in Fiji.

Consumption of electricity would have been ideal but this was not readily available at a monthly frequency. Besides, Fiji does not export or import electricity and the only discrepancy between electricity generation and consumption is leakages, which are not significant.

[19] Lambda was set at 14400 to accommodate the monthly frequency of the data.

economy with a semi-fixed exchange rate, therefore the RBF places significant importance on maintaining sufficient foreign reserves to enable Fiji to meet its import payments to the rest of the world. The RBF rarely forecasts its levels of foreign reserves for the current or future months, but instead provides a provisional estimate of foreign reserves, which are published with a one month delay in the economic review. *Reserves* represent the level of Foreign Reserves for the previous month in the regression equation above.[20] The residuals (ε_m) represent the monetary shock, which is the difference between the actual and expected change in the policy rate.

However, as of June 2007, the RBF suspended open market operations (OMO).[21] OMO is the market mechanism that the RBF uses to achieve its target policy rate. It carries out OMO using RBF notes, at a weekly auction. Therefore, suspending OMO would make the PIR redundant as a policy instrument. For the remainder of the sample period, the RBF used the statutory reserve deposit ratio (SRD) to conduct monetary policy. The SRD represents the "credit ceiling" that the RBF imposes on commercial banks. By changing the SDR, the RBF is able to control the amount of credit that commercial banks are able to lend out to agents within the economy and hence influence the level of economic activity. Therefore it is likely that the level of the SDR is also dependent upon the same factors and forecasts that influence the PIR.

As a consequence of this regime shift, the monetary shocks will be derived from both the PIR and the SRD. Consequently, equation 11 was estimated from January 2004 till May 2007, while equation 12 below was carried out on the rest of the sample. Equation 12 was estimated using WLS.

$$\begin{aligned}\Delta SDR_m = &\propto + \delta SRD_{m-1} \\ &+ \sum_{i=-1}^{0} \rho_i \pi_{m,i} \\ &+ \sum_{i=-1}^{2} \sigma_i g_{m,i} + \beta\, reserves_{m-1} + \varphi DEVALUATION_m + \omega\, outputgap_m + \sum_{i=-1}^{2} \theta_i (g_m - g_{m-1}) \\ &+ \sum_{i=-1}^{2} \tau_i (\pi_m - \pi_{m-1}) + \epsilon_m\end{aligned} \quad \textbf{(12)}$$

Equation 12 is similar to equation 11, except that the SDR has replaced the PIR. To account for the devaluation that occurred on the 15 April 2009 a dummy named *Devaluation* was included. The

[20] We assume that the previous months reserves are weakly exogenous to the current months monetary policy.

[21] The RBF announced this change via a short press release on their website.

remaining variables are identical to those used in equation 11. Once the equations are estimated, the residuals from equations 11 and 12 will be combined to form the monetary shocks for the sample period.

1.4.1 Weights

The growth rates in equations 11 and 12 are year end forecasts of growth. The forecasted growth rates used in equations 11 and 12 imply that the RBF places the same emphasis on year end forecasts of growth in January, as it would in December. However, as the end of the year approaches, the realization of the current growth rate may also change the weights that the RBF places on current year growth forecasts. It may very well be that the RBF may start to look at next year's growth rate as its current rate of growth, as opposed to the current year end growth rate. To allow for such a possibility, I have also created a separate growth series that tries to make the weights placed on each year's forecast, a function of the twelve months in a year. [22]

$$\hat{g}_{t+k} = [1 - \omega(M)]g_{t+k} + \omega(M)g_{t+k+1} \quad \textbf{(13)}$$

$\hat{g}$ represents the weighted growth forecast.

g is the growth series used in equations 11 and 12

t is the current year end growth forecast

k is the period forecast in years, k ranges from 0 to 1, to reflect current and one year out growth forecasts.[23]

ω(M) are the weights as function of the months in a year (M); as M approaches 12, ω gets larger. Therefore in January 2004, the weight placed on 2005 growth forecast is near zero; however as December 2004 approaches, ω approaches one. So in general, meetings that are closer to December place less weight on the current year's growth forecast (t+k) and greater weight is placed on next year's growth forecast (t+k+1).

Weights were generated using the following formula[24]

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[22] This could not be done for inflation as the RBF rarely forecasts outside the current year.

[23] The RBF only forecast year end output growth two years ahead of the current period, Therefore one can only weight the current and next year's growth series.

[24] I settled on *M-12* as it means that the RBF essentially disregards this year's forecasts and considers next year's forecasts as the end of the year approaches.

$$\omega(M) = e^{M-12} \qquad M \epsilon\, Z,\ 1 \leq M \leq 12 \qquad \textbf{(14)}$$

It will be interesting to see if this alternative growth series has implications for the monetary shocks that are derived in this study.

1.4.2 Interval regressions

It is well accepted that central banks could set their policy rate at whatever rate they so choose. However the vast majority of central banks set their policy rate in twenty-five basis points increments. The RBF is no different. Therefore the WLS methodology applied to equation 11, the Romer and Romer and Bluedorn and Bowdler papers does not necessarily reflect the discrete nature of the PIR. This can often lead to biased estimates (Cameron and Huppert, 1989). This study will attempt to rectify this issue by employing interval regression methods, which helps account for the discrete nature of the dependent variable. Cameron and Huppert (1989) assess the Willingness to pay (WTP) estimates based on *OLS* and interval regression methods.

The interval regression method is based on a maximum likelihood function that takes into account the discrete nature of the data. In the WTP studies, respondents are usually given intervals, in which lies their true WTP. [25] For example WTP for an individual for good may lie between $5 and $10. Therefore OLS (and therefore WLS) would take the mid-point of the interval as the dependent variable. However, who is to say that WTP is not $5.10 or $9.75? This problem can be resolved by using the interval regression approach via the maximum likelihood procedure. For a greater discussion of the maximum likelihood procedure relevant to interval regression methods see Cameron and Huppert (1989).

The interval regression methodology from Cameron and Huppert can be applied to the PIR, as the RBF sets the PIR in increments of 25 basis points. Therefore the true PIR could possibly lie between the relevant intervals. Logically the next issue then becomes the intervals that are employed. I have decided to use intervals that are 25 basis points wide; therefore the intervals lie 12.5 basis points either side of the true PIR. For example, the lower and upper bounds for a PIR assumed to be 1.25%, would be 1.125% and 1.375% respectively. These intervals should help reflect the discrete nature of the PIR.

However, Cameron and Huppert warn of the sensitivity of interval regression and OLS methods, to the width of the intervals employed. They have found that widening or making the intervals less coarse can bias results vis-à-vis the original intervals.

Once the appropriate intervals have been sought, the following equation is estimated using the maximum likelihood procedure for interval regressions.

[25] This is done to induce higher participant response rates.

$$(lowerPIR_m, Upper\ PIR_m) = \propto + \gamma PIR_{m-1} + \sum_{i=-1}^{0} \rho_i \pi_{m,i} + \sum_{i=-1}^{2} \sigma_i g_{m,i} + \beta\ reserves_{m-1} + \omega\ outputgap_m + \sum_{i=-1}^{2} \theta_i (g_m - g_{m-1}) + \sum_{i=-1}^{2} \tau_i (\pi_m - \pi_{m-1}) + \varepsilon_m$$

(15)

All the variables and subscripts are identical to those in equation 11, except for the lower and upper bound for each period's PIR being named "*lower PIR*" and "*upper PIR*" respectively. This study also applied weights to the variables in the interval regression, to help take into account the months where there were no meetings.[26] The interval regression method will also be applied to the weighted growth series in accordance with equation *15* above.[27]

[26] This was done via the interval regression options in Stata. This study also employed robust standard errors to solve Heteroscedasticity.

[27] This is presented in the appendices and uses the same weighting system employed by the OLS methodology

1.5 Results

1.5.1 Policy indicator rate (PIR)

The sum of the coefficients on the *growth forecasts*, *inflation forecasts* and *changes in the forecast of inflation* in table 2 are all positive. This would suggest that the RBF behaves counter-cyclically which would imply that any sign of increased economic activity would be met with an increase in the PIR, to try and combat possible future inflationary pressures. The magnitude of the coefficients in this study appears larger than those in the Romer and Romer regressions. However, these estimates are quite imprecise as none of them were significant at even the ten percent level of significance.

The rest of the results show that none of the other variables, bar the PIR from the previous meeting, are significant. However, the sample size is limited to forty-one observations; consequently the degrees of freedom in the model are limited. Therefore, one faces a trade off:

- Decrease the number of variables in the regression and not account for some of the RBF expectations.
- Leave all the variables in the regression, but suffer from small sample bias.

Due to the limited sample size, this study could not address the former, without dropping variables. This study has opted for the latter as it is the goal of this chapter to remove any central bank expectations from the monetary shocks. The adjusted R^2 is quite low at approximately 2.3%, while the R^2 is approximately 42%.[28] The low adjusted R^2 could be as a result of the small sample size and the associated degrees of freedom. While the low adjusted R^2 is worrying, the focus of this chapter is not necessarily on the significance of the individual coefficients, but trying to remove as much of the RBF's systemic response to future economic conditions. Nevertheless, the R^2 would imply that the RBF does consider the variables employed in equation 11, when calculating the PIR.

The weighted growth series did not prove to have any significantly different outcomes vis-à-vis the un-weighted growth series[29]. Therefore, this implies that the RBF may not apply *weights* to their growth forecasts when deciding on the PIR. Consequently the residuals from each of the

[28] Using R^2 as a goodness of fit is dubious, as it increases when more variables are added to the regression, despite the significance of the extra variables. On the other hand, the adjusted R^2 encompasses the degrees of freedom lost vs. the gains from adding these extra variables.

[29] Refer to appendices (A.1.1) for the OLS regression results for the growth series using "M-12" as the weighting system.

regressions should be highly correlated. This can be seen via a plot of the residuals in figure 1 and by the correlation coefficients in table 4 below.

Table 2 Determinants of the policy indicator rate using Weighted Least Squares

Regressors	**Coefficient**	**P value**
Constant	-0.451	0.765
PIR from previous meeting	-0.371	0.021
Forecasted inflation		
Period		
-1	0.082	0.440
Current	0.053	0.816
Total effect	0.136	0.604
Revised forecast of inflation		
Period		
-1	0.000	0.997
Current	0.078	0.643
Total effect	0.078	0.678
Forecasted economic growth		
Period		
-1	-0.039	0.564
Current	0.070	0.558
1	0.256	0.439
2	0.385	0.161
Total effect	0.673	0.102
Revised forecast of economic growth		
Period		
-1	-0.028	0.756
Current	-0.070	0.584
1	-0.180	0.570
2	-0.235	0.228
Total effect	-0.512	0.173
Output gap	-0.002	0.878
Reserves of previous period	0.000	0.848
Adjusted R^2	**2%**	
R^2	**42%**	
N	41	

The estimates from the interval regression in table 3 below proved to be similar to those from the WLS regression in table 2, with none of the variables, bar the PIR from the previous meeting, being significant. The lack of statistical significance could be a result of the small samples used in the regression analysis. The interval regression that employed the weighted growth series generally yielded the same results. [30]

[30] The only major difference was that the lagged level of growth was found to be negative and significant. Results of the interval regression that used the weighted growth series can be found in the appendices (A.1.2).

Table 3. Determinant of the policy indicator rate using interval regression methods [31]

Regressors	Coefficient	P value
Constant	-0.449	0.602
PIR from previous meeting	-0.374	0
Forecasted inflation		
Period		
-1	0.083	0.094
Current	0.055	0.742
Revised forecast of inflation		
Period		
-1	0.000	0.995
Current	0.079	0.611
Forecasted economic growth		
Period		
-1	-0.039	0.181
Current	0.071	0.442
1	0.259	0.225
2	0.388	0.141
Revised forecast of economic growth		
Period		
-1	-0.028	0.667
Current	-0.071	0.478
1	-0.181	0.381
2	-0.236	0.153
Output gap	-0.002	0.779
Reserves of previous period	0.000	0.768
N	41	

[31] The Interval regression procedure is calculated using maximum likelihood, therefore Stata did not produce a R^2 or adjusted R^2. A persudo R^2 could be calculated but given the results in figure one below, this was not necessary.

Figure 1. Residuals from various PIR regressions

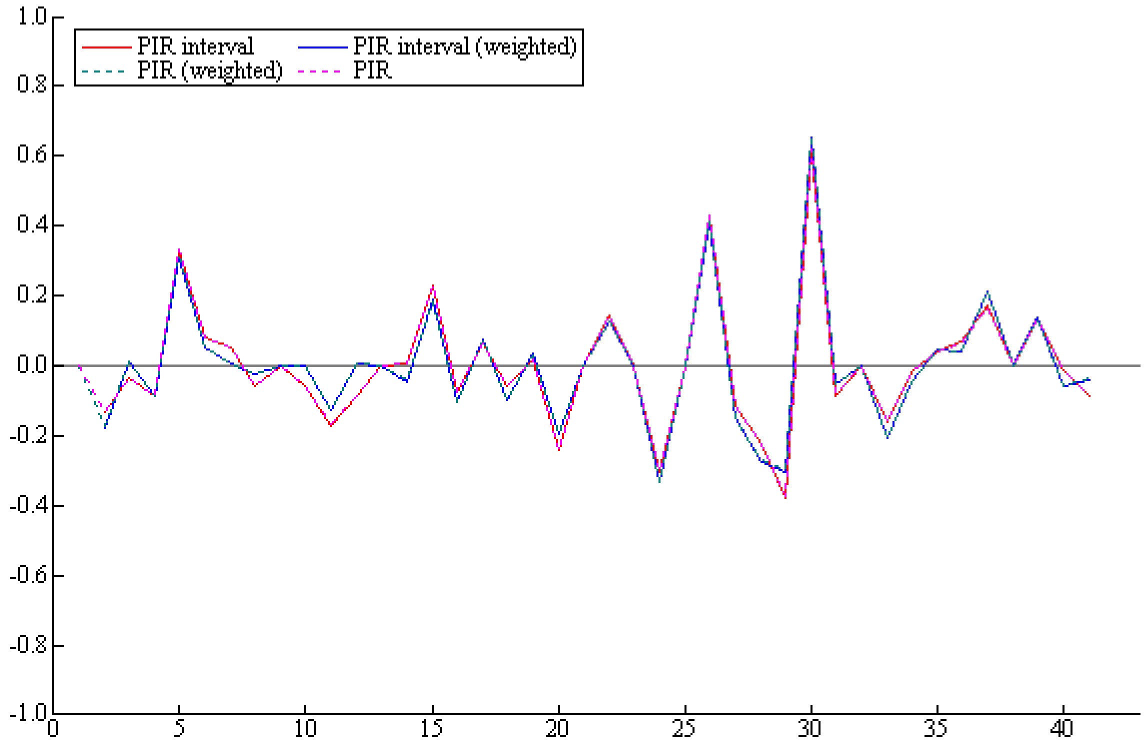

Table 4. Correlation coefficients of residuals from PIR regressions

	RR interval	RR interval(weighted)	RR (weighted)	RR
RR interval	1			
RR interval(weighted)	0.98	1		
RR (weighted)	0.98	1.00	1	
RR	1.00	0.98	0.98	1

The plots of the different monetary shocks as well as the correlation coefficients reveal that the shocks generated from the WLS and interval regression methods are very similar. In addition, the weighted growth series has not produced significantly different results from the un-weighted series. As a result, this study will use the monetary shocks that are generated with WLS, using the un-weighted growth series.

1.5.2 Statutory reserve deposit ratio (SRD)

The sum of the growth forecasts, inflation forecasts, revisions of growth forecasts and revisions of inflation forecasts in table 5 below would imply that the RBF behaves in a pro-cyclical manner[32]. Therefore, any sign of future economic growth would be further encouraged with a lowering of the SDR. A lower SDR would imply an easing of monetary policy, which would encourage economic activity and eventually raise inflation. This is peculiar, particularly with regard to the sum on the inflation forecasts, as this implies that an increase in forecasted inflation would imply a decrease in the SDR, further exacerbating the problem.

However, given the various coups that have occurred in Fiji since 1987, policy makers have tried to revive the Fijian economy.[33] Therefore the pro-cyclical behavior of the RBF could be viewed as a response to the Military coup in December 2006. The global recession that plagued economies worldwide may also help explain the RBF's pro-cyclical behavior. Consequently, the RBF may have been willing to allow for higher inflation, in return for greater economic growth. Therefore, underpinning forecasts of economic growth with looser monetary policy may have been an attempt to help nurture future growth and not stifle it with tighter monetary conditions. Further evidence of this can be seen via the magnitude of the coefficients on the sum of the growth forecasts vs. those on the sum of the inflation forecasts, which suggest that growth has a greater influence on the SDR. In addition the devaluation in April 2009 could further prove the RBF's stance on inflation, as it resulted in inflation spiking to 10% in May 2010.

A devaluation would normally cause an increase in the price of imports, hence driving up inflation. Since Fiji is a net importer, this would also eventually increase the costs of production, which would lead to an increase in the price of local goods and hence inflation. Therefore one would expect the coefficient on the devaluation term to be positive and not negative, as observed in the above results. However, the devaluation may have helped increase the competitiveness of Fijian exports and help increase economic activity, which would then be further stimulated by looser monetary conditions, thus possibly explaining the negative coefficient.

[32] However, these coefficients were found to be statistically insignificant. This problem may have been as a result of the limited sample size and the associated degrees of freedom.

[33] We have not included a dummy for the 2006 coup as it could be viewed as unexpected event and therefore may invoke an unexpected policy response.

The adjusted R^2 (70%) is relatively high when compared to the PIR regressions (2-3%) while the R^2 is approximately 86%.[34] The high R^2 would imply that the RBF does place considerable emphasis on the variables employed in equation 12, when calculating the SDR. The results from the SDR regressions that were carried out using the weighted growth series have been shown to be quite different.[35] Of particular interest is the sign on the coefficients of the growth forecasts, inflation forecasts, revisions of growth forecasts and revisions of inflation forecasts. They appear to be the complete opposite of the un-weighted growth series and consequently more consistent with conventional economic theory. The sum on the growth forecasts and the revision of inflation forecasts also appears to be statistically significant, which was not present in any of the other regressions.

[34] Using R^2 as a goodness of fit is dubious, as it increases when more variables are added to the regression, despite the significance of the extra variables. On the other hand, the adjusted R^2 encompasses the degrees of freedom lost vs. the gains from adding these extra variables.

[35] These can be seen in the appendices (A.1.3). The weights employed are identical to those used in the PIR regression from section 1.4.1.

Table 5. Determinants of the SRD using Weighted least squares (WLS)

Regressors	**Coefficient**	**P value**
Constant	2.667	0.046
SRD from previous meeting	-0.226	0.359
Forecasted inflation		
Period		
-1	0.083	0.057
Current	-0.111	0.015
Total effect	-0.028	0.585
Revised forecast of inflation		
Period		
-1	-0.060	0.344
Current	-0.029	0.519
Total effect	-0.089	0.196
Forecasted economic growth		
Period		
-1	-0.026	0.515
Current	-0.184	0.132
1	0.262	0.367
2	-0.819	0.057
Total effect	-0.767	0.238
Revised forecast of economic growth		
Period		
-1	-0.012	0.855
Current	-0.111	0.286
1	-0.442	0.128
2	1.197	0.010
Total effect	0.632	0.316
Devaluation	-1.675	0.003
Output gap	-0.022	0.542
Reserves of previous period	0.000	0.821
Adjusted R^2	**70%**	
R^2	**86%**	
Aikaike	**47**	
N	31	

The plot and correlation coefficients of the residuals from the two regressions are shown below. They reveal that there is indeed a marked difference between the two series and therefore using the weighted growth series may influence the results obtained.

Figure 2. Residuals from the various SRD regressions

Table 6. Correlation coefficients of residuals from SRD regressions

	weighted residuals	un-weighted residuals
weighted residuals	1	
un-weighted residuals	0.42	1

To help select which model to use, without appearing to favor a model that gave what was conventional, this study employed two different criteria. The first was via the widely accepted Aikaike criterion, while the second was the adjusted R^2. Both measures found that the model using the un-weighted growth series was superior to the model that employed the weighted growth series. In light of this result, this study will persist with the un-weighted series. However, due to the small sample used in equation 12, it must be emphasized that these results may suffer from small sample bias and limited degrees of freedom.

1.5.3 The amalgamation of SRD and PIR residuals

Changes to the PIR and SRD may have different effects on commercial interest rates. Therefore simply adding the residuals from the PIR and SRD regressions may not be correct. To gauge the effects of the PIR and SRD on market interest rates and subsequently determine how to splice the residuals from the PIR and SRD series together, we need to look at the effects that these two series have on a common interest rate. We have decided to regress the interest rate that the RBF charges on short term loans to banks (Brate), against the PIR and SRD respectively. [36]

The first regression equation is carried out from January 2004 to May 2007 using the following specification:

$$Brate_t = c + \alpha PIR_t \quad \textbf{(16)}$$

The second regression is carried out from June 2007 till December 2009 and uses the following specification:

$$Brate_t = d + \gamma SRD_t \quad \textbf{(17)}$$

c and d are constants of the regression

α and γ are the effects that the PIR and SRD have on the short term interest rate (*Brate*)

[36] Regressions were carried out using OLS. *Brate* is available from the IMF-IFS data base and covers the entire sample period.

	Coefficients[37]
c	0.14
d	-2.97
α	1.19
γ	1.36

The scale factor from which we can determine how to splice our series is calculated using the coefficients on the PIR and SRD variables. The scale factor is set relative to the PIR.

$$scale\ factor = \frac{\gamma}{\alpha} \quad \textbf{(18)}$$

The scale factor calculated from equations 16 and 17 equates to 1.14. This makes intuitive sense as a scale factor greater than one would imply that the SRD (a form of direct intervention) has a greater effect on commercial rates than the PIR. However, in this case the effects of the PIR and SRD are similar.

Using our scale factor the amalgam of residuals from the PIR and SRD regressions are calculated using equation 19 below:

$$residuals = PIR + \frac{\gamma}{\alpha}SRD \quad \textbf{(19)}$$

The scale factor is close to one which would imply that the residuals that have been generated by simply adding the PIR and SRD residuals are near identical to the residuals generated using a scale factor of 1.14.

[37] Both coefficients are positive which is consistent with economic theory. The t-stats have not been included as the significance of the individual variables is not the primary objective of this exercise.

Figure 3 Residuals using scale factor of 1.14 vs. residuals from using a scale factor of 1

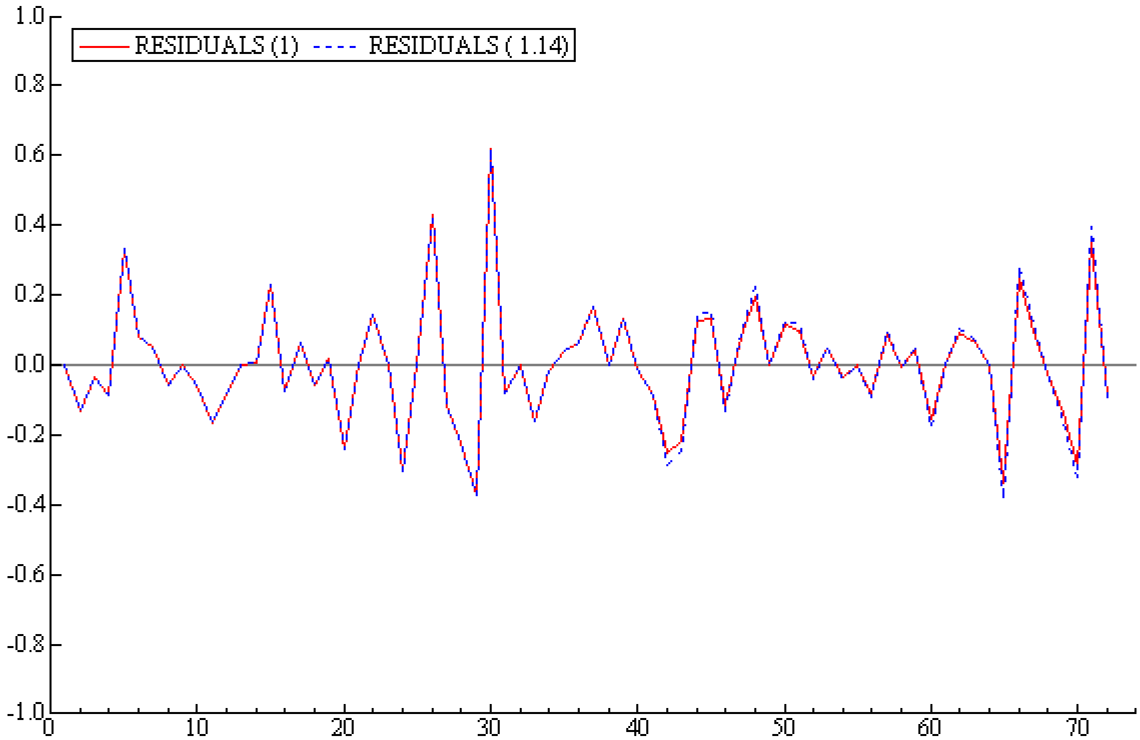

Table 7. Correlation between residuals (scale factor of 1) vs. residuals (scale factor of 1.14)

	Residuals (scale factor =1)	Residuals (scale factor =1.14)
Residuals (scale factor =1)	1	
Residuals (scale factor =1.14)	1.00	1

Since there is very little difference between the two residual series, the residuals which have been calculated with a scale factor of one (which is equivalent to simply adding the residuals from the PIR and SRD regressions) will be sufficient for obtaining residuals that cover the entire sample period.

1.6 Translating meetings to months

1.6.1 Romer and Romer shocks

The time intervals in the Romer and Romer regressions were based on meeting dates and not symmetric time intervals. Subsequently, the residuals from their regressions (monetary shocks) needed to be transformed into symmetric time intervals. Romer and Romer address this issue by simply putting a zero for months where there was no meeting and if more than two meetings occurred in a month they would simply add the resulting shocks.

Thanks to WLS, the residuals from our regressions are in symmetric time intervals. To ensure that the months without meetings have no monetary shocks, we simply multiply the residual series by a series that contains 1 for months when the board had a meeting and 0 for months when the board did not meet. [38]

1.6.1 Bluedorn and Bowdler shocks

Bluedorn and Bowdler argue that the Romer and Romer approach above ignores the "*dynamic and contemporaneous*" effects of monetary policy on the economy (Bluedorn and Bowdler, 2006). Subsequently, Bluedorn and Bowdler advocate weighting the shocks relative to when they occur within the month.

The methodology for the Bluedorn and Bowdler (BB) approach (as applied in this study) is as follows:

1. The first step is to cumulate the shocks of the monthly Romer and Romer (RR) series (y_t). This translates the monetary shocks into an I(1) series as it is approximately taking the integral of the series.

   $$F_z = \sum_{t=1}^{z} y_t$$

2. The next step is to weight the shocks according to when they occur within the month.

   $$P_z = \propto_i F_z + (1 - \propto_i) F_{z-1} \qquad {}_{i=meeting\ dates}$$

where α_i is the weights based on when the RBF board meetings occurs. To create the weights from the meetings, one simply takes the meeting date of the board as a weighted average based on the number of days within a month. Therefore if the meeting occurs toward the end of the month, more weight is placed on the previous month's shocks. If there was no meeting in the month, the weight (α_i) would equal zero. Take the following example:

Shock in January 2004 is zero (F_{z-1}=0)

Shock that occurs on the 10 February 2004 is equal to 50 basis points (F_z=0.5%). [39]

$$\alpha_i = \frac{29-10}{29}$$

Therefore, the shock for February is equal to:

$$\left[\frac{29-10}{29}\right] 0.5\% + \left[\frac{10}{29}\right] \times 0 = .3276\%$$

3. The last step is to take the difference of the weighted series to transform it back into a stationary series $(\widetilde{Y_z})$.

From figure 4 it appears that the BB shocks lag the RR shocks. This is attributed to the weights that are applied in the BB series. In addition the magnitude of the BB shocks also appears less extreme vis-à-vis the RR shocks. The former is particularly interesting and could be a result of the *moving average* component the BB series introduces to the shock series. This should not be viewed as problematic, but instead as an alternative way to measure monetary shocks. The following helps explain how this moving average component comes about.

Incorporating the three steps above:

$$F_z = \sum_{t=1}^{z} y_t$$

$$P_z = \propto_i F_z + (1 - \propto_i) F_{z-1} \qquad \text{i=meeting dates}$$

where α is the weights based on when the RBF board meetings occurs

$$\widetilde{Y_z} = d(P_z) = \left[\propto_i \sum_{t=1}^{z} y_t + (1 - \propto_i) \sum_{t=1}^{z-1} y_t\right] - \left[\propto_{i-1} \sum_{t=1}^{z-1} y_t + (1 - \propto_{i-1}) \sum_{t=1}^{z-2} y_t\right]$$

---

[38] Throughout the sample period, the board never had more than one meeting in a month.
[39] 2004 was a leap year hence the 29 days in February.

$$\widetilde{Y}_z = \propto_i y_z + \sum_{t=1}^{z-1} y_t - \propto_{i-1} y_{z-1} - \sum_{t=1}^{z-2} y_t$$

$$\widetilde{Y}_z = \propto_i y_z - \propto_{i-1} y_{z-1} + y_{z-1}$$

$$\widetilde{Y}_z = \propto_i y_z + (1 - \propto_{i-1}) y_{z-1} \quad \textbf{(20)}$$

Some literature suggests that the timing of information releases in itself contains valuable information. This is an issue that is scrutinized in financial markets, particularly with the arrival of intraday trading data, where new information does not arrive in symmetric time intervals. Engle (2000) looked into this issue in the context of news releases in financial markets. He develops a model that deals with the time irregularities as opposed to trying to adjust the data into fixed and regular time intervals (putting zeros for times where there were no observations). Therefore, it may be of interest to ascertain the effects of the timing of the meetings and consequently the effects of information releases, on monetary shocks. However, it could be argued that Bluedorn and Bowdler have tried to address this issue by weighting the shocks, according to when the board meetings occur within the month.

Figure 4. Monthly Shocks derived using the Romer and Romer (RR) and Bluedorn and Bowdler(BB) aggregation methods

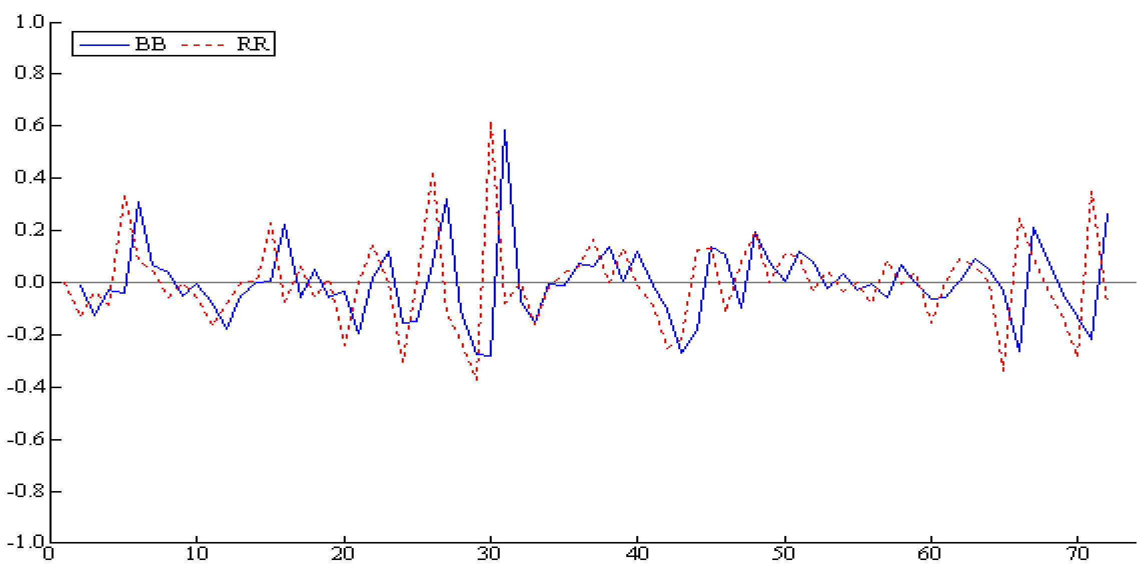

Table 8. The monetary shock series based on the BB aggregation method

	2004	2005	2006	2007	2008	2009
Jan	.	-0.0511	-0.1478	0.0622	0.0818	-0.0555
Feb	-0.0138	0.0007	0.0765	0.1363	0.0039	0.0066
march	-0.1263	0.0042	0.3220	0.0083	0.1220	0.0940
April	-0.0294	0.2239	-0.1079	0.1191	0.0789	0.0543
May	-0.0403	-0.0593	-0.2737	-0.0100	-0.0256	-0.0328
June	0.3078	0.0520	-0.2798	-0.1027	0.0371	-0.2643
July	0.0669	-0.0549	0.5858	-0.2692	-0.0308	0.2106
August	0.0409	-0.0326	-0.0708	-0.1839	-0.0051	0.0932
Sept	-0.0491	-0.1944	-0.1527	0.1385	-0.0602	-0.0472
Oct	-0.0055	0.0181	-0.0078	0.1061	0.0705	-0.1298
Nov	-0.0792	0.1224	-0.0130	-0.0987	-0.0006	-0.2193
Dec	-0.1778	-0.1576	0.0735	0.1920	-0.0658	0.2634

1.7 Discussion

From the various regressions that were carried out, it becomes apparent that the RBF places a heavy emphasis on their forecasts of growth and inflation. It must be emphasized that this study is not trying to estimate a reaction function or Taylor rule. We are simply trying to formulate monetary shocks free from market expectations. Indeed the R^2 of the regressions do reveal that economic agents' forecast of inflation and growth, as well as the other variables used in the regressions, do account for some of the RBF's decision making process. Therefore, using the residuals from these regressions should produce monetary shocks that are free from market expectations. [40] We tried to use the interval regression methods to account for the discrete nature of the PIR however, the results were extremely close to those from the OLS procedure and therefore did not warrant a change in estimation method.

However, it is interesting that reserves do not appear to be significant in any of the regression methods, given that the RBF are committed to maintaining a stable exchange rate. Consequently, the lack of statistical significance associated with reserves could imply that reserves are not an exogenous determinant of monetary policy. On the contrary, it may appear that monetary policy may determine the level of reserves used. The following example may help clarify this notion. A looser monetary policy would induce higher aggregate demand and greater economic activity. However, since Fiji has strict capital controls, interest rate differentials cannot be exploited, thus closing a direct exchange rate mechanism. Nevertheless, an increase in economic activity would increase the demand for imports and hence import receipts. This would consequently lead to an increase in the supply of Fijian dollars. If the exchange rate fluctuates within its prescribed band, then the RBF need not intervene. However, if the exchange rate were to deviate below its prescribed band, then the RBF would have to sell reserves to bolster the dollar back within target. Consequently, looser monetary policy would indirectly lead to a decrease in foreign reserves.

However, if the dollar continued to depreciate over a substantial period of time (as is the case in Fiji as it is a net importer), intervention in the foreign exchange market cannot be sustained. This would imply tighter monetary conditions to help reserves recover. However, the recent financial crisis and coups have meant that the RBF has had to try and foster economic growth; therefore tighter conditions may have been viewed as counter-intuitive. To help ease the strain on reserves,

[40] Given that the RBF forecasts are made public, it is safe to assume that market expectations embody the expectations of the majority of agents within the economy.

the RBF devalued the dollar in April 2009. The above illustration would imply that perhaps monetary policy is an indirect determinant of reserves.

We have not included variables that control for external economic conditions. However seeing as reserves did not appear significant, it made sense not to include these additional variables as foreign conditions would ultimately influence reserves and thus invoke a monetary policy response. Seeing as reserves were not significant in any of the regressions, including foreign variables in the PIR and SRD regressions would not yield additional benefits, especially since there are already limited degrees of freedom with the current variable set.

While the narrative approach to formulating monetary shocks appears relatively straightforward and concrete, there are caveats to consider. Bluedorn and Bowdler raise the important issue that the data used to set monetary policy (the PIR and SDR) at board meetings may embody market expectations of the expected PIR and SDR after the board meeting. However, as the forecasts are released after the PIR and SDR have been set, it is unlikely that any reverse causation would occur. Furthermore Bluedorn and Bowdler suggest that this problem could be averted if economic variables take a sufficiently long time to respond to policy. This idea is not so farfetched, particularly in a small developing economy where the transmission of monetary policy may not be as quick as more developed economies. Given that the forecasts used are generally exogenous, a single equation approach can be adopted, as been done in this study.

Another caveat is the quality and size of the RBF forecasts. While the RBF is arguably the most developed central bank in the Pacific region, bar those of Australia and New Zealand, it is still relatively small and under-resourced compared to banks in the developed countries in the world. Therefore the forecasts that the RBF generates, while being the best available in Fiji, may not be comparable to the Federal Reserve's forecasts of the US economy. Given the quality of the forecasts, policy decisions based on this can be viewed with some degree of cynicism.[41]

The shocks generated in this study could be used across a host of aggregate and disaggregate economic variables within Fiji, to gauge the effects of these shocks on these variables.

[41] However, comprehensively comparing the quality of forecasts formed by the RBF is beyond the scope of this paper.

Chapter 2

2.1 Introduction

This chapter looks to utilize the monetary shocks formulated in the previous chapter and analyze their effects on aggregate regional price indices and their components.

The effects of monetary shocks on aggregate output, prices and other economic variables for each country as well as across countries are well documented in the literature. However, only a few studies have actually investigated the asymmetries that these monetary shocks cause **within** a country. Carlino and DeFina (1998) investigated the asymmetric response of regional output to monetary shocks in the US. Fielding and Shields (2007) investigated the asymmetric effects of monetary shocks on intercity price levels in the US. However, there is a void in the literature on the intra-country effects of monetary policy on a small Pacific Island economy. Therefore it is hoped that this body of work will go some way in addressing this issue and serve as a template for further work on the effects of monetary policy on small Pacific Island countries.

The analysis in this chapter is carried out from January 2005 till December 2009.[42] The general consensus from the results is that the effects of monetary shocks on the price level are a short run phenomenon. However, regional prices do appear to respond asymmetrically to monetary shocks, although these symmetries are found to be short-lived. Regional inflation differentials caused after a monetary shock are also found to dissipate within a year.

The chapter is structured as follows: the first section will review the relevant literature; this is to be followed by an outline of the data used and the methods employed in this study. We then present the results section, followed by the conclusion.

[42] The time period was motivated by the availability of data.

2.2 Literature review

This section will provide an introduction and brief explanation of the real exchange rate followed by a brief survey of the literature of the real exchange rate in an international context. While the latter may not be directly related to this study, it does give a flavor of the context in which the real exchange rate concept was developed. This is to be followed by a review of the intra-country real exchange rate as well as real exchange rates within a currency union, and whether purchasing power parity (PPP) holds in the long run. A country can be likened to a currency union, as each of the regions within a country, (like member countries within a currency union) shares a common currency.[43] Following the review of intra-country real exchange rates, this study will examine the literature on what factors allow or hinder real exchange rate convergence and the rate at which it converges. Attention will also be placed on the type of shocks that affect the intra-country real exchange rate (in particular monetary shocks) and what these imply for real exchange rates within Fiji.

This study will then make a case for the relevance of the literature *on the inflation differentials between regions within a currency union* and how it relates to intra-country real exchange rates. It will also briefly look into the idea of sticky prices and what this entails for the response of prices to monetary shocks.

2.2.1 The real exchange rate: a brief introduction and context in an international and intra-national setting

The stationarity of the real exchange rate and the implications for (PPP) have been keenly debated in the literature for over two decades. Consequently a wealth of studies have investigated international deviations of the real exchange rates and the implications for PPP. Before a review of the literature can take place, the following helps outline some of the basic principles behind the real exchange rate. The real exchange rate can be defined as follows:

Consider countries A and B. The real exchange rate is defined as:

$$\frac{P^A}{P^B \times ER} = real\ exchange\ rate \qquad \textbf{(21)}$$

[43] However, monetary unions may also have autonomous fiscal policy, while a country has a common fiscal policy.

P^A is defined as the price of goods in country A

P^B is defined as the price of goods in country B

ER is the nominal exchange rate between A and B expressed as the price of currency A in terms of currency B

In theory, any deviation between the two prices in A and B should be captured by the adjustment of the *nominal exchange rate* so that the *real exchange rate* is constant. The real exchange rate does not have to equal one, but can reflect a constant price differential between A and B because of transport costs or other trade related costs. Any deviation of prices in A or B that is not captured by the nominal exchange rate should result in arbitrage opportunities which would help restore PPP. A necessary (but not sufficient) condition for PPP requires a stationary long run real exchange rate, which would imply that the real exchange rate is not permanently affected by shocks (Cheung and Lai, 2000). Under this framework, PPP misalignments should only occur in the short run and in the long run revert to a stable equilibrium.

Over the years, the scores of studies in the field have presented evidence for and against the acceptance of PPP. The review by Taylor and Taylor (2004) provides an overview of studies that have been undertaken since the end of the Breton Woods era.

Studies based on the immediate post Breton Woods period (1972-1973) found support for PPP, which appeared to hold continuously Frenkel (1976), Frenkel and Johnson (1978). In hindsight this result was likely brought about by the lack of floating exchange rate data, as a result of the recent abandonment of the Breton and Woods exchange rate regime, which may have also resulted in a transitional phase which caused stable nominal exchange rates (Taylor and Taylor, 2004). The evidence on PPP changed dramatically in the early eighties as more exchange rate data became available and the exchange rates had greater variation, possibly due to the oil shocks that engulfed economies around the world (Frenkel, 1981).

From the period of the late seventies till the mid eighties, researchers used the following equation (and slight variants) to test whether the real exchange rate was mean reverting, or whether it followed a random walk process:

$$RER_t = c + \alpha RER_{t-1} + \varepsilon_t \quad \textbf{(22)}$$

RER is the real exchange rate

C is a constant

α is the coefficient in front of the autoregressive term. This term would be tested against the null that it was a random walk (and hence equal to one) or the alternative that it was mean reverting (significantly less than one)

ε_t is the random error term ~N(0,1)

It appeared that the results of these studies varied according to the subtle variations in the method and assumptions employed.[44] In hindsight, the results were most likely due to the potential non-stationary data. This meant that the traditional, asymptotically normal critical values that were used in these models were no longer valid.

However, toward the end of the eighties the literature on unit root testing started to gain momentum. Critical values were generated that took into account the potential non-stationary nature of the data. Studies then began to apply this new-found testing strategy on the real exchange rate data. The test equation that was typically employed by these studies was similar to equation 22, but used the newly simulated critical values.

The null hypothesis was that the real exchange rates followed *a random walk with drift.* This would imply that the α term was equal to one, thereby implying that the first difference of the real exchange rate would be equal to the constant term (c) and the random error term (ε_t) which was assumed to be *N(0,1)*. The vast majority of these studies (which were predominantly in the context of developed countries) could not reject the hypothesized unit root process. However, it is now generally accepted that these unit root tests suffered from low power.

Since then there has been an array of different tests for the stationarity of the real exchange rates and the implications for PPP. These have ranged from panel unit root tests (Holmes, 2000) which use time series data for multiple countries in a panel, to using smooth transition autoregressive (STAR) models and variants such as the exponential smooth transition autoregressive (ESTAR) (Baum et al., 2001, Michael et al., 1997). Proponents of the panel unit root tests cite the power

[44] Lagged dependent variables or procedures similar to the Cochrane-Orcutt method were used to adjust for serial correlation. In addition, the data span and data used in the regression equations varied.

gains derived from the increased number of observations, while advocates of the STAR models cite the possibility of the real exchange rate following a non-linear adjustment process. The latter implies that the rate of convergence is not constant, but is conditional on how far along the real exchange rate is in the adjustment process.

The time taken for an international real exchange rate to recover from fifty percent of a shock is known as a half life. This can take anywhere from two to five years for developed countries such as the US or those in Europe (Cheung and Lai, 2000, Wu, 1996, Coakley and Fuertes, 1997, Kilian et al., 1999).[45] Studies have also investigated whether PPP is likely to hold between the least developed countries (LDCs) and their trading partners, in addition to estimating the half lives of their real exchange rates. Cashin and McDermott (2004) state that rapid growth prevalent in LDCs tends to increase the relative price of tradables and non-tradables which would cause a slower real exchange rate reversion or a longer half life. Furthermore one could argue that LDCs tend to have lower levels of infrastructure relative to developed countries, which would lead to greater price dispersion via higher transport costs.

However, Cheung and Lai (2000), Holmes (2001) and Crucini and Shintani (2008) suggest that LDCs have a half life of approximately one to three years. These studies state that this is quicker than in developed countries, as LDCs often have higher levels of inflation vis-à-vis developed countries, which makes real exchange rate adjustments faster (Cheung and Lai, 2000). Crucini and Shintani (2008) also state that LDCs tend to have more volatile nominal exchange rates which can often make real exchange rate adjustment much quicker.

In the context of the South Pacific and in particular Fiji, there have been limited studies on whether real exchange rates are mean reverting or non-stationary. Narayan and Prasad (2008) found that Samoa and Papua New Guinea had stationary real exchange rates with their trading partners, while Fiji and the Solomon Islands displayed a non-stationary real exchange rate.

However, it must be emphasised that the articles cited so far are in the context of multinational and inter-country studies and not necessarily in an intra-country context. Since all the regions in Fiji use the same currency, the real exchange rate from equation 21 is reduced to the relative prices between the various regions.[46]

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[45] Half lives refer to the **time** taken to recover from 50% of the shock. The process of recovery is known as convergence.
[46] The term *relative prices* and the *real exchange rate* will be used interchangeably from here on.

$$\frac{P^A}{P^B} = real\ exchange\ rate$$

Intra-country real exchange rates, unlike inter-country real exchange rates, are not affected by fluctuating nominal exchange rates and trade barriers (Parsley and Wei, 1996). Engel and Rogers (1996), Parsley and Wei (1996), Cecchetti et al. (2002) and Crucini and Shintani (2008) are some of the authors who have looked at real exchange rates within the US. They generally found that the real exchange rate is stationary amongst the majority of cities and regions included in their studies. Consequently prices in the US are exhibiting some form of convergence in the long run. This means that prices are allowed to differ in the short run (often due to shocks), but move toward their long run equilibrium. In the European context, Blanchard (2004) and Rogers (2007) found that prices across Europe have been converging since the completion of the *single market* intitative in 1993.

The majority of the studies surveyed applied variants of the panel unit root tests, which are more powerful than the traditional univariate unit root testing methods. However, while these studies found that the majority of the real exchange rates were stationary, the rates at which prices converged differed across studies. This could be due to the differences in the sample period and frequency of the data used.

The majority of the literature cited above confirms the convergence of prices within a currency union. The subsequent logical step is to ask "what influences the rate of convergence and what may hinder it?"

Unlike international real exchange rates, prices within a single currency area do not suffer from exchange rate volatility, tariffs or other political barriers to trade. Consequently, there must be other factors that influence regional price differences and the rate of relative price convergence.

Engel and Rogers (1996) and Crucini and Shintani (2008) suggest that geography as well as border effects may be responsible for some of the price differences observed in the continental US. Geography relates to the physical distance between trading partners. Therefore, the greater the distance between two trading partners, the greater the costs associated with transporting goods between trading locations. Border effects may account for the intra-country integrated marketing activity, such as price mark ups and advertising, which are possibly country specific. This is an explanation supported by Engel and Rogers who found that cities lying on opposite sides of the US and Canadian border, were more likely to have greater price diversity vis-à-vis cities that were an equal distant apart, but within the same country.

One could also argue that different region specific tax rates, which are common in the US, could help dictate the rates of convergence amongst prices. Measurement errors and other errors in the data may also hinder the rates of convergence. Parsley and Wei (1996) found that measurement error did not impact on the rate of convergence.

However, Parsley and Wei (1996) did observe that the distinction between tradable and non-tradable commodities helped explain the discrepancy in the rates of convergence. This is consistent with the Balassa–Samuelson (BS) effect, which states that two regions may have different overall price levels because of their non-traded goods, which are not subjected to arbitrage opportunities. [47] The BS effect has often been used in an international context, but it makes just as much sense in an intra-national setting.

The size of a shock to prices has also been put forward by some as an explanation of why prices may remain diverse within a country. Relative prices may be allowed to fluctuate within a band (*band of inaction*). If relative prices deviate within this band, there is little incentive for arbitrage: this may be due to transport or menu costs outweighing the potential gains from arbitrage. Consequently, small shocks can cause persistent deviations of the relative prices (assuming the relative prices stay within the *band of inaction*). However, large shocks which push the relative prices outside this *band of inaction* will cause swift adjustment back toward equilibrium due to the presence of arbitrage. Cecchetti et al. (2002) had similar findings when looking at the relative prices amongst cities in the US.

In the Fijian context the transport cost rationale for regional price diversity is valid, given the country is made up of many small islands, where transport costs are likely to influence prices. The Balassa Samuelson effect could also contribute to price differences, given the potential price differential of non tradable services amongst the regions in Fiji. Lastly, the size of the shocks on prices may only result in minor price differences across regions, which may not be enough to induce arbitrage opportunities. However, *border effects* could not possibly explain regional price differences in Fiji, given that all the regions in the country are subject to the same integrated marketing strategies. In addition none of the regions has its own fiscal policy. Instead they are all subjected to the universal tax system set by the government.

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[47] For a further exposition into the Balassa Samuelson effect refer to Pilbeam Pilbeam, K. 1992. *International finance*, Palgrave Macmillan, 2006.

These studies represent some of the widely held views on the determination of the intra-country real exchange rates and the speed at which they recover from shocks. However, the majority place little emphasis on the type of shock and the source of the shocks which affect relative prices. The literature on the source of these shocks, whether oil price shocks or monetary shocks and their effects on relative prices, are few and far between.

Carstensen et al. (2009) looked into the effects of oil price shocks on prices in the euro area. They found that these shocks had a heterogeneous effect on prices across Europe. In addition, they state that the short run heterogeneity is due to the differences in weights placed on *energy items* in the consumption index of the various countries. Heterogeneity in the medium term is caused by the degree of wage and price rigidities prevalent in the countries concerned.

With regard to the asymmetric effects of monetary policy on prices within a common currency area, Fielding and Shields (2006) looked at this issue in the context of South Africa. They found that there was no long run integration of prices at the provincial level and more importantly, monetary policy led to persistent and significant changes to relative prices amongst the regions. However, Fielding and Shields did not investigate the components of the CPI for each of the regions. Arguably, some of these components in the regional CPI may be more responsive to monetary shocks than the rest. The weighting of these items in the regional CPI could potentially drive the regional price response to monetary shocks. If these *sensitive* components have different weightings in each of the regional consumption indices, then this could very well be the source of the asymmetric response of aggregate regional CPI to monetary shocks, particularly in the short run.

Fielding and Shields (2007) looked at the effects of monetary shocks in the US and also noted that monetary shocks had significant asymmetric effects on the price level for each of the cities concerned. However, they go a step further than their study of South Africa and look at the disaggregated CPI components for each of the cities as well as trying to quantify and explain why and what demographic and economic city-specific characteristics may cause such asymmetries. They use firm size, the share of interest sensitive industries, bank size, house prices and the age demographic for each of the cities. They note that all of the above, bar firm size and population proxies (which were highly correlated), are significant determinants in the asymmetric responses of cities to a monetary shock.

The evidence presented by the articles above show that prices seldom react symmetrically to shocks, whether they be oil or monetary shocks. Consequently, one could argue that there is a need for central banks to coordinate monetary policy across the regions within a currency area and that the "*one shoe fits all"* policy can have serious consequences. As noted by Fielding and Shields (2006) in their study of South Africa, these asymmetries could hinder regional competitiveness, which may have negative effects on regions that are already worse off vis-à-vis the rest of the country. Furthermore, Carstensen et al. (2009) advises that monetary authorities should place greater emphasis on regions that appear to have greater rigidities when formulating monetary policy. In the Fijian context, quantitatively addressing which factors are responsible for the monetary policy asymmetries (if they exist) amongst the regions may not be possible due to the limited regional data available. However, identifying potential asymmetries in the regional response to monetary shocks may be an incentive to start investigating the factors responsible for these asymmetries.

From a methodological point of view, there are subtle differences in the methods used in the study of South Africa and the US. The most significant is the modeling of inflation (former) vs. relative prices (latter); one could argue that policy makers place more emphasis on inflation and their differential, amongst the regions. With this notion in mind, the following helps bridge the literature on relative prices and inflation differentials between the different regions in a currency area.

2.2.2 Relative prices and inflation differentials within a currency union

It is easily shown how relative prices are related to inflation differentials. Taking logs of equation 17 yields (remembering that nominal exchange rate is equal to one):

$$\ln\left(real\ exchange\ rate_t\right) = ln\left[\frac{P_t^A}{P_t^B}\right] = rer_t$$

Taking the first difference of the log of the real exchange rate (rer_t) yields:

$$\Delta rer_t = ln\left[\frac{P_t^A}{P_t^B}\right] - ln\left[\frac{P_{t-1}^A}{P_{t-1}^B}\right]$$

The above is equivalent to the inflation differential between A and B:

$$\pi_t^A - \pi_t^B = ln\left[\frac{P_t^A}{P_{t-1}^A}\right] - ln\left[\frac{P_t^B}{P_{t-1}^B}\right] = \Delta rer_t \quad \textbf{(23)}$$

This relationship helps introduce the relevance of the literature on the inflation differentials between regions within a currency union. More importantly, the above formulae can be used to explore if there exists an inflation differential amongst the regions in Fiji and how long it persists, particularly after a monetary shock.

There are several sources of inflation differentials amongst regions in a common currency area. Angeloni and Ehrmann (2007) simulate a stylized 12 country model to emulate the European union. They then subject their model to aggregate demand and supply shocks and note the inflation differentials that are created as a consequence of these shocks. The resulting inflation differentials are largely attributed to inflation persistence. Furthermore, high levels of inflation persistence, even if they are symmetric across member countries, could actually widen the inflation differential vis-à-vis other factors. Other factors which account for the inflation differentials include asymmetries in the transmission mechanism. As a result of their findings, Angeloni and Ehrmann advocate controlling area-wide inflation and limiting the deviations from target inflation, as a means of keeping the inflation differential between member countries at a minimum. In the context of Fiji this last point seems particularly important, as the devaluation of April 2009 has meant inflation for Fiji is well above its three percent target. This implies that the increase in the overall inflation rate (10.5% as at May 2010) could **increase** the inflation differential amongst the regions in Fiji.[48]

However, Angeloni and Ehrmann do not explictly specify the aggregate demand (AD) and supply (AS) shocks that are applied to their model. These could have ranged from fiscal and monetary (AD) to productiuvity and oil shocks(AS).

Duarte and Wolman (2002) investigate the simulated effects of regional fiscal policy on the inflation differential between two regions in a European context.[49] The authors then subject their model to fiscal shocks and find that this does not exhibit any significant influence. However, as mentioned earlier, Fiji has a central government with no region-specific fiscal policy. Subsequently, studies which have cited regional fiscal policy as a potential driver of inflation differentials would do little in explaining inflation differentials amongst the regions in Fiji.

[48] However, our sample ends at December 2009 and the full effect of the devaluation on prices did not occur till the later months of 2009 and early 2010. Consequently, the full effects of the devaluation on the regional inflation differential may not be captured by this study.

[49] They use the *popular* DSGE modelling approach to simulate inflation differentials. Furthermore they cite traded vs non-traded goods and the ability of producers to price discriminate across markets as possible channels for inflation differentials. This is consistent with what was answered above with regards to *"what causes convergence and what influences the rate of convergence?*

Duarte and Wolman have carried out their investigation based on a two country simulation, while Angeloni and Ehrmann have done theirs on a twelve country model. Subsquently, one could argue that the results of Angeloni and Ehrmann would render a better understanding of inflation differentials than Duarte and Wolmans' two country case.

Studies have also looked into the asymmetric structural rigidities that exist amongst the regions. This is particularly relevant in the European Union, where labor and other factor markets differ from country to country. Some countries have quite rigid factor markets as a result of regulation or other market conditions, while others are quite flexible. Shocks to the economy, particularly productivity shocks, tend to be short lived in countries that exhibit greater flexibility in their factor markets, as opposed to those that have more rigid factor markets. As a result, this could translate into price differences between these countries. Duarte and Wolman and Alberola (2000) both allude to this and are adamant that the existing asymmetric structural rigidities between member countries of the European Union are the key drivers of the inflation differentials. While structural rigidities are prevalent across countries, it is not so farfetched to assume that these rigidities could exist between regions within a country. These are plausible in Fiji given the differences in industry prevalent in each of the regions. While official data on region specific economic activity is rare, it is well known that the different areas of Fiji specialize in different economic activities and industry, all of which may have some form of structural rigidities attached to them. For instance Labasa in the northern island of Vanua Levu is dominated by the sugar industry, consequently, the labor market in Labasa is predominantly sugar based. The heavy involvement of employee unions in the sugar industry would therefore make the labor market in Labasa quite rigid. This contrasts with the capital Suva, where the labor market is predominantly made up of office workers, civil servants and other service and industry based employees which, with the exception of civil servants, has considerably less union involvement. Ergo this would render an asymmetric degree of flexibility amongst the regional labor markets. Labor market asymmetries are just one of other possible structural asymmetries that may exist amongst the regions, which may in turn affect the transmission of, and recovery from, economic shocks.

Furthermore, regions with industry(s) that are highly susceptible to monetary disturbances will have a greater response to monetary shocks. This has obvious implications on regional relative prices and inflation differentials.

A further source of inflation differentials can be price convergence, if prices are converging over divergent states. It is widely accepted (as mentioned earlier) that prices are not always in their long run equilibrium state, but are converging toward their long run equilibrium. However, if regional prices are converging to a common equilibrium from divergent starting points, then this would entail a larger inflation differential. As mentioned earlier, prices across Europe have been converging post 1993, so much so, that the level of price differences within Europe is now on par with the level in the US (Rogers, 2007). Therefore converging prices, particularly from highly divergent states, may be the cause of the inflation differentials in Europe. Rogers (2001b) and Hofmann and Remsperger (2005) in their study of the European Union (EU), allude to this as a possible cause of the inflation differential present amongst member countries, but cannot find evidence to support this hypothesis.[50]

In the Fijian context price convergence from a highly divergent state is hard to prove. Over time it is most likely that regional prices in Fiji may have exhibited the same level of price diversity as prices in cities in the US. This is in contrast to the EU member countries which, prior to the *single market initiative,* experienced quite diverse prices. Furthermore, unlike the members of the EU, Fiji did not comprise of independent countries with independent fiscal and monetary policy, the latter in particular adding to regional (country) price differences. However trying to ascertain the level of price divergence empirically for Fiji over a vast length of time may prove difficult, given the limited data available.

The literature above has helped shed light on the channels and factors that may cause inflation differentials. It is hoped that some of these factors could help explain the regional inflation differentials that result after a monetary shock.

2.2.3 Sticky prices

Under a Keynesian paradigm prices are sticky as a result of the set frequency at which producers adjust their prices, *menu costs* or other costs related to unexpected price changes. Consequently monetary shocks do not always have immediate or contemporaneous effects on relative prices and inflation. Numerous papers using various econometric methods and assumptions, find that aggregate prices generally react to monetary shocks with a significant time lag Christiano et al. (1999), Monticelli and Tristani (1999) and Uhlig (2005). Furthermore, it is often the case that aggregate prices respond more slowly to monetary shocks relative to disaggregated prices (Boivin

[50] However, the limited data span may have influenced their results.

et al., 2009). Others such as Caplin and Spulber (1987) argue that monetary shocks have very minor effects on prices and money is in fact neutral.

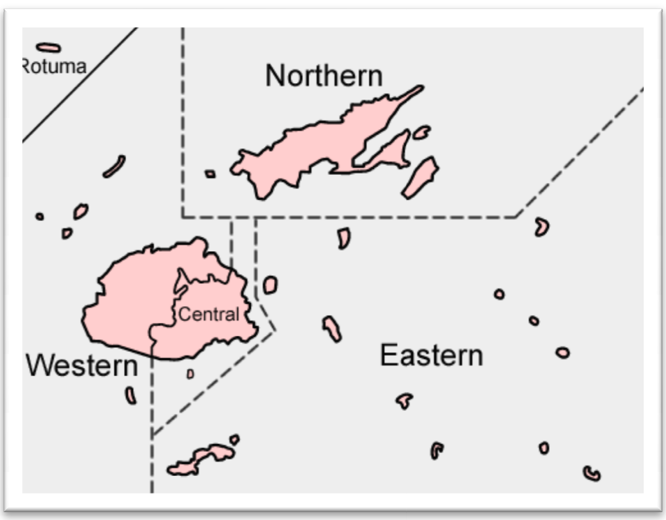
Results and various economic methods aside, the majority of these studies have not allowed for the direct **lagged** effects of monetary shocks on economic variables. Instead monetary shocks are contemporaneously subjected to economic variables, which then reverberate through the economy by means of these variables. This study intends to include lagged values of the monetary shocks to allow for the possibility that firms react to monetary shocks with a time delay, due to sticky prices. Furthermore, the effects of the monetary shocks on the aggregated and disaggregated regional CPI will also help settle any concerns of whether prices in Fiji are sticky or not.

2.3 Data

The price level data was sourced from Statistics Fiji at a monthly frequency from January 2005 to December 2009. The time period was motivated by the availability of regional price level data.

The monthly price level data used in this study consist of the nine categories of goods and services which form the consumer price index (CPI) for the Central, Western and Northern divisions of Fiji. Statistics Fiji only collects price level data from the main urban areas in each of the regions. Consequently, they have excluded the eastern region as it has no urban centers but is comprised of small islands in a rural setting. This makes intuitive sense as those who dwell in rural areas are most likely to commute into the nearest urban centers for purchases. Fielding and Shields (2006) made a similar assumption in their study of South Africa.

Figure 5. Regional Divisions in Fiji



The urban areas in the central region are Suva, Lami and Nausori. Economic activity in Nausori consists primarily of light manufacturing, while Lami has heavy and light industry. Suva (the capital) houses the headquarters for most government agencies, companies and regional organizations. It also has light and heavy manufacturing.

The urban centers in the western division are Lautoka, Nadi and Ba. Ba and Lautoka are primarily driven by the sugar industry, particularly the sugar mills that process sugar cane from the western region. Both areas also have light industry, while Lautoka also possesses heavy industry. Nadi's economy is mostly driven by tourism, however there are sugar cane farms on the outskirts of the town. All six urban centers lie on the same island, Viti Levu, Fiji's largest island. [51]

The Northern region has a sole urban centre, Labasa. It is located on Fiji's second largest island Vanua Levu. It is driven mainly by the sugar industry in particular the mill, which processes sugar cane from Vanua Levu. All seven urban centers have a local market, where nearby villages can sell their produce. This provides further support for the earlier notion put forward by Fielding and Shields (2006).[52]

Studies often carry out their analysis on regional aggregate data and as a consequence this may mask some of the underlying relationships and effects that monetary shocks have on the disaggregated level of the CPI, some of which may explain the relationships that are found at the aggregate level. Consequently this study will also look at regional CPI components as well as the aggregate regional CPI data, to try and disaggregate the effects of monetary shocks.

The CPI for each region consisted of the following nine categories:

Food	Durable Household Goods
Alcoholic Drinks and Tobacco	Clothing and Footwear
Housing	Transport
Heating and Lighting	Services
Miscellaneous	

The nine commodities were then aggregated according to a standard arithmetic weighting system derived from the Household Labor Force Survey (HLFS), to form an aggregate regional price series (*all items*).[53]

[51] Lautoka and Suva are Fiji's only two cities.
[52] Housing makes up approximately 8-10% of the regional CPI, therefore the fact that these villages do not dwell in the urban areas does not severely impact on the aggregate regional CPI.
[53] These have been approved by the IMF via the General Data Dissemination System and the process of how prices are collected is available from the Statistics Fiji website.

Upon inspection of the price level data from Statistics Fiji, there appeared to be some discrepancies in the following categories for the Central and Western price series for March 2009:

- Housing
- Durable Household goods
- Transport
- Services
- Miscellaneous
- Clothing and Footwear

It became apparent that for each of the categories above, the Central and Western observations had been mistakenly swapped with each other. This caused outliers in the series, which had implications for not only the aggregated regional indices, but more importantly the econometric results of this study. This was corrected accordingly.

The price indices were rebased to January 2005 and transformed using natural logs. The data was also seasonally adjusted using the census X12 method.[54] Seasonally adjusting the data made little graphical difference; however it did alter the econometric results later on. Consequently, this study has decided to take the seasonal difference of the CPI and its components.[55]

[54] Rebasing the price indices to the start of the sample was done out of convenience. Seasonally adjusting the data entails removing any seasonal fluctuations from the data. The reliability of the census X12 method has come under scrutiny; given the time constraints, this study has persisted with this method of seasonally adjusting the data.

[55] The national CPI and its components (which are available over a longer time horizon) appeared to have a seasonal component in them.

2.4 The effects of monetary policy shocks on relative prices

This section will try to model the effects of monetary shocks on aggregate regional prices and their components.

The Romer and Romer monetary Shocks (RR) and the Bluedorn and Bowdler shocks (BB) from the previous chapter will be applied to aggregate regional prices and their components. This study has also included the actual change in the policy indicator rate and statutory reserve deposit ratio (DPIR) as a possible monetary disturbance term.[56] These are included to gauge the robustness of regional price responses to different or alternative measures of monetary shocks.

The shocks are not highly correlated as seen in the table below. The BB shocks are simply a different way of aggregating monthly shocks as noted in the first chapter. However, unlike the RR and BB shocks generated in Fielding and Shields (2008), the BB and RR shocks appear to be orthogonal to each other. However, there is a simple explanation for this. The RBF board meetings in our sample period often took place toward the end of the month. Therefore, there is greater weight placed on the previous month's shock. This creates a one period lag in the BB shock (relative to the RR shock).[57]

Table 9. Correlation matrix between the three monetary shocks

Correlation Matrix

	BB	RR	DPIR
BB	**1.00**		
RR	**0.03**	**1.00**	
DPIR	**-0.21**	**0.52**	**1.00**

To help capture any deviation of regional prices, this study has decided to use relative regional prices to examine the effects of monetary shocks on the regional price level. These are calculated for aggregate regional price indices and their components. This study has opted not to make prices relative to the national average. Since there are only three distinct divisions in this study, the central division (which houses the capital Suva) would most likely have the greatest weight in the national CPI. Therefore one would essentially observe the interaction of the western vis-à-vis the

[56] DPIR is simply the change in the PIR from January 2004 till May 2007, plus the change in the SDR from June 2007 till December 2009.

central division and the northern vis-à-vis the central division and consequently lose out on the direct western and northern comparisons. The relative price series for the three possible region pairs, across the ten different categories were created using the following equation:[58]

$$p_{ij}^{s} = \ln P_{i}^{s} - \ln P_{j}^{s} \quad j \neq i \tag{24}$$

Where i and j represent any two of the central, western or northern regions

s represents the aggregate CPI or one of the nine different CPI components

$\ln P_{i}^{s}$ is the natural log of the price index of component *s,* for region i

$\ln P_{j}^{s}$ is the natural log of the price index of component *s,* for region j

If the regional prices respond symmetrically to monetary shocks, then one should not observe any change in the relative price series, as symmetric changes in regional prices should cancel each other out.

2.4.1 Specifying the model

The following model will be used to analyze the effects of monetary shocks on relative regional prices.[59]

$$p_{ij,t}^{s} = c + \sum_{i=1}^{n} \alpha p_{ij,t-i}^{s} + \sum_{i=0}^{q} \omega MS_{t-i} + \varepsilon_t \tag{25}$$

$p_{ij,t}^{s}$ ss the relative price series for each component of the CPI as well as the aggregate regional CPI

MS_{t-i} represents the various monetary shocks (RR, BB or DPIR)

n and q refer to the number of lags on the relative price and monetary shock terms respectively

c is a constant

ε_t is the random error term ~N(0,1)

[57] This point was observed in the first chapter and was explained through a short algebraic proof on page 41.
[58] The different regions in Fiji employ the same currency. Therefore the nominal currency term cancels out.
[59] Since the relative price series starts at January 2005, this study will apply the monetary shocks that occurred from January 2005 till December 2010. Consequently, the shocks from January 2004 till December 2004 will not be used in the regression analysis.

By construction the monetary shocks are orthogonal to the disturbance term (ε_t). Consequently, non-monetary shocks are captured by (ε_t). A violation of this assumption would defeat the purpose of this study as one could not ascertain the direct effects of **monetary** shocks on relative prices. Lags of the monetary shocks were included because the effects on prices may not always be contemporaneous but may take effect after a certain time delay. The time delays could be a result of sticky prices, which may be sticky due to the set frequency at which producers review their prices. Therefore a shock that happens in the middle of the month might not change prices immediately but may take effect in the subsequent months when producers recalculate their prices.

The time delays could also be brought about by the slow adjustment of commercial lending and deposit rates to changes in the PIR and SDR. The SDR dictates the level of deposits that commercial banks are legally required to hold with the Reserve Bank of Fiji. Consequently changes in the SDR may have a delayed effect on the rates that banks offer on deposits and loans. A further reason for the time delays could be the weak link between the PIR and the commercial rates. As a result of this, there was a change to the monetary policy framework in May 2010. The new policy instrument, the overnight policy rate (OPR), was introduced to strengthen the link between the policy interest rate and the commercial lending and deposit rates.

Fiji's underdeveloped capital markets may also hinder the rate that banks offer on deposits and loans. The very small share market and lack of market participants may hinder the ability and choice available to firms and individuals when investing or raising capital. Consequently, commercial and personal lending and borrowing is restricted to the commercial banks with very few individuals and firms actually participating in the local share market.[60]

Experimenting with the different lag lengths on the monetary shock terms across the various equations while taking into account the limited sample size, this study has decided to adopt six lags of the monetary shocks (q=6). Theoretically half a year (six lags) should be enough time for agents in the economy to react to the direct effects of a monetary shock, even for a small economy like Fiji. Six lags (n=6) of the relative price series were included in the model to account for any autocorrelation in the relative price series.

Fielding and Shields (2007) included longer lag lengths on the variables in their model to account for the extremely slow (near unit root-like) adjustment process of relative prices. Unfortunately

[60] Banking off shore is not practical as there are strict capital controls in place, therefore depositing money off shore would be cumbersome and in some cases impossible.

this study only has a small sample size, therefore to conserve degrees of freedom this study has had to adopt the minimum number of lags that satisfy the basic theoretical and econometric requirements.[61]

2.4.2 Unit root tests

Before any regression analysis can be carried out on equation 25, the stationarity of the relative price series needs to be checked. This is an econometric requirement, as non-stationary test statistics are not normally distributed and as a result the standard critical values are no longer valid (Banerjee et al., 1993).

The Dickey Fuller GLS test has been employed to carry out the unit root testing procedures because of its robust performance in small samples relative to the other unit root tests. However, unit root tests in general have low power, so the Dickey Fuller GLS tests have been used with critical values at the ten percent level of significance.[62]

To account for any fixed or permanent price differential between the various regional pairs, a constant was included in the unit root test equation. Relative prices may exhibit a trend over time because income, labor costs or property prices in one region may be growing over time relative to the other regions. This would imply higher demand for goods and services (rising incomes) and higher costs of production (increase in the prices of the factors of production). Some of these factors of production, goods and services would embody non-tradables, which would consequently imply higher prices in one region vis-à-vis the others. To allow for this possibility, we allow for a trend in the data. [63]

However, there may be instances when including a trend (when there actually is no trend in the data) could bias results toward finding a unit root. From an econometric perspective, the norm would be to look at a plot of the data and judge whether there is a trend. This study has used the unit root testing strategy contained in Elder and Kennedy (2001). The lag length for each relative price series was selected using the Aikaike Criterion.

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[61] These requirements were mentioned above, theoretically allowing a long enough lag length to account for the delayed response to monetary shocks and the minimum lag length to account for any autocorrelation in the model

[62] Elliott-Rothenberg-Stock DF-GLS critical values were used via Eviews.

[63] Plots of some of the relative price series show a trend in them; these have been included in the appendices (A.2.1)

Alternatively, one could apply one of the many panel unit root tests such as those carried out by Levin et al. (2002) and Im et al. (2003). While these have been shown to be a lot more powerful than conventional unit root tests, the interpretation of the results are often questionable. The null hypothesis of the panel unit root tests state that **all** of the series in the panel are non-stationary, while the alternative states that **at least one** is stationary. Therefore rejection of the null does not necessarily imply that **all** the series in the panel are stationary, but rather that at **least one** of the series is stationary.[64] There are other possible null and alternative hypotheses (each subtlety different for the various panel unit root tests), however none of the tests can specifically identify if an individual series is stationary or not. For thorough critic of panel unit root tests refer to Banerjee et al. (2004).

Arguably, the inconclusive results that accompany the panel unit root tests outweigh any of the associated power gains. In addition, there are only three regions in Fiji, which arguably does not provide enough cross-sectional variation. As a result, this study will persist with the conventional univariate unit root tests.

The test statistics from the Dickey Fuller GLS unit root tests are reported in the table below.

Table 10. The test statistics from the Dickey Fuller GLS unit root tests

Series	northern/central	western/central	western/northern
Food	-1.564186	-5.239158*	-2.370420*
Alcohol and Tobacco	-1.385872(wt)	-1.927108(wt)	-3.328491*
Housing	-1.890440(wt)	-2.091415(wt)	-1.777536(wt)
Heating and Lighting	-1.284941	-1.707325(wt)	-2.047843*
Durable	-4.306208(wt)*	-1.434532(wt)	-3.079191(wt)*
Clothing	-0.230528	-1.541685(wt)	-2.081604(wt)
Transport	-1.478076	-3.294080(wt)*	-2.932995(wt)*
Services	-1.585160(wt)	-1.607298	-2.534925(wt)
Miscellaneous	-2.307960*	-1.496145(wt)	-3.469706(wt)*
All items	-1.902383*	-4.295818(wt)*	-2.346730*

*Indicates significance at ten percent level of significance

"wt" indicates that a trend was included in the unit root tests

[64] Take a panel with Q series in it, rejection of the null simply means that n series are stationary; $1 \leq n \leq Q$

From plots of the data, it appeared that a few of the relative price series had structural breaks in them, possibly due to the devaluation. This may have affected the results of the unit root tests. To allow for the devaluation, the unit root tests were carried out with the sample ending prior to the devaluation.[65] However, only six out of the thirty series had different outcomes from the re-sampled unit root tests. Since the sample in this study is quite small at sixty observations, reducing it to fifty-one observations may further exacerbate the small sample bias inherent in these univariate unit root tests and thus taint the results further.

Dummy variables could have been included to account for the structural breaks but justifying these dummies, outside the ones used to account for the devaluation, would not be possible. In addition, adding dummy variables may bias the critical values and render them inappropriate.

2.4.3 Estimation techniques

Equation 25 was estimated using OLS, however the Jarque-Bera (JB) test revealed that the errors from some of the relative price series regressions were not normal.[66] The Jarque-Bera test for normality uses the Lagrange multiplier (LM) to measure the degree of skewness and kurtosis present in the distribution of the errors. It then compares this to what would be found under a normal distribution. In the null of the Jarque-Bera test the errors are normally distributed.[67] The JB critical values have a chi squared distribution with two degrees of freedom.

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[65] To account for the April Devaluation, the sample ended at March 2009.

[66] Refer to the table below for the distribution of the error terms from equation 25.

[67] For an in depth exposition of the JB test for normality, refer to Jarque, C. & Bera, A. 1987. A test for normality of observations and regression residuals. *International Statistical Review/Revue Internationale de Statistique,* 55**,** 163-172.

Table 11. JB Distribution of the residuals from equation 25 using RR shocks

Relative Price series	NC	WC	WN
All Items	NORMAL#	NON	NORMAL
Food	NORMAL#	NON	NON
Alcohol and Tobacco	NON	NORMAL	NORMAL#
Housing	NON	NON	NON
Heating and Lighting	NON	NON	NON
Durable Household	NON	NON	NON
Clothing and Footwear	NORMAL#	NORMAL#	NORMAL#
Transport	NORMAL	NON	NON
Services	NON	NON	NON
Miscellaneous	NORMAL#	NORMAL#	NORMAL

NON is not normally distribution
NORMAL# is normally distributed at 5% level of sig
NORMAL is normally distributed at 1% level of sig

Table 12. JB Distribution of the residuals from equation 25 using BB shocks

Relative Price series	NC	WC	WN
All Items	NORMAL	NON	NORMAL
Food	NORMAL#	NON	NON
Alcohol and Tobacco	NON	NORMAL	NORMAL
Housing	NON	NON	NON
Heating and Lighting	NON	NON	NON
Durable Household	NON	NON	NON
Clothing and Footwear	NORMAL#	NORMAL	NORMAL#
Transport	NORMAL#	NON	NON
Services	NON	NON	NON
Miscellaneous	NORMAL#	NON	NORMAL#

Table 13. JB Distribution of the residuals from equation 25 using DPIR shocks

Relative Price series	NC	WC	WN
All Items	NON	NON	NORMAL
Food	NORMAL#	NON	NORMAL
Alcohol and Tobacco	NON	NON	NORMAL#
Housing	NON	NON	NON
Heating and Lighting	NON	NON	NORMAL
Durable Household	NON	NON	NON
Clothing and Footwear	NORMAL#	NORMAL#	NORMAL#
Transport	NON	NON	NON
Services	NON	NON	NON
Miscellaneous	NORMAL#	NON	NORMAL

Generally there could be a whole host of problems which would lead to non-normal errors. These range from misspecification of the equations to outliers in the data sets. A plot of the residuals revealed that there were some relatively large outliers in the data that were causing a violation of the normality assumption. Large outliers in the data can bias the estimates derived from OLS. Ordinary least squares (OLS) minimizes the sum of squared error, therefore large outliers in the errors often increases the sum of squared error and this consequently biases the results of OLS estimates (Stock and Watson, 2003). Dummies for large outliers could have been included, but no possible economic significance would have been attached to these dummies. Carrying on with this practice may have resulted in data mining accusations. Consequently, dummies were not included in the analysis of equation 25.

Functional form misspecification of equation 25 may have contributed to the non-normal errors. However the Ramsey RESET test in TSP cleared the equations of any functional form misspecification, at the one percent level of significance.[68] Therefore the non-normal errors are most likely due to outliers in the data.

Data mining issues aside, simply inserting dummies to account for outliers would only work if there were a relatively small number of outliers. However, based on the skewness and in particular the

[68] The relative service price between the northern and central regions failed the RESET test, however services make up a small portion of the CPI.

kurtosis of the residuals, it appears that there are a number of outliers in some of the relative price series. [69]

To account for the large number of outliers in some of the relative price series, the least absolute deviation (LAD) method will also be used to estimate equation 25. LAD tries to minimize the **absolute** deviations of fitted vs. actual values and is therefore more robust to outliers in the data.

Bloomfield and Steiger (1980) conducted an in depth analysis into the properties of LAD; of particular interest is the use and properties of LAD in an autoregressive process (AR). Due to the uncertainty of the unit root tests, one cannot be sure if the relative price series are indeed stationary or non-stationary. This is particularly troubling for LAD estimates as Bloomfield and Steiger emphasize the stationary nature of the data when investigating AR processes in a LAD framework.

However, various studies by Knight (1989) and (1991), Davis et al.(1992), Phillips (1995), Herce (1996) and Rogers (2001a) have proven the asymptotic and finite sample properties of LAD estimates in a non-stationary setting, under certain conditions. These studies state that LAD is more efficient and less biased vis-à-vis OLS, if the errors have a non normal distribution, particularly if the distribution is one of fat tails (Thavaneswaran and Peiris, 2001, Herce, 1996) or a Cauchy distribution (Phillips, 1995, Knight, 1989).

The critical values for non-stationary variables used in the Autoregressive LAD equations could not be found. In addition, the stationary critical values for the coefficients estimated using OLS may also come into question, given the potential non-stationary nature of the data. Consequently this study has decided to simulate its own critical values based on the distribution of the relative prices series in this study.

2.4.4 Critical values

The OLS and LAD asymptotic critical values may not be valid given the small samples used in this study. In addition, the low power bias of the univariate unit root tests provides sufficient reason to doubt the stationarity of each of the relative price series. Therefore the standard critical values on

[69] Histograms of the relative price series revealed that some of the price series were not normally distributed. However, these were not necessarily the ones that gave non normal errors in *equation 25*. Jarque-Bera results of the relative price series are available in the appendices (A.2.2). However, Patterson (2000) states that normality is not required to ensure the validity of the DF tests. Patterson, K. 2000. *An introduction to applied econometrics: a time series approach.,* London, Palgrave London.

the coefficients from equation 25 may not be suitable. This study has consequently decided to simulate its own critical values to address the potential problems of small sample bias and non-stationarity. Therefore a stationary and non-stationary set of critical values will be calculated for each model.

However because RR and BB are generated regressors, a *generated regressor* problem exists. This arises because the generated regressor, in this case the monetary shocks (RR and BB) have some error attached to them as they have been generated by other variables. Pagan (1984), Oxley and McAleer (1993) and McKenzie and McAleer (1997) have investigated the issues associated with generated regressors. Consequently, when simulating critical values, one has to take into account the variance or error associated with the RR and BB shocks. This study uses the bootstrapping method to simulate the critical values (Freedman and Peters, 1984a, Freedman and Peters, 1984b). Since none of the equations were found to have autocorrelation in the residuals, a block bootstrap was not necessary. [70]

The following is a guideline on how this study has simulated critical values and is similar to the methods in Patterson (2000). There are six steps to simulating critical values. Steps 1 and 2 help account for the *generated regressor* issues and apply to both sets of critical values. The remaining steps have subtle variants across the two sets of critical values. [71]

Step one[72]

The first step is to create a simulated PIR and SDR. By using the fitted coefficients and random numbers drawn from the empirical distribution of the PIR and SRD residuals respectively, one has to simulate a PIR and SRD series that varies according to the random component.

Step two

The next step is to replicate the Romer and Romer regression, but instead of using the original PIR and SRD series, the **simulated** PIR ($P\hat{I}R$) and SRD ($S\hat{R}D$) are used instead. [73]

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[70] Refer to page 84 in the results section for a brief description of the diagnostic tests.
[71] Codes for the simulation of the critical values are available in the appendices (A.2.3).
[72] The actual change in the PIR and SRD (DPIR) is not a generated regressor. Therefore models that employ the DPIR monetary shock do not have to go through steps 1 and 2 and can proceed directly to step 3.
[73]Due to the lag on some of the variables in equation 26 and 27, the original PIR and SRD are used as the first observations, after which the simulated values follow. The random numbers which are drawn from the empirical distribution of the residuals from equations 11 and 12 (in chapter one), are used to replace the residuals from equation 26 and 27 respectively, when calculating the PÎR and $S\hat{R}D$.

$$\Delta P\hat{I}R_m = \propto + \gamma P\hat{I}R_{m-1} + \sum_{i=-1}^{0} \rho_i \pi_{m,i} + \sum_{i=-1}^{2} \sigma_i g_{m,i} + \beta\ reserves_{m-1} + \varphi DEVALUATION_m + \omega\ outputgap_m + \sum_{i=-1}^{2} \theta_i (g_m - g_{m-1}) + \sum_{i=-1}^{2} \tau_i (\pi_m - \pi_{m-1}) + \varepsilon_m \tag{26}$$

$$\Delta S\hat{R}D_m = \propto + \gamma S\hat{R}D_{m-1} + \sum_{i=-1}^{0} \rho_i \pi_{m,i} + \sum_{i=-1}^{2} \sigma_i g_{m,i} + \beta\ reserves_{m-1} + \varphi DEVALUATION_m + \omega\ outputgap_m + \sum_{i=-1}^{2} \theta_i (g_m - g_{m-1}) + \sum_{i=-1}^{2} \tau_i (\pi_m - \pi_{m-1}) + \varepsilon_m \tag{27}$$

The same procedures from chapter one are then used to obtain the monetary shocks (RR and BB), from the residuals of equations 26 and 27. The monetary shocks are generated from January 2004 till December 2009.

Step three

This step tries to generate a relative price series based on two different data generating processes (DGP). The first DGP process assumes that relative prices follow a stationary process. Consequently they are generated using the following equation:

$$\widehat{rp}_t = \varepsilon_t \tag{28}$$

$\widehat{rp}_t$ is the simulated relative prices.

ε_t are the errors from the empirical distribution of the residuals from equation 25. Using the residuals from the original relative price equations, as opposed to random numbers drawn from a normal distribution, helps maintain the unique distribution that the data may have (Freedman and Peters, 1984b).

The second data generating process assumes that the relative price series follows a non-stationary process:[74]

$$\widehat{rp}_t = \widehat{rp}_{t-1} + \varepsilon_t \quad (29)$$

Step four

The next step is to run equation 25, using the **simulated** relative price series (from DGP1 and DGP2) and the simulated monetary shocks and DPIR. This renders the following equation:

$$\hat{\mathrm{p}}^{\mathrm{s}}_{\mathrm{ij,t}} = \dot{c} + \sum_{i=1}^{6} \dot{\alpha}_\iota \hat{\mathrm{p}}^{\mathrm{s}}_{\mathrm{ij,t-i}} + \sum_{i=0}^{6} \dot{\omega} M\hat{S}_{t-i} + \varepsilon_t \quad (30)$$

$\hat{\mathrm{p}}^{\mathrm{s}}_{\mathrm{ij,}}$ is the simulated relative price series from either the stationary or non-stationary DGP

$M\hat{S}$ represents one of the various simulated monetary shocks (BB and RR) or the actual change in the PIR and SRD (DPIR)

$\dot{c}$ is the constant

$\dot{\alpha}$ are the coefficients on the AR terms calculated from the simulated series

$\dot{\omega}$ are the coefficients on the simulated shock series

Equation 30 is estimated using either LAD or OLS, the choice being dependent on the distribution of the errors from the original relative price regressions.

Step five

This step entails calculating and collecting the test statistics from equation 30. However, since we have two different data generating processes, the critical values will differ for the stationary and non-stationary models.

[74] For a brief exposition of how we have arrived at the DGP for a non stationary AR(6) model refer to A.2.3 in the appendices.

Stationary critical values

The data generating process assumes that none of the coefficients are significantly different from zero. This yields the following test statistic.

$$t = \frac{\dot{d}_1 - 0}{\dot{se}} \tag{31}$$

t is the test statistic

$\dot{d}$ represent the coefficients from equation 30 $\dot{c}, \dot{\alpha}, \dot{\omega}$

$\dot{se}$ is the standard error on the coefficients from equation 30

Non-stationary critical values

The critical values on the individual coefficients, generated from a non-stationary DGP are calculated using equation 30. However, the non-stationary DGP assumes that the sum of the autoregressive coefficients ($\dot{\alpha}_i$) should sum to 1. To test this hypothesis we have used a Wald test to simulate the critical values. This unit root test encompasses characteristics that are unique to each series, when compared to the generic unit root test employed earlier. Therefore this unit root test is imperative in determining whether the stationary or non-stationary critical values are applied to each of the relative price equations.

$$\frac{\sum_{i=1}^{6} \dot{\alpha}_i - 1}{\dot{se}} = F\ stat \tag{32}$$

$\sum_{i=1}^{6} \dot{\alpha}_i$ is the sum of the coefficients on the lagged dependent terms.

$\dot{se}$ is the standard error on the sum of the lagged dependent terms

The null hypothesis in the Wald test assumes that the sum of the AR coefficients (using the simulated series) is statistically equal to one and is therefore a unit root process.

Step six

Steps one to five are carried out five thousand times to ensure a large enough sample size. The last step involves ordering the resultant t and F statistics and taking the lower and upper one, five and ten percent of the generated critical values. This is done for each variable in equation 25, across the thirty different relative price series, for each of the three monetary shocks.

2.4.5 Impulse response functions

Relative prices

Once the fitted values and coefficients from equation 25 have been estimated either by OLS or LAD, the response to monetary shocks can be simulated via impulse response functions. These are not to be confused with the commonly employed impulse response functions from the VAR literature. The shocks in this instance have been generated beforehand and there is no "impulse" in the error term (ε_t), however, the impulse response functions do include the autoregressive components (AR) of the relative price series (six lags in this study). The impulse response functions were simulated using a negative one percent monetary shock.[75] For clarity on how these impulse responses are simulated take the following example:

Fitted coefficients from equation 25:

$$\mathrm{p}^{\mathrm{s}}_{\mathrm{ij,t}} = \hat{c} + \sum_{i=1}^{6} \hat{\alpha}_i \mathrm{p}^{\mathrm{s}}_{\mathrm{ij,t-i}} + \sum_{i=0}^{6} \widehat{\omega}_i MS_{t-i} + \varepsilon_t \tag{33}$$

Take the period that the shock initially happens (month 0):

$$\mathrm{p}^{\mathrm{s}}_{\mathrm{ij,0=}} \widehat{\omega}_0 \times 1\%$$

Relative price at month 1:

$$\mathrm{p}^{\mathrm{s}}_{\mathrm{ij,1}} = \hat{\alpha}_1 \mathrm{p}^{\mathrm{s}}_{\mathrm{ij,0}} + \widehat{\omega}_1 \times 1\%$$

The above is carried out over a twenty-four month horizon. The direct effects of the shocks ($\widehat{\omega}_i$) will dissipate after the first six periods and the impulse response functions beyond this point will comprise solely of the AR dynamics.

Once the impulse response functions have been generated, the next step is to formulate standard errors. As mentioned earlier, the RR and BB shocks are generated regressors. Therefore the standard errors on the impulse response functions need to account for the error associated with

[75] This actually represents a positive value for the *MS* term in equation 33.

the RR and BB shocks. This study uses the bootstrapping method adopted by Fielding, Shields (2007) to generate the standard errors and address the generated regressor issue. There are five steps to performing the bootstrap method.

The first two steps are identical to those in the simulation of the critical values.[76] The first step is to replicate the Romer and Romer regressions from equations 11 and 12 in chapter one. By using the fitted coefficients and random numbers drawn from the empirical distribution of the PIR and SRD residuals respectively, one is able to recreate PIR and SRD series that vary according to the random component.

The next step is to replicate the Romer and Romer regression, but instead of using the original PIR and SRD series, the **simulated** PIR ($P\hat{I}R$) and SRD ($S\hat{R}D$) are used instead (refer to equation 26 and 27).

The same procedures from chapter one are then used to obtain the monetary shocks from the residuals of equations 26 and 27 (RR and BB). Recall the monetary shocks in chapter one were generated from January 2004 till December 2009. However, since the relative price series starts from January 2005, only the simulated monetary shocks that correspond with this time period will be used in the following steps.

The third step is to recreate a relative price level series using the fitted coefficients from equation 25 as well as a random component drawn from the empirical distribution of the residuals from equation 25.[77] The newly simulated relative price series $\hat{p}^{s}_{ij,t}$ uses the simulated RR and BB shocks instead of the original RR and BB shocks. This helps incorporate the variance or error associated with calculating the monetary shocks.

The next step is to run equation 25, with both the **simulated** relative price series and simulated monetary shocks. This renders the following equation:[78]

---

[76] However they have been included so that the reader has a clear idea of the bootstrap process.

[77] Due to the lag on some of the relative prices series in equation 33, the original relative price series are used for the first six observations, after which the simulated values follow. The random numbers which are drawn from the empirical distribution of the residuals from the original equation 33 replace the residuals when calculating the simulated relative price series.

[78] The DPIR is not a generated regressor, therefore models which have the DPIR as the monetary shocks do not have go through steps 1 and 2 when generating standard errors for their impulse response functions.

$$\hat{p}^{s}_{ij,t} = \dot{c} + \sum_{i=1}^{6} \dot{\alpha}\hat{p}^{s}_{ij,t-i} + \sum_{i=0}^{6} \dot{\omega}M\hat{S}_{t-i} + \varepsilon_t$$

(34)

$\hat{p}^{s}_{ij,}$ is the simulated relative price series

$M\hat{S}$ represents one of the various simulated monetary shocks (BB and RR) or the actual change in the PIR and SRD (DPIR)

$\dot{c}$ is the constant calculated from the simulated series

$\dot{\alpha}$ are the coefficients on the AR terms calculated from the simulated series

$\dot{\omega}$ are the coefficients on the simulated shock series

Equation 33 is estimated using either LAD or OLS, the choice being dependent on the distribution of the errors from the original relative price regressions.

The fifth and final step is calculating the *impulse (K_i)* derived from the coefficients in equation 25, which are carried out in accordance with the method stated earlier in the section. The bootstrap is run a thousand times to ensure accuracy.

The standard errors for each of the *impulses* are calculated using the commonly used sample variance formula (Wooldridge, 2009).

$$SE = \sqrt{\frac{1}{1000}\sum_{i=1}^{1000}(K_i - \overline{K})^2}$$

(35)

i is the number of bootstrap replications.

K_i is the *impulse* values generated from the simulated series for every bootstrap replication

$\overline{K}$ is the *impulse response* derived using the original series.

Inflation differentials

The inflation differentials between the regions are calculated in accordance with equation 23 using the simulated relative price responses. The standard errors for the estimates were calculated using the methods outlined above. However, in equation 35, K_i represents the inflation differential from each replication and $\overline{K}$ represents the inflation differential from the original series.

Once the impulse response functions and their corresponding standard errors have been calculated we can proceed to estimate and interpret the results.

2.5 Results

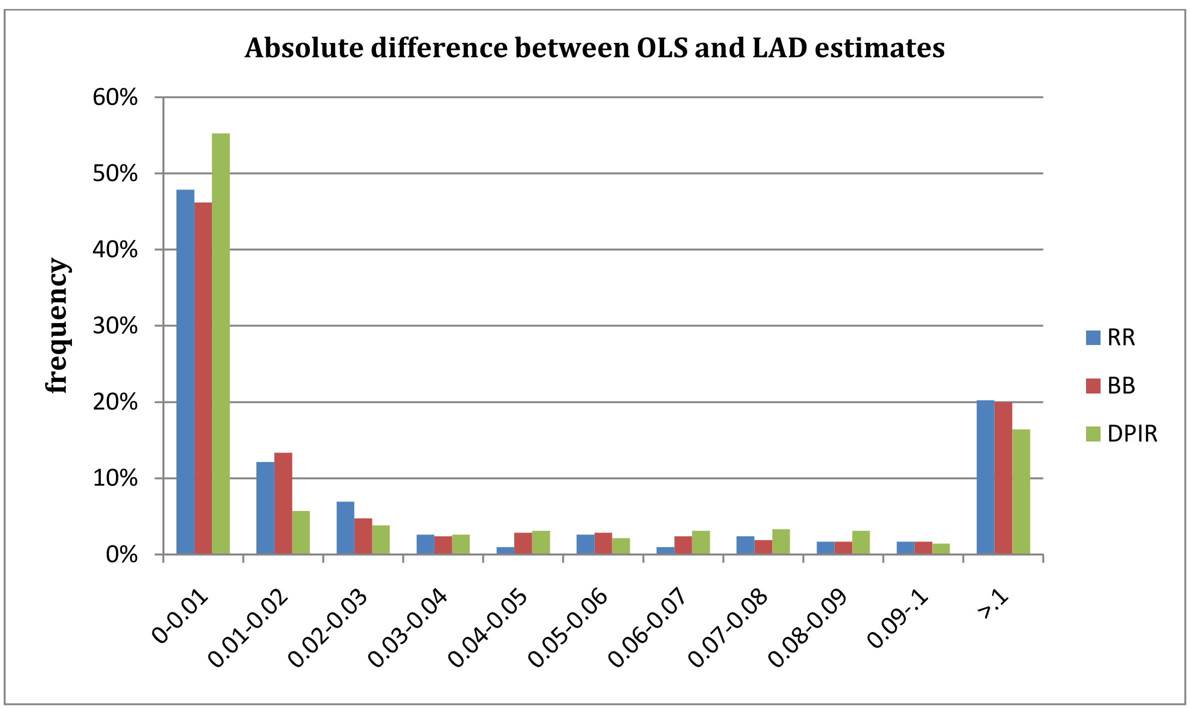
This section will report and analyze the results from equation 25 in the previous section. It will first look at the coefficients and their significance followed by the effect of a one unit monetary shock on regional relative prices and inflation differentials.

2.5.1 Coefficients

LAD vs. OLS estimates

Equation 25 was estimated using LAD and OLS. Figure 6 shows the absolute difference between the OLS and LAD estimates. The differences are predominantly within the 0 to 0.01 range. These differences appear to be minute, however the true extent of these differences can be seen in the impulse response functions in Figure 14 in the appendices. In most instances there appears to be a minor but significant difference between the impulse response functions generated with the OLS coefficients and those generated from the LAD coefficients. However, there were instances when there was a marked difference between the impulses generated by the two estimation methods (food and heating are the most obvious categories).

Figure 6. Absolute differences between the OLS and LAD estimates



In light of these differences, the choice of estimation technique is shown to have a significant bearing on the impulse response functions. The less than perfect correlation across the different estimation techniques in Table 14 below is further evidence of this.

Table 14. Correlation between the twelve month average IRF estimated using OLS and LAD coefficients

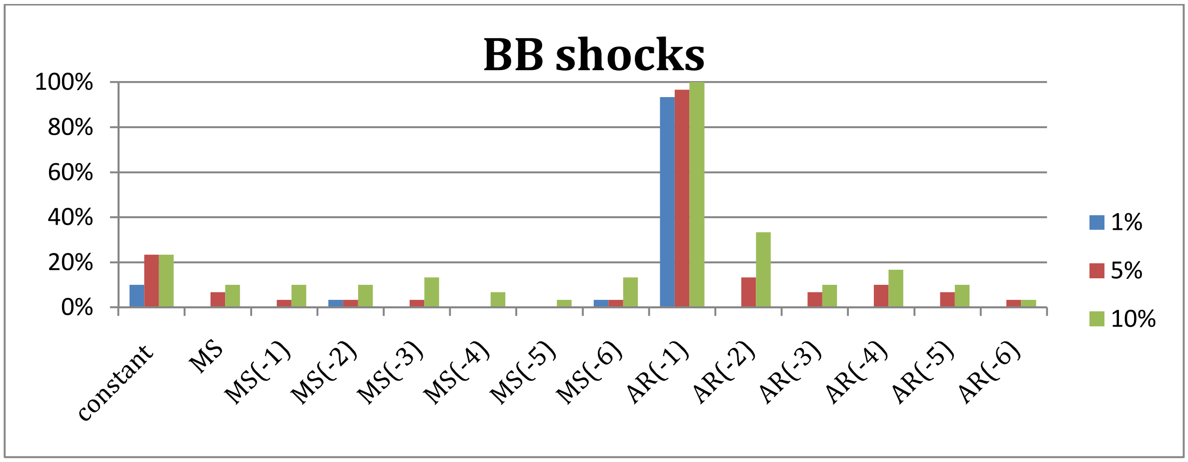
	BB OLS	DPIR OLS	RR OLS
BB LAD	**0.66**	-0.18	0.28
DPIR LAD	-0.49	**0.66**	0.07
RR LAD	0.64	-0.17	**0.68**

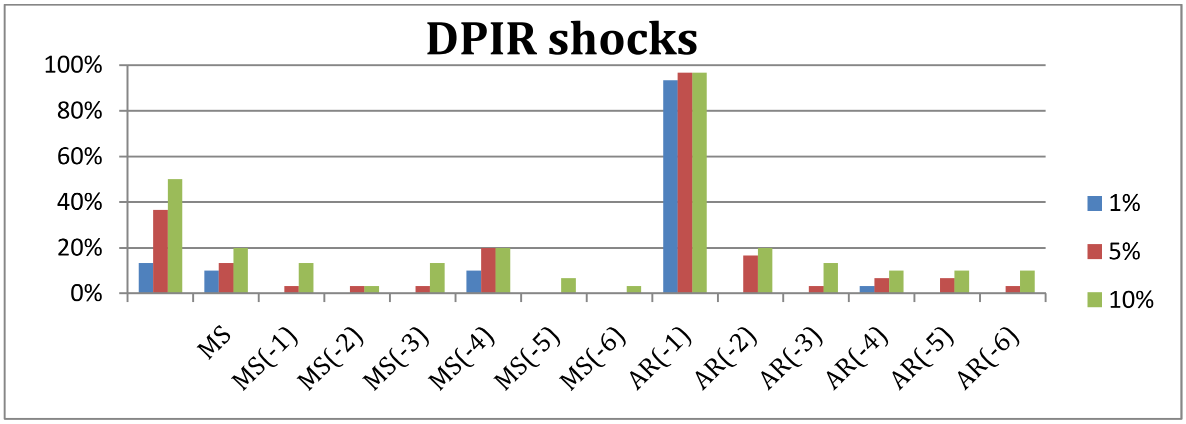
Given the thirty different region pairs and three different monetary shocks, generating critical values for each coefficient using the two different estimation techniques would be cumbersome and highly impractical. Therefore, a choice has to be made on the appropriate estimation technique for each of the ninety different regression equations. This study has decided to use the Jarque-Bera (JB) test at the one percent level of significance, to determine which estimation technique to employ. If the residuals are normally distributed at the one percent level of significance, then the OLS estimator will be used. However if the residuals are not normally distributed, then the LAD estimator will be used to calculate the coefficients, critical values and the subsequent impulse response functions.

The regressions were also checked for Heteroscedasticity and autocorrelation. The LM test (set at six lags) in TSP did not detect any autocorrelation, while the LM test for Heteroscedasticity (OLS), cleared all but one of the regressions of Heteroscedasticity. In the single regression where Heteroscedasticity was found, robust standard errors were used. These were also used in the simulation of the relevant critical values for this particular regression equation.

Critical values

Figure 7. Significance of coefficients using critical values generated under a stationary data generating process, across the three different monetary shocks





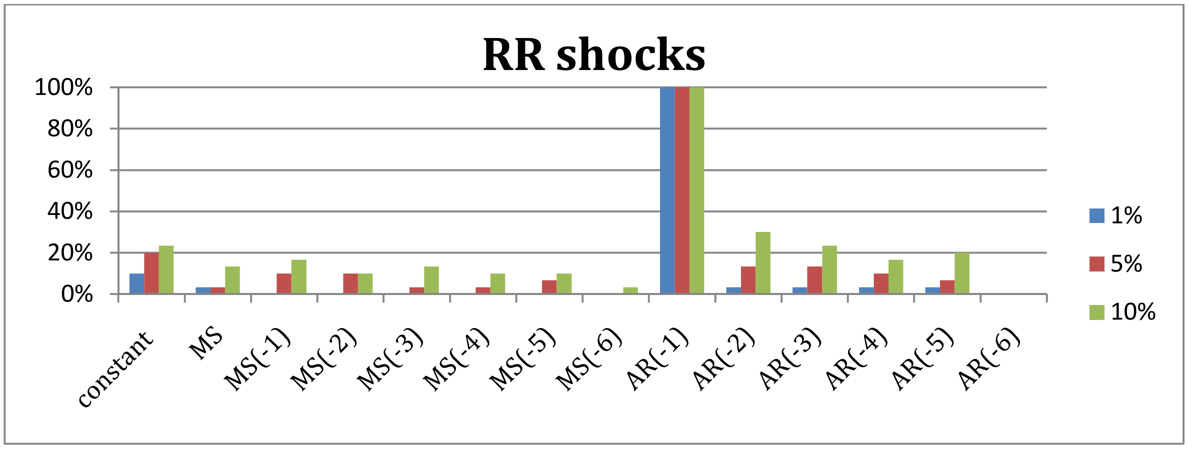
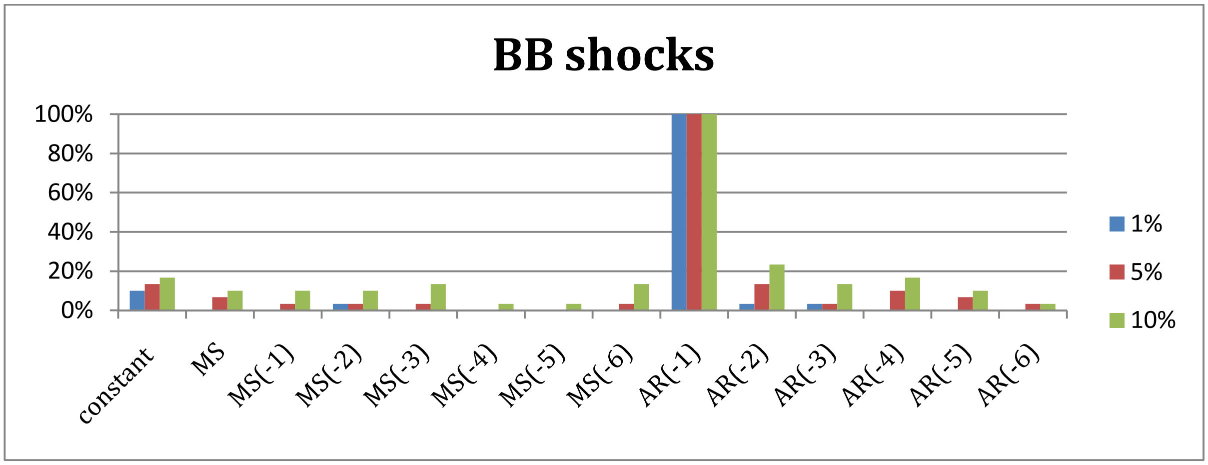


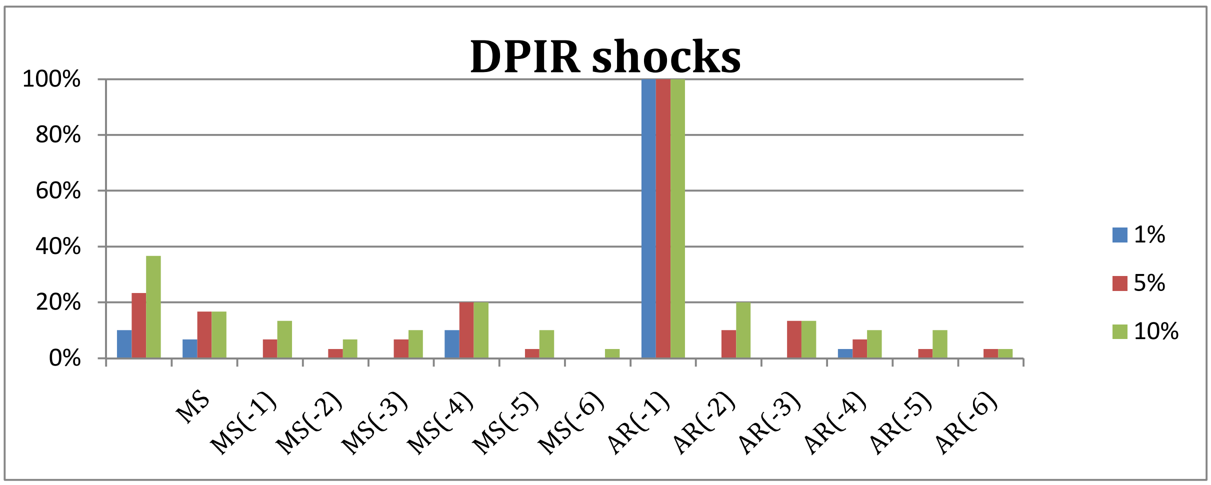
Table 15. Unit root results using simulated critical values

Series	BB	RR	DPIR
alcohol_nc	cannot	cannot	cannot
alcohol_wc	cannot	cannot	cannot
alcohol_wn	cannot	cannot	cannot
allitems_nc	reject$^{1\%}$	reject$^{1\%}$	reject$^{1\%}$
allitems_wc	cannot	cannot	cannot
allitems_wn	cannot	cannot	cannot
clothing_nc	cannot	cannot	cannot
clothing_wc	cannot	cannot	cannot
clothing_wn	cannot	reject$^{10\%}$	cannot
durable_nc	cannot	cannot	reject$^{10\%}$
durable_wc	cannot	cannot	reject$^{5\%}$
durable_wn	cannot	cannot	cannot
food_nc	cannot	cannot	cannot
food_wc	cannot	reject$^{10\%}$	reject$^{10\%}$
food_wn	cannot	cannot	cannot
heating_nc	cannot	cannot	cannot
heating_wc	cannot	cannot	cannot
heating_wn	cannot	cannot	cannot
housing_nc	cannot	cannot	cannot
housing_wc	cannot	cannot	cannot
housing_wn	cannot	cannot	cannot
misc_nc	reject$^{10\%}$	cannot	cannot
misc_wc	reject$^{5\%}$	cannot	cannot
misc_wn	cannot	cannot	cannot
services_nc	cannot	reject$^{5\%}$	cannot
services_wc	cannot	cannot	cannot
services_wn	cannot	cannot	cannot
transport_nc	cannot	cannot	cannot
transport_wc	cannot	cannot	cannot
transport_wn	cannot	cannot	cannot

reject $^{10\%}$ rejects the null hypothesis at the 10% level of significance.
reject $^{5\%}$ rejects the null hypothesis at the 5% level of significance.
reject $^{1\%}$ rejects the null hypothesis at the 1% level of significance.

Figure 8. Significance of the coefficients using critical values generated under a non-stationary data generating process, across the three different monetary shocks





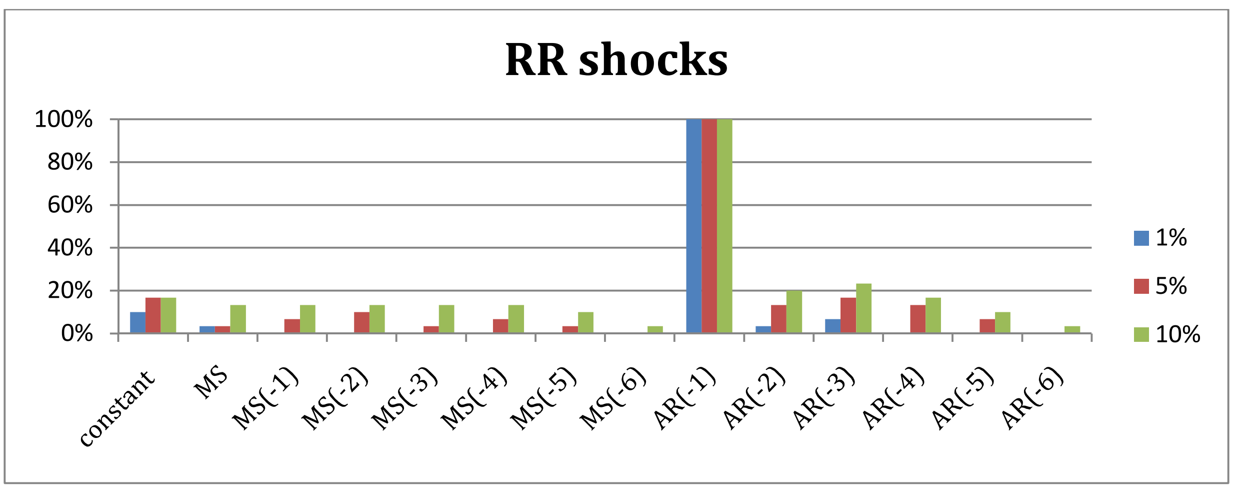


Table 15 reveals that the sum of the autoregressive coefficients, on the majority of the relative prices, are statistically indifferent from one. This would imply that the majority of the relative price series are non-stationary.[79] Ergo, monetary shocks should have permanent and persistent effects on the (non-stationary) majority of the relative price series. Figures 7 and 8 reveal that the significance of the variables in equation 25 appear to be similar across the stationary and non-stationary critical values. The various contemporaneous and lagged values of the three monetary shocks appear to be significant in less than 20% of the relative price equations. In addition, the effects of the monetary shocks appear to be spread across the specified lags of the shocks.

Even though the various monetary shocks are not statistically significant, it will be interesting to gauge the effects of these shocks on the IRFs of relative prices in the next section.

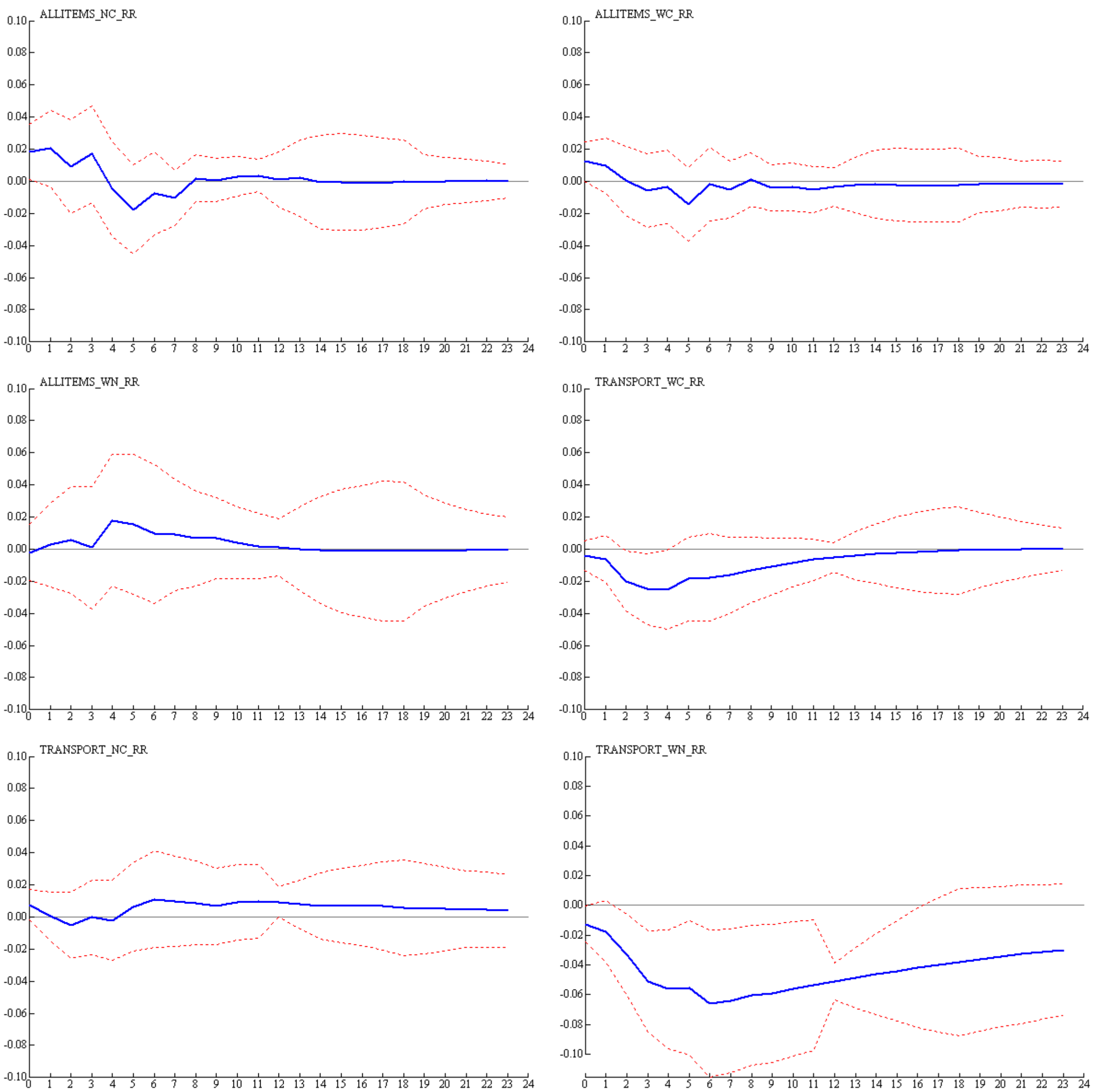
[79] The regression coefficients have not been included, but are available upon request.

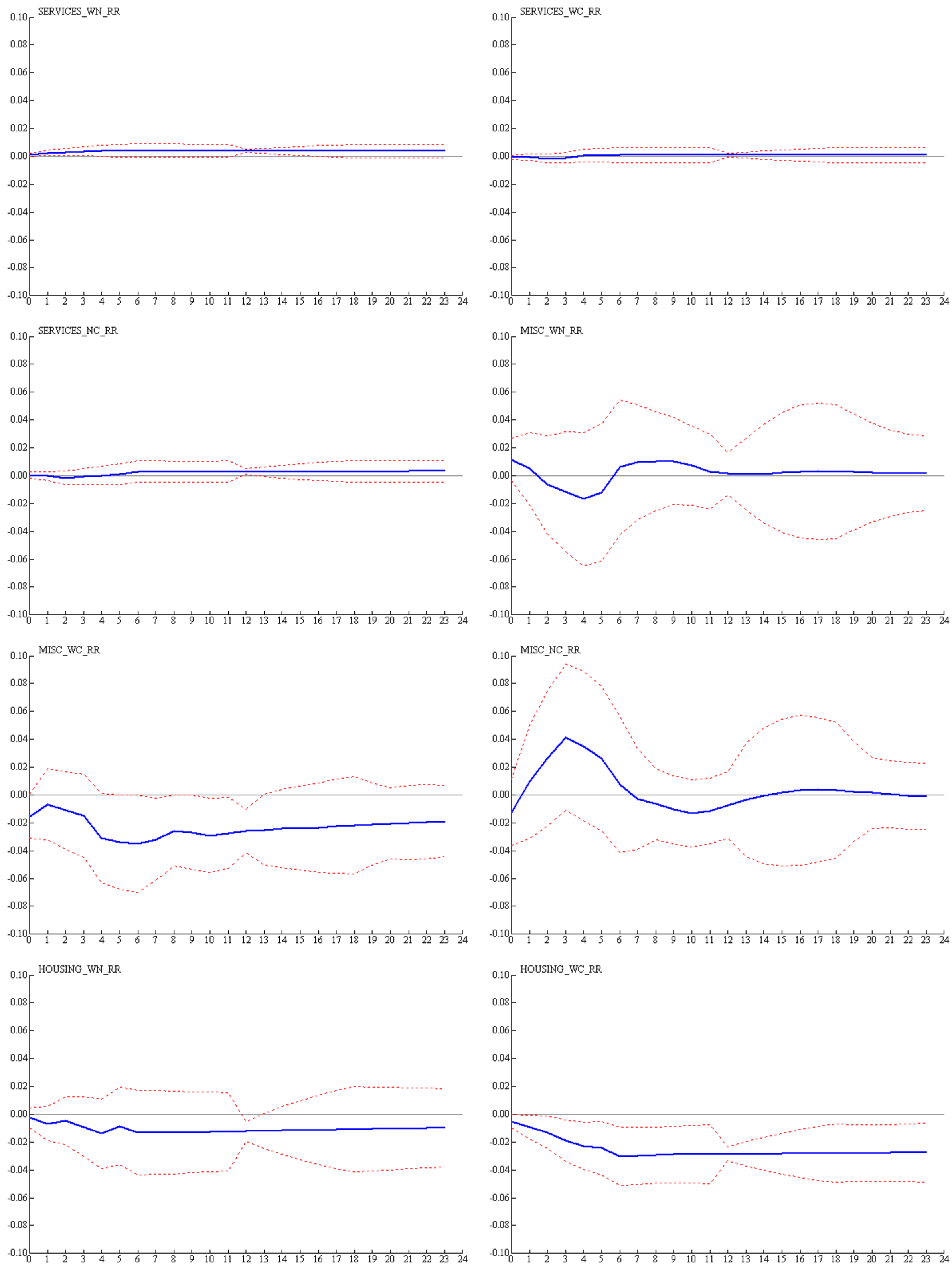
2.5.2 Impulse response functions

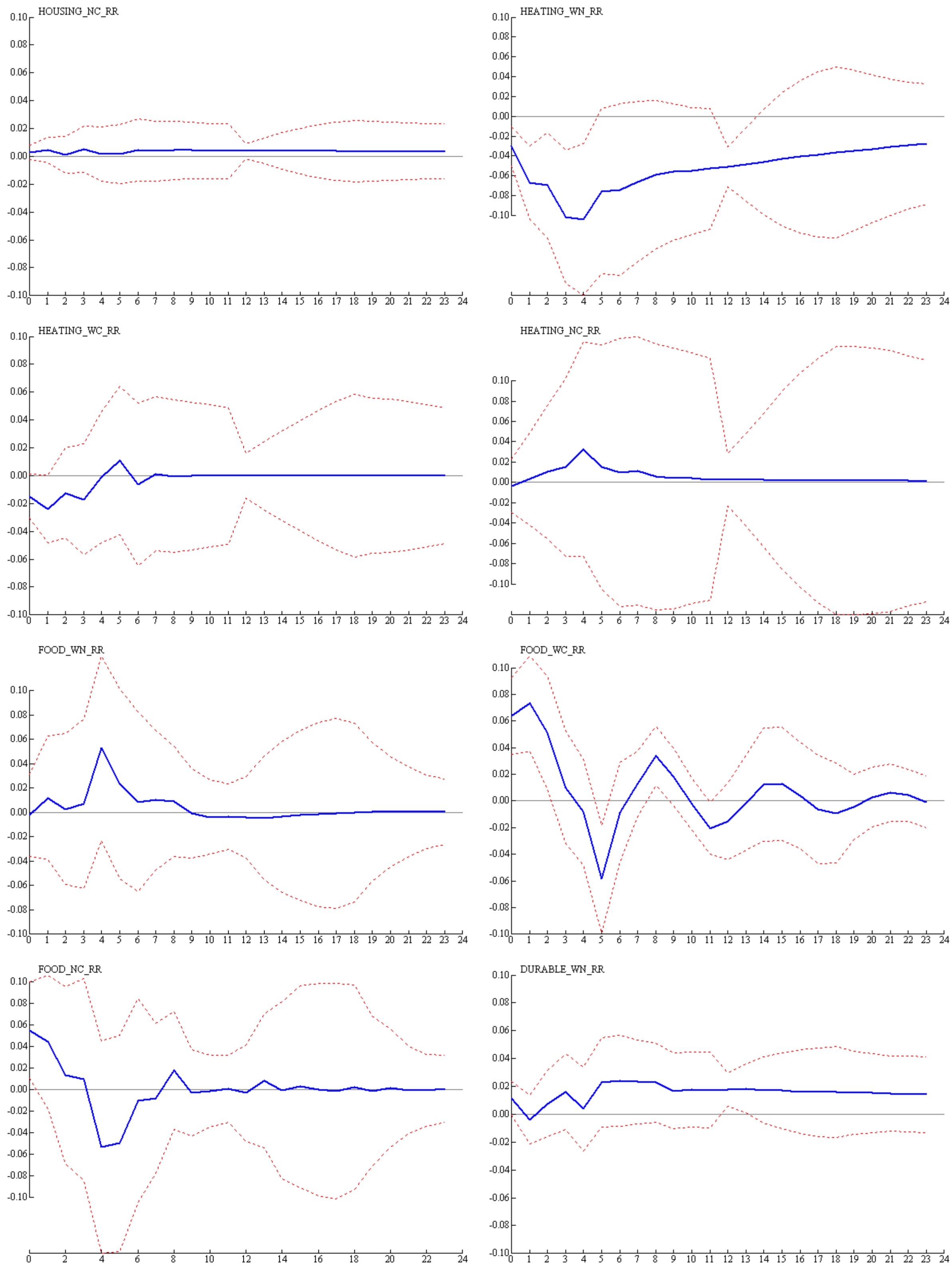
The effects of monetary shocks on relative prices

A one percent monetary shock was applied to equation 25 as outlined in the previous section. Below are the results of the simulations. The confidence bands are calculated from one standard error from the IRFs.

Figure 9. Impulse response of relative regional prices from a one percent RR monetary shock




SERVICES_WN_RR
SERVICES_WC_RR
SERVICES_NC_RR
MISC_WN_RR
MISC_WC_RR
MISC_NC_RR
HOUSING_WN_RR
HOUSING_WC_RR


HOUSING_NC_RR
HEATING_WN_RR
HEATING_WC_RR
HEATING_NC_RR
FOOD_WN_RR
FOOD_WC_RR
FOOD_NC_RR
DURABLE_WN_RR

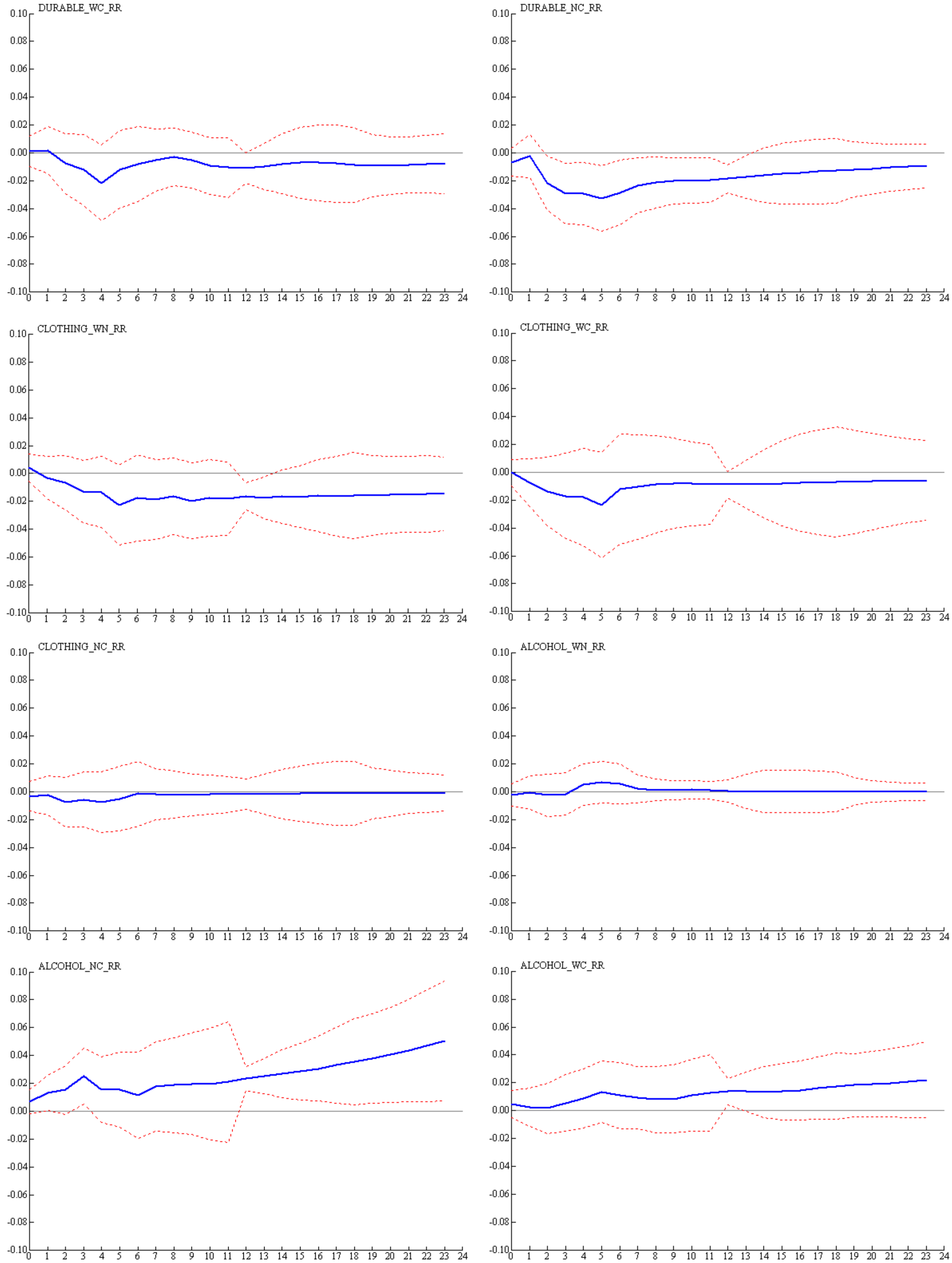

DURABLE_WC_RR
DURABLE_NC_RR
CLOTHING_WN_RR
CLOTHING_WC_RR
CLOTHING_NC_RR
ALCOHOL_WN_RR
ALCOHOL_NC_RR
ALCOHOL_WC_RR

Figure 9 shows the response of relative prices to a one percent monetary shock.[80] The standard error attached to the impulse responses is quite large and this could bring the accuracy of the responses into question. The large standard errors may be due to the limited data available. Since there was only five years of regional data available, there may not be enough variation in the data to render statistically significant results. Unfortunately, there is very little that econometrics can do to remedy this problem.

The aggregate relative regional price indices suggest that regional prices do not respond symmetrically to monetary shocks. Regional price differences appear to peak at around two percent, a quarter after the initial monetary shock. However, these price differences appear to dissipate within the first twelve months after the initial monetary shock. This would suggest that monetary shocks do not cause permanent aggregate price differences amongst the three regions.

The impulse response functions reveal that the majority of the relative regional CPI components converge to zero approximately 12- 18 months after a monetary shock. This would indicate that the effects of monetary shocks on the majority of the regional CPI components are short lived. Monetary shocks to food (the largest item in the regional CPI which accounts for approximately 40%) appear to dissipate within twelve months after the initial shock. This may help explain the results in the aggregate regional indices. However, there are a few regional components which appear to have a sustained and constant price difference after a monetary shock. This would indicate that monetary shocks do have a long term effect on certain regional price differences. Household durables and clothing display constant long term regional price differences, after a monetary shock. This is not surprising given the nature of these items. Furthermore, one could argue that household durables are particularly susceptible to monetary shocks, given they can be purchased at a later date.

The short lived nature of the monetary shocks appears to contradict the results of the unit root tests performed earlier. However, the sum of the autoregressive (AR) coefficients may not equal one, but may be very close to it. Since the standard errors in the models are quite large, this may render the sum on the AR coefficients statistically insignificant from one. Furthermore, the majority of the relative price forecasts beyond the eighteenth month are extremely close to zero, but not equal to zero. This would imply that the relative price series has a long memory, consistent with **near** unit root like process. However, some of the relative price series that converge to non-zero

[80] The impulses are shown for the RR monetary shocks; the BB and DPIR impulses are in the appendices (A.2.8).

equilibrium (household durables and clothing) are consistent with a unit root process as monetary shocks **do** have a permanent effect on the relative price series.

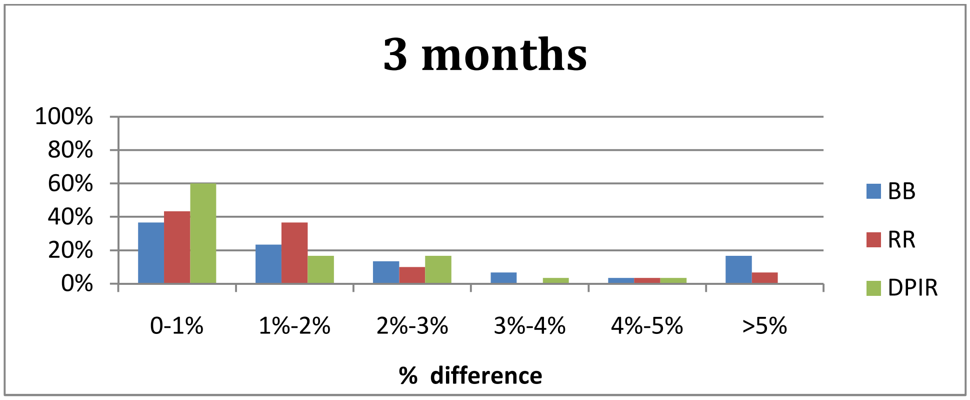
The relative price of alcohol between the Northern and Central and the Western and Central regions appears to be growing over time. This would indicate a continued increase in the price differences amongst the regions over the forecast horizon, thus implying a degree of persistence in the real exchange rate of alcohol amongst the regions concerned. Therefore a temporary monetary shock causes a persistent increase in the price differences. This is inconsistent with the aggregate regional price indices. However, the heavy duties and taxes levied on alcohol, the existence of a "black market" and the possibility of errors in this particular data set may be the reasons behind these odd findings. Nevertheless, alcohol only encompasses a small portion of the regional CPI (4-5%).

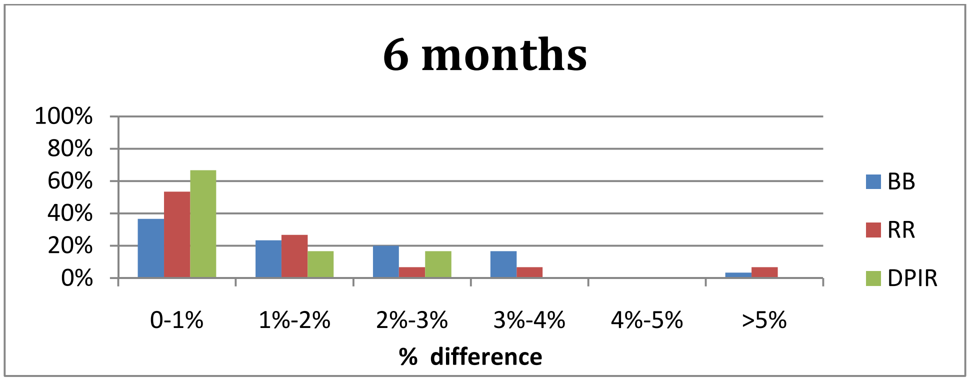
The relative regional price of services did not appear to be affected by the monetary shocks. However, this category encompasses medical, educational and entertainment services. The first two in particular are heavily regulated by the government and as a result would not be affected by monetary shocks.

Figure 10 shows the distribution of price differences that were caused **after** the initial monetary shock. Eighteen months after the initial shock, the majority of the regional prices appear to differ by less than one percent (in absolute value), compared to three months after the shock when sixty percent of the regional price differences were greater than one percent (in absolute value). These graphs help to justify further the short lived nature of the monetary shocks on regional prices.

Even though the effects of the monetary shocks appear to dissipate in the long run, in the short run the regional relative price series appear to respond asymmetrically to the monetary shocks. The IRFs reveal that the majority of the regional price differences appear to reach (and in some instances exceed) two percent. The differences in regional food prices appear to be highly sensitive to shocks in the short run, peaking at well over four percent. Figure 10 helps clarify the short run asymmetric response of regional prices, after a monetary shock. This is evident in the distribution of price differentials three months after the initial shock. However, these asymmetries appear to dissipate over time. Unfortunately, due to the large standard errors attached to the forecasts, the estimates in Figures 9 and 10 could be viewed as inaccurate, with the vast majority of the estimates statistically indifferent from zero at the five percent level of significance. The forecasts of relative prices and their associated standard errors for selected months after the monetary shock are available in the appendices (A.2.5-A.2.7).

Figure 10. Distribution of the absolute value of the forecasted regional relative prices at selected months after a monetary shock[81]





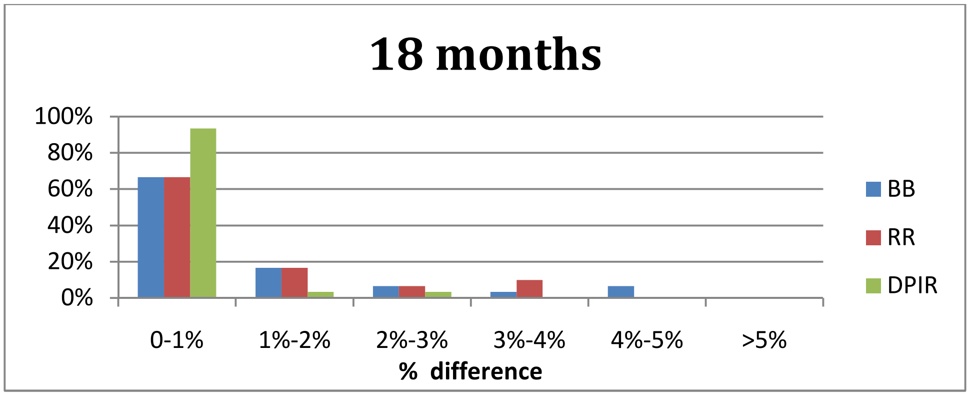


Figure 10 above and Figure 14 in the appendices show the comparison between the different measures of monetary shocks applied to each of the regional CPI components. In most instances,

[81] The differences are relative to the initial differences amongst regional prices, which were assumed to be zero.

there appears to be a marked difference in the short run response of the regional relative price indices to each of these monetary shocks. Table 16 also shows a degree of variation across the different measures of monetary shocks.

Table 16. Correlation between the twelve month average IRF generated from the various monetary shocks

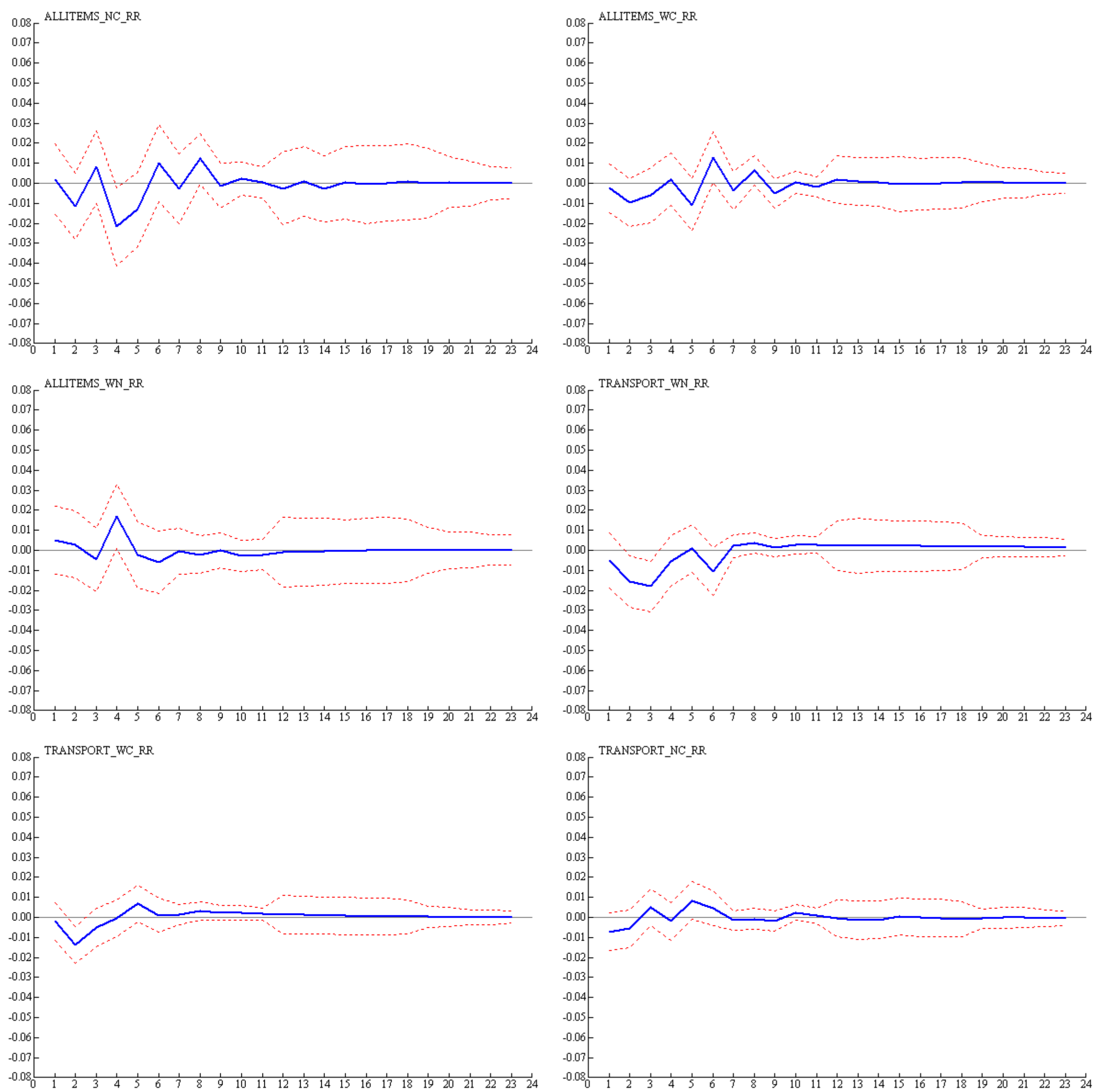
	BB	DPIR	RR
BB	1.00		
DPIR	-0.36	1.00	
RR	0.51	0.05	1.00

However, the effects of the various measures of monetary shocks on the **majority** of the relative price series all appear to dissipate in the long run.

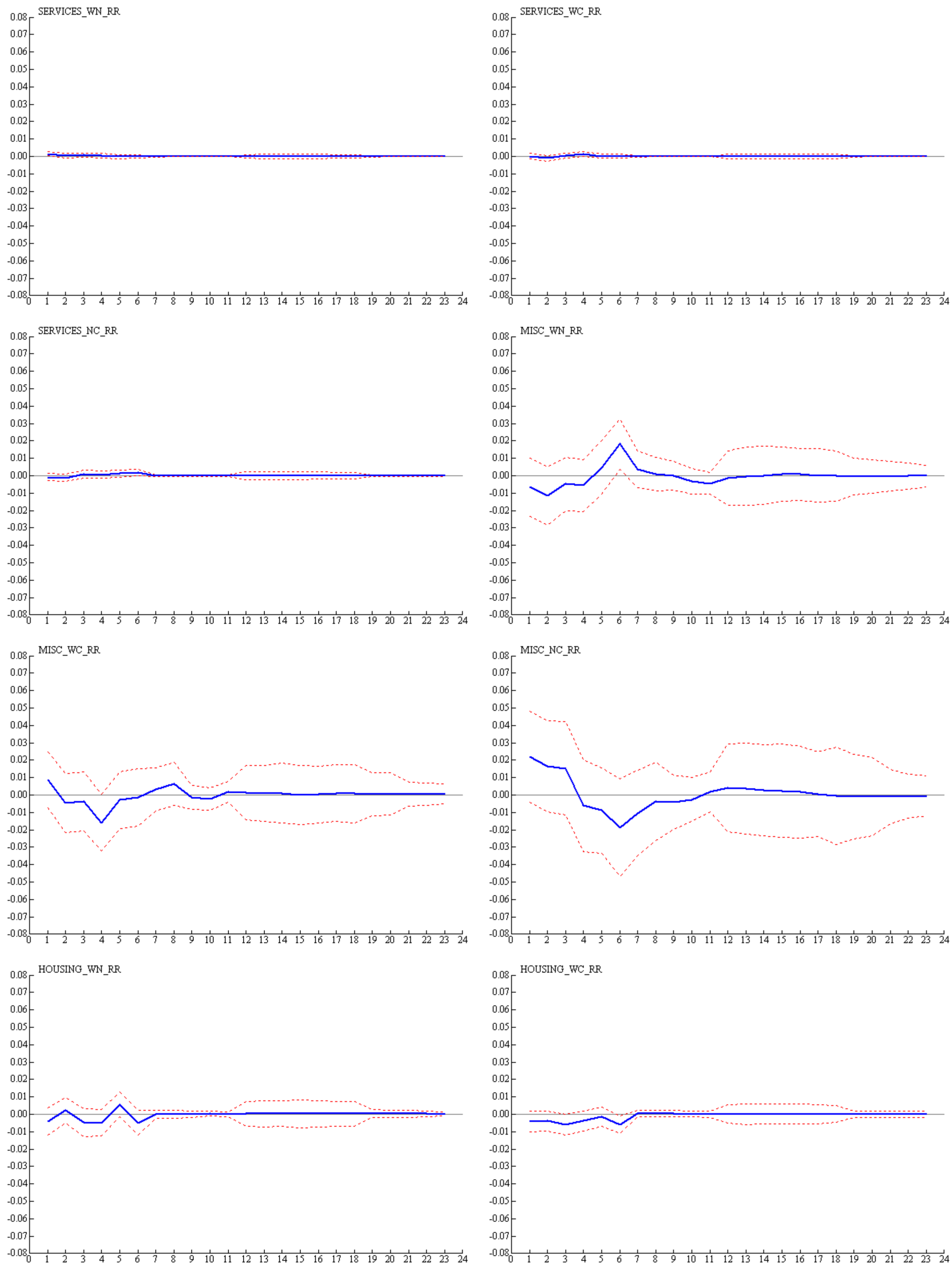
Inflation differentials

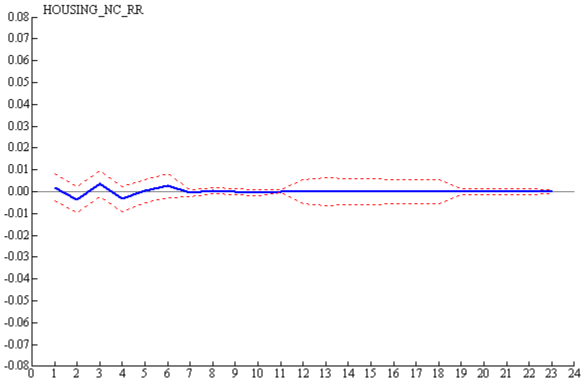
While the relative prices above go some way to revealing asymmetries between regional aggregate price indices and their components, the resulting inflation differentials will be of greater interest, particularly to policy makers. Below are the simulations of the inflation differential caused by a one percent monetary shock. The regional inflation differentials begin one month after the initial monetary shock. The confidence bands are calculated as one standard error from the IRFs.

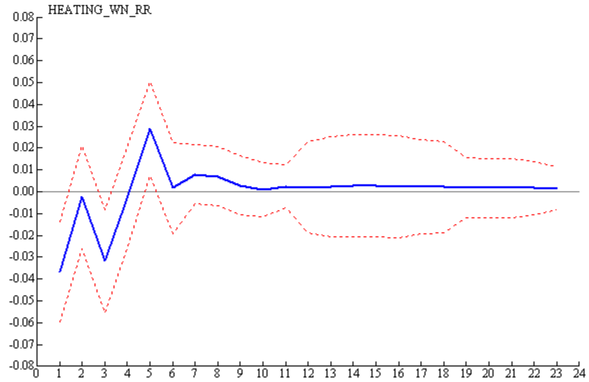
Figure 11. Regional inflation differentials after a one percent RR monetary shock[82]

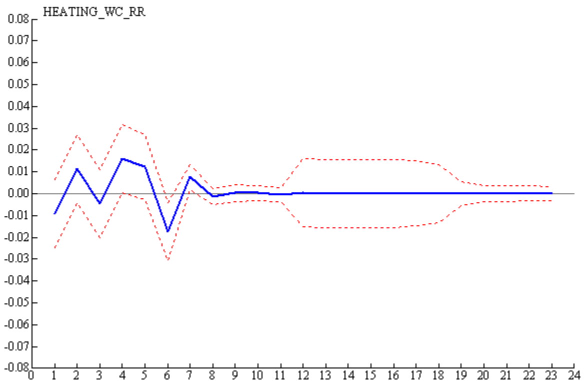


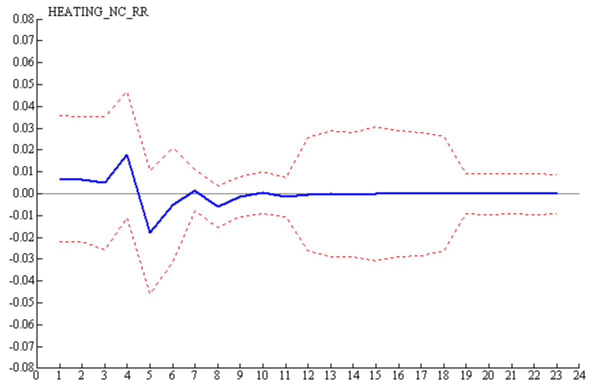
[82] The following impulses are for the RR monetary shocks; the individual BB and DPIR are available upon request.

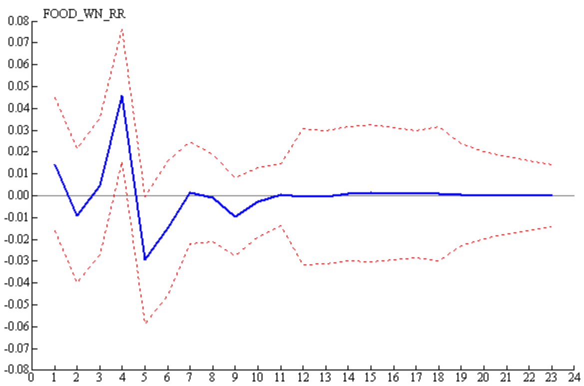

SERVICES_WN_RR
SERVICES_WC_RR
SERVICES_NC_RR
MISC_WN_RR
MISC_WC_RR
MISC_NC_RR
HOUSING_WN_RR
HOUSING_WC_RR

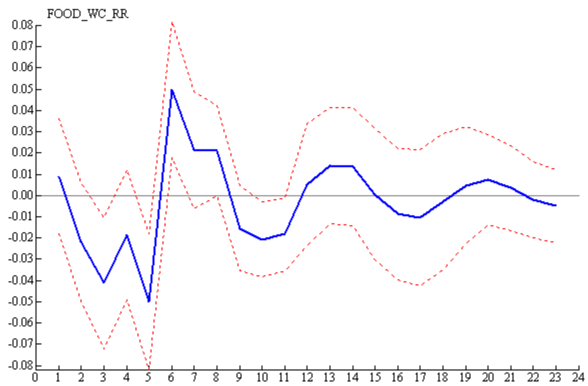

HOUSING_NC_RR

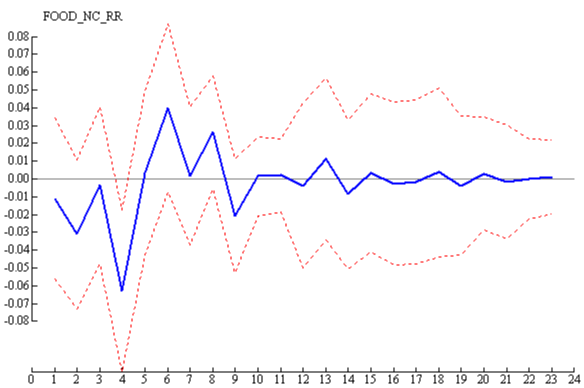

HEATING_WN_RR

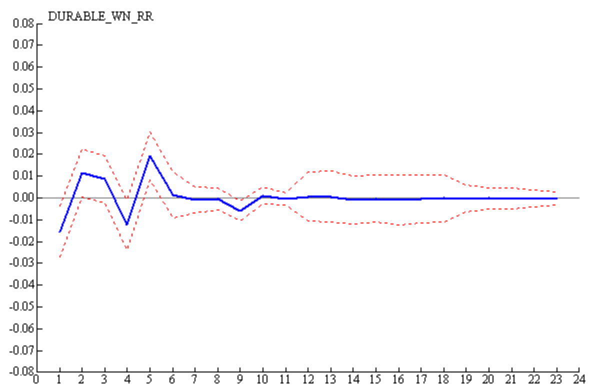

HEATING_WC_RR

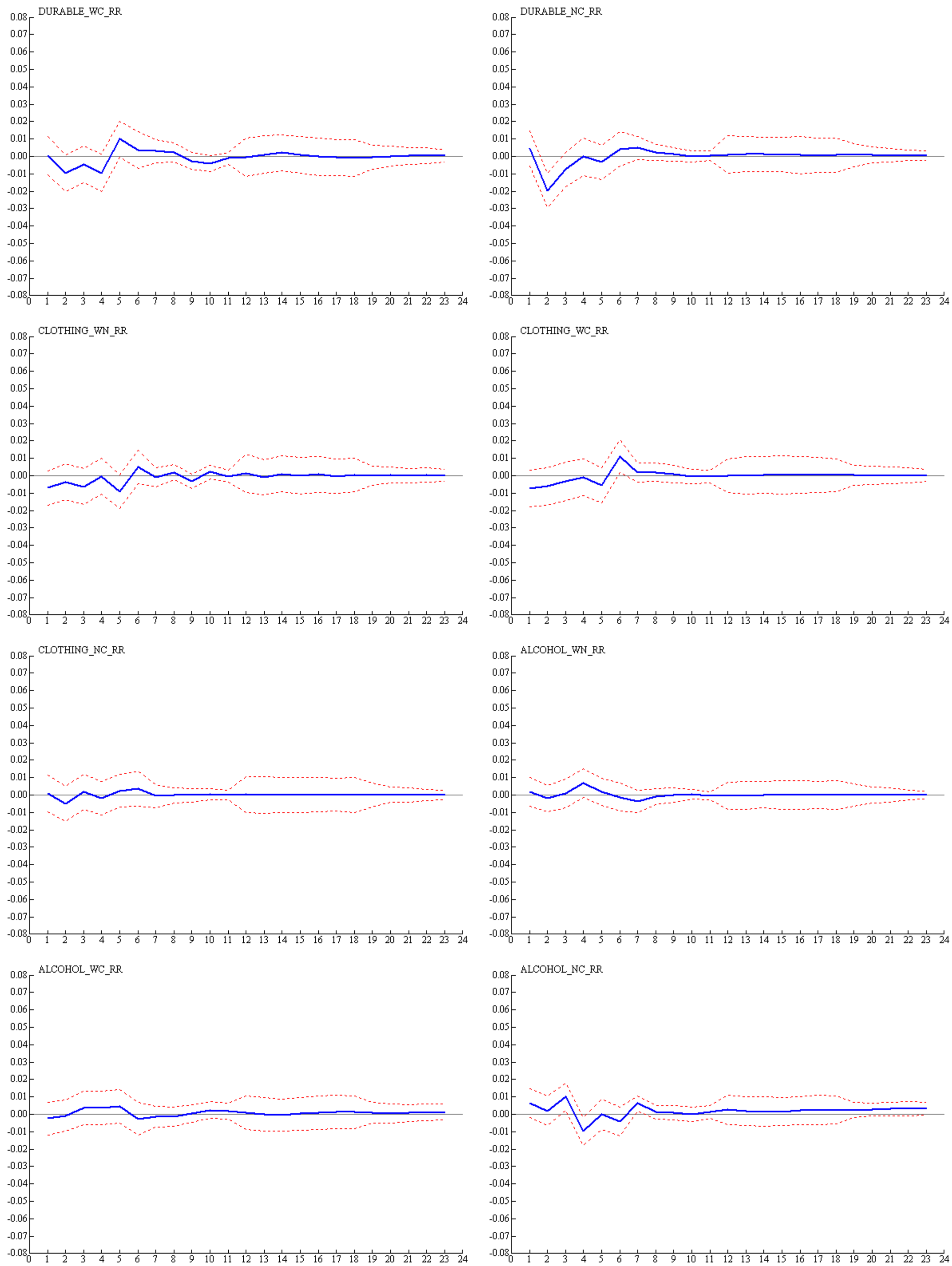

HEATING_NC_RR


FOOD_WN_RR


FOOD_WC_RR


FOOD_NC_RR


DURABLE_WN_RR


DURABLE_WC_RR
DURABLE_NC_RR
CLOTHING_WN_RR
CLOTHING_WC_RR
CLOTHING_NC_RR
ALCOHOL_WN_RR
ALCOHOL_WC_RR
ALCOHOL_NC_RR

The first notable feature of the above is the general time frame at which regional inflation differentials dissipate over the forecast horizon, after a monetary shock. Table 26 in the appendices (A.2.11) helps provide further support for this, with none of the inflation differentials being significantly different from zero, twelve months after the initial shock.[83] The general convergence of relative prices within twelve to eighteen months after the monetary shocks may help explain the above results. The aggregate regional inflation differentials disappeared within the first twelve months after the initial monetary shock.

Regional food inflation differentials (food makes up approximately 40% of the total regional consumption) disappeared well within twelve months after the initial shock. The other major component of regional CPI was transport (approximately 15% of the total regional consumption) which also recovered fairly swiftly after a monetary disturbance. These results may be the driving force behind the swift recovery of aggregate regional prices after a monetary shock. The only exception to the dissipating inflation differentials were the growth rates of alcohol prices between the Western and Central, and the Northern and Central regions which appear to have a permanent inflation differential. However, this is a direct result of the growing price differences in regional alcohol prices which was discussed earlier.

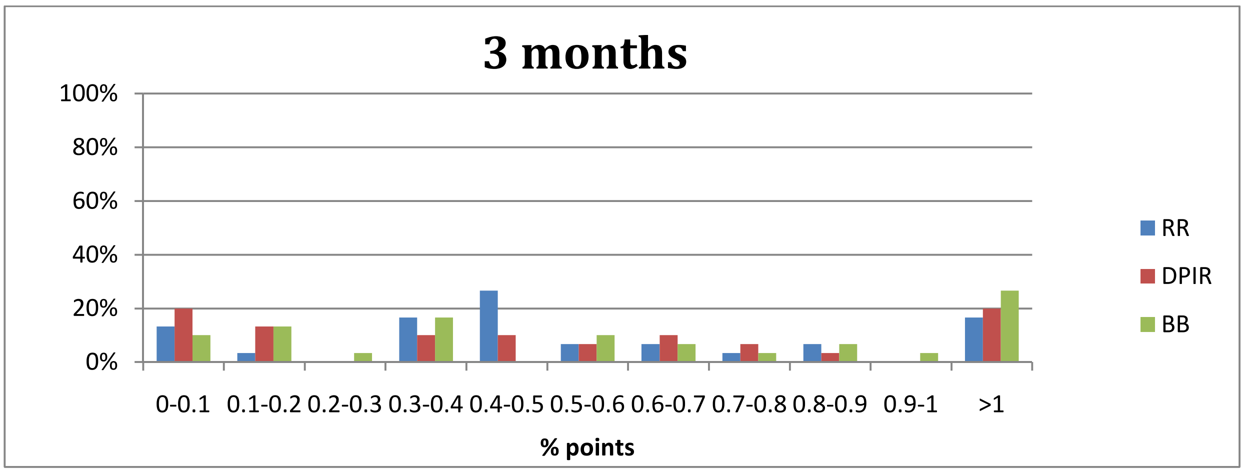
However, the differences in the short term regional rates of inflation are quite clear, particularly within the first six months after the initial monetary shock. Differences in aggregate regional inflation peak at approximately 2 percentage points in absolute value, within the first six months after the monetary shock. Regional food inflation appears to exhibit large differences over this time period, with the largest inflation differential being between the Northern and Central regions at 7.5 percentage points. The differences in the growth rates of regional food prices may help explain the differences in aggregate regional inflation rates. However, the other components of the CPI also show differences in their regional growth rates. These peak at approximately 1 to 3% points within the first six months after the initial monetary shock.

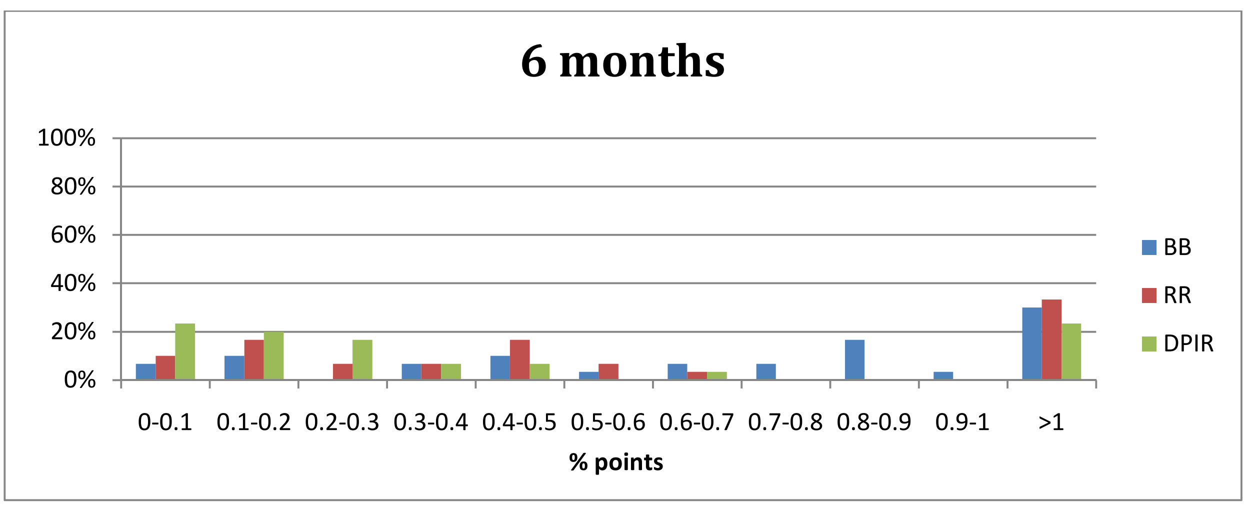
Figure 12 helps reinforce the above, as it shows the inflation differentials at three, six and twelve months after the initial shock. At three and six months after the initial monetary shock, there appears to be greater variation in the regional inflation differentials across all the CPI components. It also appears that inflation differentials amongst the three regions are at their greatest approximately six months after the initial shock. Furthermore, the lack of regional inflation

[83] Like the relative price IRFs the majority of the inflation differentials appear to be statistically insignificant for the same reasons mentioned earlier.

differentials twelve months after the monetary shocks confirm that inflation differentials are indeed a short run phenomenon.[84] Policy makers would be happy with the above results, as regional inflation asymmetries have proven to be a short run phenomenon, which would imply that there are no long term welfare losses associated with long term regional inflation differentials.

Figure 12. Distribution of the absolute value of the forecasted regional inflation differentials at selected months after a monetary shock





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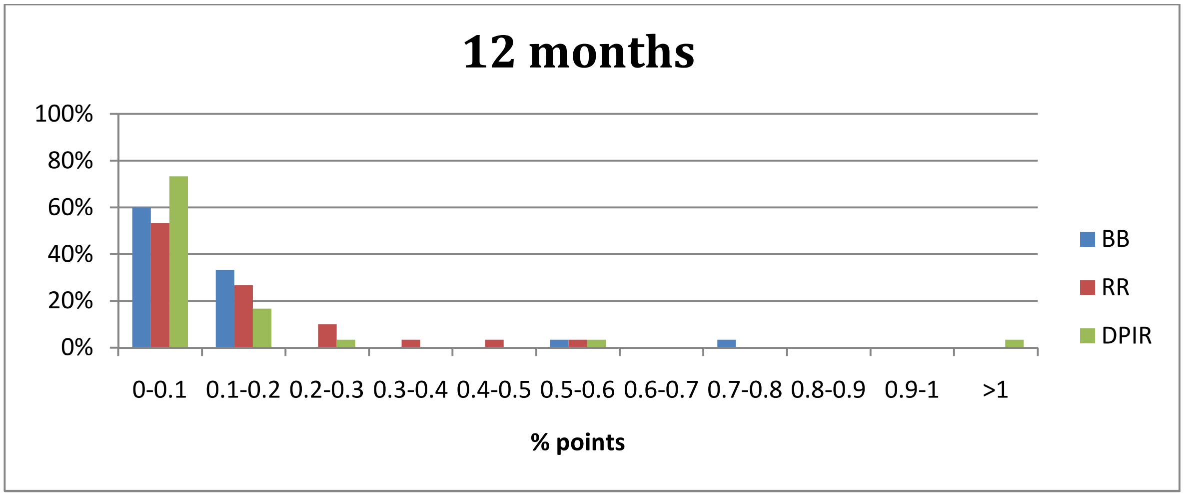
[84] Interestingly, table 24 (three months after the shock) reveals that only three of the thirty regional inflation differentials are significantly different from zero, though none of the shocks appear significant twelve months after the initial shock. However, this is with reference to the RR monetary shocks; the numbers of significant inflation differentials are slightly different when the other measures of monetary shocks are used.


12 months
100%
80%
60%
40%
20%
0%
0-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-0.8
0.8-0.9
0.9-1
>1
% points
BB
RR
DPIR

2.6 Discussion

Statistically speaking the majority of the relative price series are unaffected by monetary shocks. This is most likely due to the limited time series data available. However statistical significance aside, the results of the relative price simulations and the subsequent inflation differentials reveal that aggregate regional price differences are short lived. This result was primarily driven by the swift adjustment of the regional CPI components, with the majority of relative prices converging to some steady state within eighteen months after the initial monetary shock. This is particularly evident in the adjustment of regional food price differences (which encompass approximately 40% of regional consumption) after the monetary shock. Household Durables, which are usually relatively sensitive to monetary disturbances (given they are seen as luxury goods which can be purchased at a later time) appeared to have a permanent price differential after a monetary shock. However, they only make up approximately 3% of regional CPI. The quick adjustment of prices to monetary shocks reveals that aggregate and disaggregated prices in Fiji may not be as sticky as prices in developed countries. The twelve months taken for aggregate regional prices to recover from monetary shocks is comparably quicker than Christiano et al. (1999) found for the US. [85]

As a result of the quick convergence of regional relative prices, regional inflation differentials tended to dissipate within the first year after the monetary shock. This would satisfy policy makers as there are no long term welfare consequences that would be associated with long run regional inflation differentials. However, while there may not be any long term inflation differentials, aggregate regional inflation differentials (and the majority other components of the regional CPI) still exhibit considerable short term variation.

The use of LAD to address the distribution of the data, in addition to the simulation of critical values to address the nature of the data within a Fijian context, helps introduce an innovative element to the project.

However, there are some caveats to consider. Firstly, the limited sample size used in this study and the subsequent degrees of freedom available could jeopardize the precision of the estimates and impulse response functions reported here. This could be a contributing factor behind the large standard errors on the impulse response functions.

[85] In their study the US price level took 18 months to react to a monetary shock.

Due to the limited time frame and the time taken to generate the critical values, we had to carry out our simulations using 5000 replications. It would have been ideal to use 50000 replications to simulate our critical values, but the time and computer power needed to generate these for the ninety different relative price equations could not have been carried out in a realistic time frame.

While this study has identified the short run regional price asymmetries associated with monetary shocks, due the unavailability of data, we are unable to carry out any formal analysis on the economic, demographic and geographic factors that cause these asymmetries. Therefore we are unable to determine what region-specific characteristics or economic fundamentals underpin the observed short run asymmetries.

Conclusions

The first chapter in this study focused on generating monetary shocks, using the forecasts and data employed by the RBF when setting monetary policy. We then applied the Romer and Romer and Bluedorn and Bowdler aggregation methods when formulating the monetary shocks. The aim of this chapter was to purge the policy rate of market expectations and thus obtain true measures of monetary shocks.

Our second chapter then applied these shocks to regional prices to gauge whether they exhibited an asymmetric response to monetary shocks. A change in the conduct of monetary policy in June 2007 may have introduced a structural break in the response of inflation. However given the small sample size, a structural break test would not have much power. Consequently, the econometric methods used in this study, like all time series analysis, would have benefitted from having a longer data span. Nonetheless, the methods employed in this study could easily be applied to other developing countries to analyze the asymmetric effects of monetary policy on regional price or output. On that note, it could be left to future research to try and ascertain the effects of monetary policy shocks on Fijian regional output data (should it become available).

The results of this study would indicate that monetary shocks do not have long term effects on regional price differences in Fiji. However, regional prices did exhibit considerable variation in the first twelve to eighteen months after a monetary shock.[86] Our results are partly consistent with those of Fielding and Shields (2007) which also found heterogeneity across the city wide response to a monetary shock. However, in comparison to our study, the inter city price differences in the US tended to linger for a prolonged period of time. A monetary shock to regional inflation in South Africa, a country slightly ahead of Fiji in terms of economic development, was found to have persistent inter regional effects (Fielding and Shields 2006). This is in contrast to Fiji, where regional inflation differentials tended to dissipate within the first 12 months after a monetary shock.

Relative to South Africa and the US, Fiji is a small country. Therefore the asymmetric regional economic structures that are prevalent in larger countries, particularly in the US, may not be present in Fiji. This could provide a possible explanation into why the effects of monetary shocks do not cause prolonged price differences amongst the regions in Fiji.

[86] However, the majority of our results were not statistically significant.

However, unlike Fielding and Shields (2007), the source of the short run asymmetries could not be found due to the lack of regional data on demographic, geographic and particularly economic characteristics. Nonetheless, policy makers would view the short run nature of the regional price asymmetries as a positive as they are able to avoid the welfare consequences and social inequalities associated with long term regional price differences.

Appendix

A.1 Chapter 1

A.1.1 Table 17. Determinants of the policy indicator rate (PIR) using WLS and the weighted growth series

Regressors	Coefficient	P value
Constant	-0.120	0.931
PIR from previous meeting	-0.383	0.018
Forecasted inflation		
Period		
-1	0.118	0.308
Current	0.065	0.794
Total effect	0.183	0.509
Revised forecast of inflation		
Period		
-1	-0.012	0.881
Current	0.052	0.785
Total effect	0.040	0.846
Forecasted economic growth		
Period		
-1	-0.062	0.326
Current	5.06E-03	0.966
1	0.385	0.294
2	0.256	0.354
Total effect	0.584	0.083
Revised forecast of economic growth		
Period		
-1	-0.012	0.885
Current	0.023	0.859
1	-0.312	0.321
2	-0.181	0.332
Total effect	-0.481	0.132
Output gap	-6.07E-03	0.584
Reserves of previous period	-3.26E-04	0.675
Adjusted R^2	**2%**	
R^2	**42%**	
N	41	

A.1.2 Table 18. Determinants of the policy indicator rate (PIR) using interval regression methods and the weighted growth series

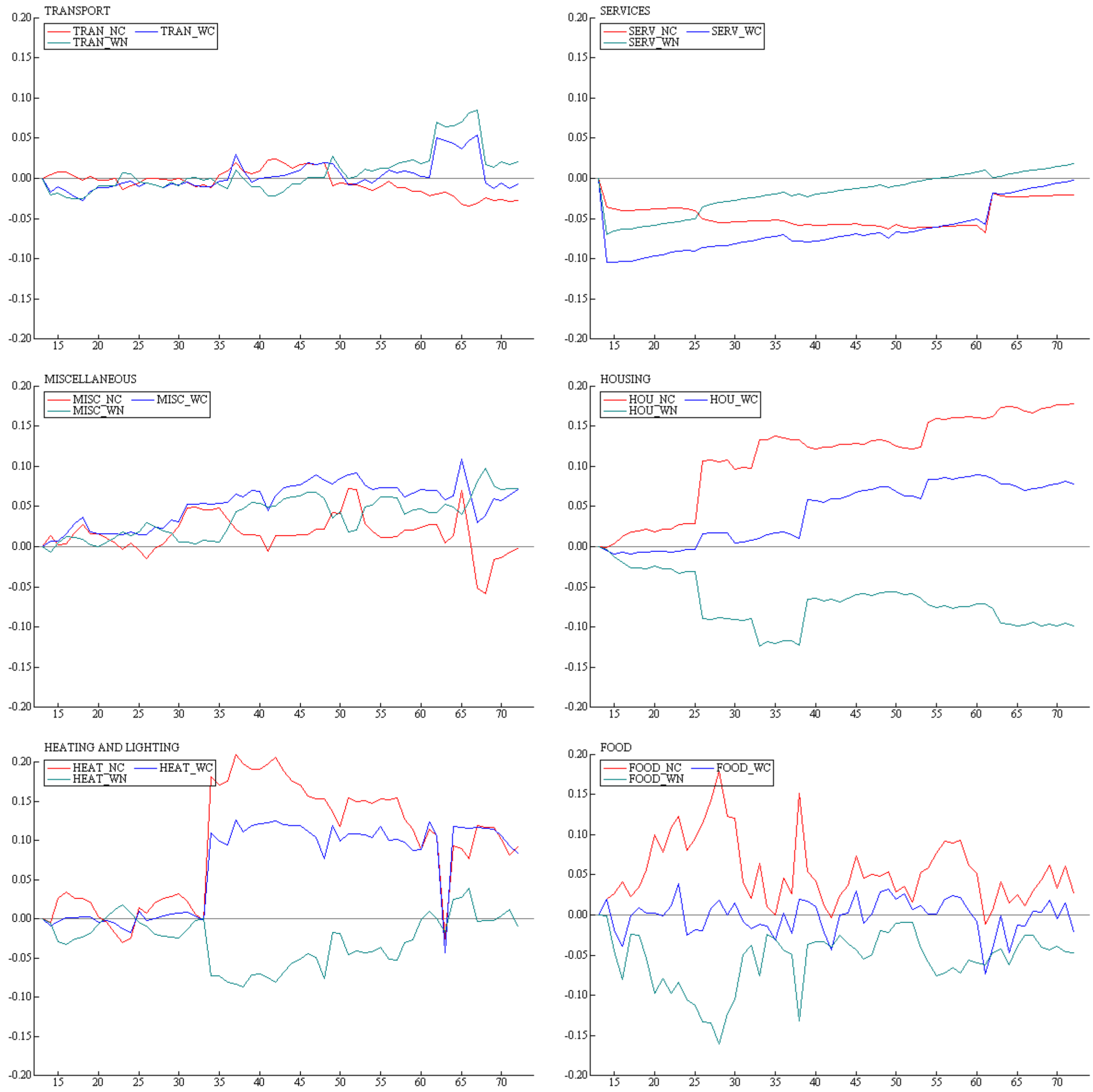
Regressors	Coefficient	P value
constant	-0.120	0.864
PIR from previous meeting	-0.387	0.00
Forecasted inflation		
Period		
-1	0.119	0.083
Current	0.066	0.657
Total effect		
Revised forecast of inflation		
Period		
-1	-0.012	0.814
Current	0.053	0.741
Total effect		
Forecasted economic growth		
Period		
-1	-0.063	0.041
Current	0.006	0.953
1	0.386	0.078
2	0.261	0.356
Total effect		
Revised forecast of economic growth		
Period		
-1	-0.011	0.871
Current	0.022	0.866
1	-0.313	0.142
2	-0.183	0.227
Total effect		
Output gap	-0.006	0.307
Reserves of previous period	0.000	0.49
N	41	

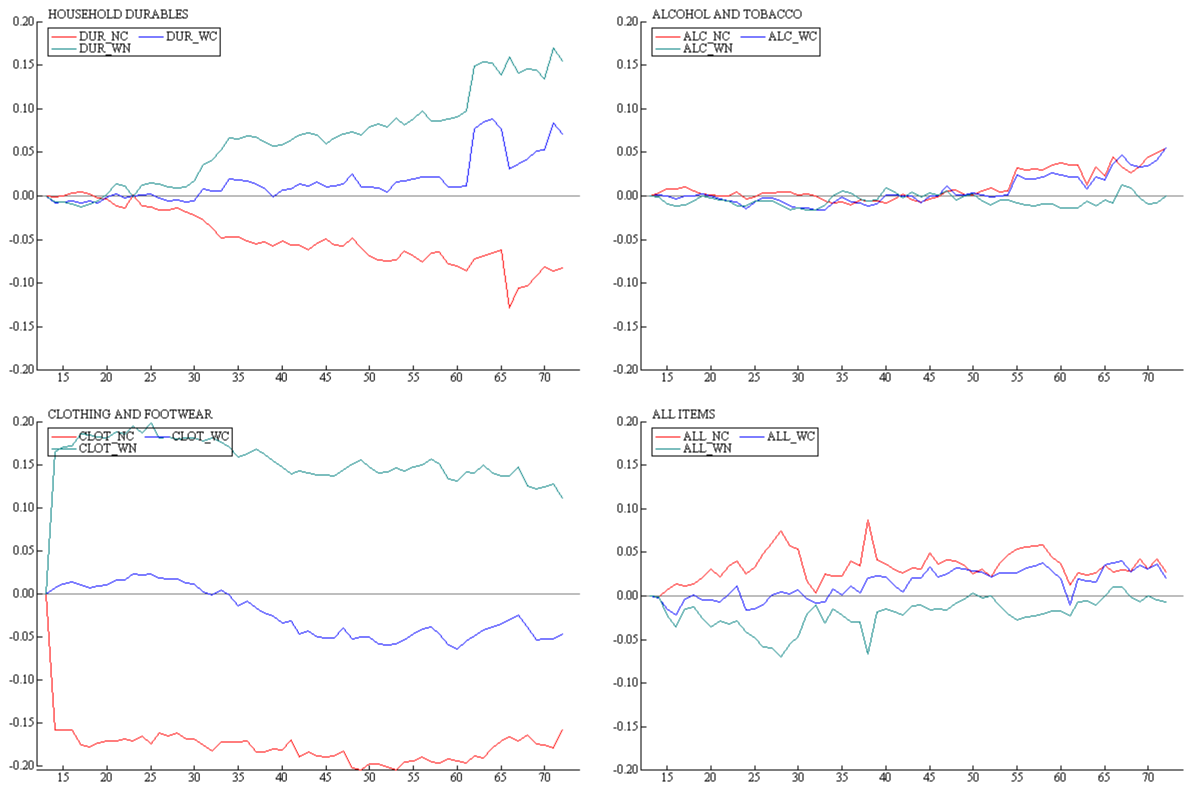
A.1.3 Table 19. Determinants of the SRD using WLS and the weighted growth series

Regressors	Coefficient	P value
Constant	3.979	0.028
SRD from previous meeting	-1.250	0.004
Forecasted inflation		
Period		
-1	0.078	0.162
Current	-0.056	0.272
Total effect	0.022	0.754
Revised forecast of inflation		
Period		
-1	-0.131	0.072
Current	-0.040	0.437
Total effect	-0.171	0.032
Forecasted economic growth		
Period		
-1	0.064	0.277
Current	0.431	0.023
1	0.178	0.647
2	1.282	0.023
Total effect	1.956	0.007
Revised forecast of economic growth		
Period		
-1	-0.090	0.271
Current	-0.185	0.136
1	-0.411	0.260
2	0.088	0.784
Total effect	-0.598	0.326
Devaluation	-0.507	0.377
Output gap	-0.079	0.066
Reserves of previous period	0.000	0.556
Adjusted R^2	**63%**	
R^2	**83%**	
Aikaike	**50**	
N	31	

A.2 Chapter 2

A.2.1 Figure 13. Plots of relative prices





A.2.2 Table 20. JB Distribution of relative price series

Relative price series.	NC	WC	WN
All Items	NORMAL	NORMAL	NORMAL#
Food	NORMAL#	NON	NORMAL#
Alcohol and Tobacco	NON	NON	NORMAL
Housing	NORMAL#	NORMAL#	NORMAL
Heating and Lighting	NORMAL	NORMAL#	NORMAL
Durable Household	NORMAL	NON	NORMAL
Clothing and Footwear	NORMAL	NORMAL#	NON
Transport	NORMAL	NON	NON
Services	NORMAL#	NORMAL#	NORMAL
Miscellaneous	NON	NORMAL	NORMAL

NON is non normal distribution

NORMAL is normally distributed at 5% level of sig NORMAL# is normally distributed at 1% level of sig

A.2.3 Derivation of the non stationary DGP for an AR(6) specification

Said and Dickey (1984) have a general specification for testing a model with an AR(p) specification. Consequently an AR(6) model would have the following specification.:

$$rp_t = \emptyset rp_{t-1} + \sum_{i=1}^{5} \rho_i \Delta\, rp_{t-i} + \varepsilon_t \tag{36}$$

$\emptyset$ is the coefficient on the lagged dependent variable. The null hypothesis on this coefficient states that it is indifferent from one and hence contains a unit root.

ρ_i are the coefficients on the lagged differenced variables.

Δrp_{t-I} are the lagged differenced variables

rp_t is the relative price series.

This would result in the following DGP:

$$rp_t = \emptyset rp_{t-1} + \rho_1 \Delta rp_{t-1} + \rho_2 \Delta rp_{t-2} + \rho_3 \Delta rp_{t-4} + \rho_4 \Delta rp_{t-4} + \rho_5 \Delta rp_{t-5} + \varepsilon_t$$

$$rp_t = \emptyset rp_{t-1} + \rho_1(rp_{t-1} - rp_{t-2}) + \rho_2(rp_{t-2} - rp_{t-3}) + \rho_3(rp_{t-3} - rp_{t-4}) + \rho_4(rp_{t-4} - rp_{t-5}) + \rho_5(rp_{t-5} - rp_{t-6}) + \varepsilon_t$$

$$rp_t = (\emptyset + \rho_1) rp_{t-1} + (\rho_2 - \rho_1) rp_{t-2} + (\rho_3 - \rho_2) rp_{t-3} + (\rho_4 - \rho_3) rp_{t-4} + (\rho_5 - \rho_4) rp_{t-5} - \rho_5 rp_{t-6} + \varepsilon_t$$

$$rp_t = \alpha_1 rp_{t-1} + \alpha_2 rp_{t-2} + \alpha_3 rp_{t-3} + \alpha_4 rp_{t-4} + \alpha_5 rp_{t-5} + \alpha_6 rp_{t-6} + \varepsilon_t \tag{37}$$

By construction an AR(6) unit root process would have the following identity:

$$\textstyle\sum_{i=1}^{6} \alpha_i = \emptyset = 1 \tag{38}$$

Therefore an AR (6) unit root process would have the following DGP:

$$\widehat{rp}_t = \widehat{rp}_{t-1} + \varepsilon_t$$

A.2.4 Codes for Simulating Critical Values in TSP[87]

The following is the code for critical values simulated under non-stationary conditions using the Romer and Romer shocks in the relative price equation. The relative price equations are estimated using OLS. The code that uses the other shocks and LAD as the estimation technique are near identical, except for changes in the appropriate fields. These have not been included due to the sheer volume of code that would be reported.

Critical Value simulation

```
OPTIONS MEMORY=100;
OPTIONS CRT;
OPTIONS LIMNUM=10000000;
OPTIONS LIMWARN=0;
SUPRES SMPL;
READ(FILE='\\commerce\Users\Economics\fgibson\My Documents\data\cpi by
division\tsp\variables.xls',FORMAT=EXCEL);
SET NT=1;
```

Original Regressions

Shock variables

```
smpl 1,72;
genr(silent) dsrd= srd-srd(-1);
GENR(silent) dpir=pir-pir(-1);
GENR(SILENT) WGT1=WGT+10^-10;
```

PIR

```
smpl 1,41;
OLSQ(WEIGHT=WGT1,SILENT) Dpir,current_g, devaluation,
growthlag_1,growthlead_1,growthlead_2,inflag_1,current_inf,pir(-
1),dcurrentg,dgrowthlag1,dgrowthlead1,dgrowthlead2,dinflag1,dcurrentinf,gap,reserves(-1),c;
Unmake @COEF  M1 M2     M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17;
GENR(SILENT) RRI=(WGT=0)*0+(WGT^=0)*@RES;
GENR(SILENT) TFIT=(WGT=0)*0+(WGT^=0)*@FIT;
```

SRD

```
smpl 42,72;
OLSQ(WEIGHT=WGT1,SILENT)dSRD current_g, devaluation,
growthlag_1,growthlead_1,growthlead_2,inflag_1,current_inf,srd(-
1),dcurrentg,dgrowthlag1,dgrowthlead1,dgrowthlead2,dinflag1,dcurrentinf,gap,reserves(-1),c;
Unmake @COEF  SM1 SM2 SM3 SM4 SM5 SM6 SM7 SM8 SM9 SM10 SM11 SM12 SM13 SM14 SM15 SM16 SM17;
GENR(SILENT) RR_srd=(WGT=0)*0+(WGT^=0)*@RES;
```

RR shock

```
SMPL 1 72;
genr(silent) RR=P*RRI+Q*RR_SRD;
```

This next set of commands creates the BB aggregation series - ALPHA is the fraction of the month left when the meeting happens

```
GENR(silent) bb=ALPHA*rr+((1-ALPHA(-1))*rr(-1));
plot bb rr;
corr bb rr;
```

[87] Parts of this code have been adopted and modified from Fielding and Shields (2007)

Response of relative prices

Generating variables

```
DOT ALC,ALL,CLOT,DUR,FOOD,HEAT,HOU,MISC,SERV,TRAN;
genr(silent)R._nc=log(._n/._c);
genr(silent)R._wc=log(._w/._c);
genr(silent)R._wn=log(._w/._n);
enddot;
```

```
DOT alc_nc,alc_wc,alc_wn,all_nc,all_wc,all_wn,clot_nc,clot_wc,clot_wn,dur_nc,dur_wc,dur_wn,
food_nc,food_wc,food_wn,heat_nc,heat_wc,heat_wn,hou_nc,hou_wc,hou_wn,misc_nc,misc_wc,misc_wn,serv_nc,serv_wc,ser
v_wn,
tran_nc,tran_wc,tran_wn;
DOT H. A0. A1. A2. A3. A4. A5. A6. B1. B2. B3. B4. B5. B6. SUM;
mform (nrow=NT, ncol=1) TS.;
ENDDOT;
ENDDOT;
```

SHOCK ON RELATIVE PRICES.

```
DOT alc_nc,alc_wc,alc_wn,all_nc,all_wc,all_wn,clot_nc,clot_wc,clot_wn,dur_nc,dur_wc,dur_wn,
food_nc,food_wc,food_wn,heat_nc,heat_wc,heat_wn,hou_nc,hou_wc,hou_wn,misc_nc,misc_wc,misc_wn,serv_nc,serv_wc,ser
v_wn,
tran_nc,tran_wc,tran_wn;
SMPL 14  72;
OLSQ(silent) R. C,RR,RR(-1),RR(-2),RR(-3),RR(-4),
RR(-5),RR(-6),R.(-1),R.(-2),R.(-3),R.(-4),
R.(-5),R.(-6);
GENR(SILENT) R.RE=@RES;
SET JB.=%JB;
UNMAKE @COEF H. A0. A1. A2. A3. A4. A5. A6. B1. B2. B3. B4. B5. B6.;
ENDDOT;
```

```
DOT alc_nc,alc_wc,alc_wn,all_nc,all_wc,all_wn,clot_nc,clot_wc,clot_wn,dur_nc,dur_wc,dur_wn,
food_nc,food_wc,food_wn,heat_nc,heat_wc,heat_wn,hou_nc,hou_wc,hou_wn,misc_nc,misc_wc,misc_wn,serv_nc,serv_wc,ser
v_wn,
tran_nc,tran_wc,tran_wn;
DO TR=1,NT;
smpl 1 72;
```

Steps 1 and 2: monetary shock variation

PIR

```
smpl 1 41;
```

Step 1a: simulate the PIR based on the fitted coefficients

```
RANDOM(DRAW=RRI) E;  THIS IS ASSUMED TO BE DRAWN FROM EMPIRICAL DISTRIBUTION
GENR(SILENT) PIRS=0;
GENR(SILENT)PIRS=(M1*current_g+M2*devaluation+M3*growthlag_1+M4*growthlead_1+M5*growthlead_2+M6*inflag_
1+M7*current_inf+
M8*PIRS(-1)
+M9*dcurrentg+M10*dgrowthlag1+M11*dgrowthlead1+M12*dgrowthlead2+M13*dinflag1+M14*dcurrentinf+M15*gap
+M16*reserves(-1)+M17+E)*(TIME>2)+PIR*(TIME<3);
```

Step 2a: use the simulated PIR in place of the original PIR

```
GENR(SILENT) DPIRS=PIRS-PIRS(-1);
OLSQ(WEIGHT=WGT1,silent) DPIRS, current_g, devaluation,
growthlag_1,growthlead_1,growthlead_2,inflag_1,current_inf,PIRS(-1) ,dcurrentg, dgrowthlag1, dgrowthlead1,
dgrowthlead2,  dinflag1, dcurrentinf,gap,reserves(-1),c;
```

Transforming the residuals into the Romer and Romer style shock
GENR(SILENT) RRP=(WGT=0)*0+(WGT^=0)*@RES;

SRD

smpl 41 72;

Step 1b:simulate the SRD based on the fitted coefficients

RANDOM(DRAW=RR_srd) Z; **THIS IS ASSUMED TO BE DRAWN FROM EMPIRICAL DISTRIBUTION**
GENR(SILENT) SRDS=0;
GENR(SILENT)SRDS=(SM1*current_g+SM2*devaluation+SM3*growthlag_1+SM4*growthlead_1+SM5*growthlead_2+SM6*inflag_1+SM7*current_inf+
SM8*srdS(-1)+SM9*dcurrentg+SM10*dgrowthlag1+SM11*dgrowthlead1+SM12*dgrowthlead2+SM13*dinflag1+SM14*dcurrentinf+SM15*gap+SM16*reserves(-1)+SM17+Z)*(TIME>41)+PIR*(TIME<42);

Step 2b: use the simulated SRD in place of the original SRD

GENR(SILENT) DSRDS=SRDS-SRDS(-1);
OLSQ(WEIGHT=WGT1,SILENT) dSRDS current_g, devaluation, growthlag_1,growthlead_1,growthlead_2,inflag_1,current_inf,srdS(-1),dcurrentg,dgrowthlag1,dgrowthlead1,dgrowthlead2,dinflag1,dcurrentinf,gap,reserves(-1),c;

Transforming the residuals into the Romer and Romer style shock
GENR(SILENT) RRP_SRD=(WGT=0)*0+(WGT^=0)*@RES;

RR AND BB shock

SMPL 1 72;
genr(silent) RRS=P*RRP+Q*RRP_SRD; **aggregating the RR shocks derived from the PIR and SRD shocks**
GENR(silent) BBS=ALPHA*rrs+((1-ALPHA(-1))*rrs(-1)); **produces the Bluedorn and Bowdler shocks**

Step 3: relative price simulation

RANDOM(DRAW=R.RE) P.; **THIS IS ASSUMED TO BE DRAWN FROM EMPIRICAL DISTRIBUTION**
GENR(SILENT) R.SQ=0;
GENR(SILENT) R.SQ=(R.sq(-1)+P.)*(time>2); **ASSUMED TO FOLLOW A NON-STATIONARY PROCESS**

Step 4: REGRESSION USING SIMULATED RELATIVE PRICES AND SHOCKS

SMPL 14 72;
olsq(SILENT) R.SQ C,RRS,RRS(-1),RRS(-2),RRS(-3),RRS(-4),RRS(-5), RRS(-6),R.SQ(-1),R.SQ(-2),R.SQ(-3),R.SQ(-4),R.SQ(-5),R.SQ(-6);

Step 5: Calculating the relevant critical values from step 4

```
SET     TSH.(TR)= @T(1);
SET     TSA0.(TR)=@T(2);
SET     TSA1.(TR)=@T(3);
SET     TSA2.(TR)=@T(4);
SET     TSA3.(TR)=@T(5);
SET     TSA4.(TR)=@T(6);
SET     TSA5.(TR)=@T(7);
SET     TSA6.(TR)=@T(8);
SET     TSB1.(TR)=@ T(9);
SET     TSB2.(TR)=@T(10);
SET     TSB3.(TR)=@T(11);
SET     TSB4.(TR)=@T(12);
SET     TSB5.(TR)=@T(13);
SET     TSB6.(TR)=@T(14);
FRML SUM1 RRS.(-1)+RRS.(-2)+RRS.(-3)+RRS.(-4)+RRS.(-5)+RRS.(-6)-1;
ANALYZ(SILENT) SUM1;
SET     TSSUM.= @WALD;
```

```
ENDDO;
DELETE H.; DELETE A0.; DELETE A1.; DELETE A2.; DELETE A3.; DELETE A4.;
DELETE A5.; DELETE A6.; DELETE B1.; DELETE B2.; DELETE B3.; DELETE B4.;
DELETE B5.; DELETE B6.;
```

Step 6: THIS SORTS T-STATS AND GETS APPROPRIATE CRITICAL VALUES

```
smpl 1,NT;
DOT H. A0. A1. A2. A3. A4. A5. A6. B1. B2. B3. B4. B5. B6.  SUM;
UNMAKE TS. TSTAT_.;
SORT TSTAT_.;
SET HP = int(.005*@nob);
SET t005%. = TSTAT_.(HP);
SET HP = int(.025*@nob);
SET t025%. = TSTAT_.(HP);
SET HP = int(.05*@nob);
SET t05%. = TSTAT_.(HP);
SET HP = int(.95*@nob);
SET t95%. = TSTAT_.(HP);
SET HP = int(.975*@nob);
SET t975%. = TSTAT_.(HP);
SET HP = int(.995*@nob);
SET t995%. = TSTAT_.(HP);

MMAKE TV. T005%. T995%. T025%. T975%. t05%. T95%.;
Delete TS.; DELETE TSTAT_.;DELETE T025%.; DELETE T05%.; DELETE T95%; DELETE T975%;DELETE T995%; DELETE
T005%;
ENDDOT;
ENDDOT;
DELETE M1; DELETE M2; DELETE M3; DELETE M4; DELETE M5;
DELETE M6; DELETE M7; DELETE M8; DELETE M9; DELETE M10;
DELETE M11; DELETE M12; DELETE M13; DELETE M14; DELETE M15; DELETE M16;
DELETE M17; DELETE M18;
```

WRITE TO FILE.

A.2.5 Table 21. Regional relative price response three months after the initial shock

series	BB	SE	RR	SE	DPIR	SE
alcohol_nc	0.015	0.019	0.025	0.020	0.008	0.005
alcohol_wc	0.007	0.021	0.005	0.020	0.000	0.006
alcohol_wn	0.002	0.017	-0.002	0.015	-0.010	0.004
allitems_nc	-0.001	0.031	0.017	0.030	0.005	0.007
allitems_wc	-0.007	0.025	-0.006	0.023	-0.014	0.006
allitems_wn	0.018	0.044	0.001	0.038	-0.022	0.009
clothing_nc	-0.011	0.022	-0.006	0.020	0.000	0.005
clothing_wc	-0.025	0.032	-0.017	0.031	-0.001	0.007
clothing_wn	-0.015	0.024	-0.013	0.022	-0.005	0.006
durable_nc	-0.018	0.024	-0.029	0.022	0.003	0.006
durable_wc	-0.011	0.030	-0.012	0.026	-0.005	0.008
durable_wn	-0.007	0.033	0.016	0.027	-0.008	0.009
food_nc	-0.069	0.096	0.010	0.094	0.023	0.023
food_wc	-0.004	0.045	0.010	0.042	-0.006	0.014
food_wn	0.063	0.075	0.007	0.070	-0.039	0.018
heating_nc	0.064	0.092	0.015	0.088	-0.043	0.023
heating_wc	0.034	0.037	-0.017	0.040	-0.015	0.017
heating_wn	-0.051	0.057	-0.101	0.067	0.006	0.015
housing_nc	-0.005	0.018	0.005	0.017	0.001	0.006
housing_wc	-0.021	0.017	-0.019	0.015	0.000	0.005
housing_wn	-0.016	0.021	-0.009	0.021	-0.005	0.008
misc_nc	0.054	0.053	0.041	0.053	0.025	0.012
misc_wc	-0.037	0.032	-0.015	0.030	0.023	0.008
misc_wn	-0.026	0.047	-0.011	0.043	-0.020	0.008
services_nc	0.000	0.006	-0.001	0.006	-0.002	0.003
services_wc	0.000	0.004	-0.001	0.004	-0.001	0.003
services_wn	0.001	0.003	0.004	0.003	0.000	0.001
transport_nc	-0.007	0.025	0.000	0.023	0.007	0.006
transport_wc	-0.023	0.024	-0.025	0.022	-0.012	0.008
transport_wn	-0.050	0.028	-0.051	0.034	-0.012	0.010

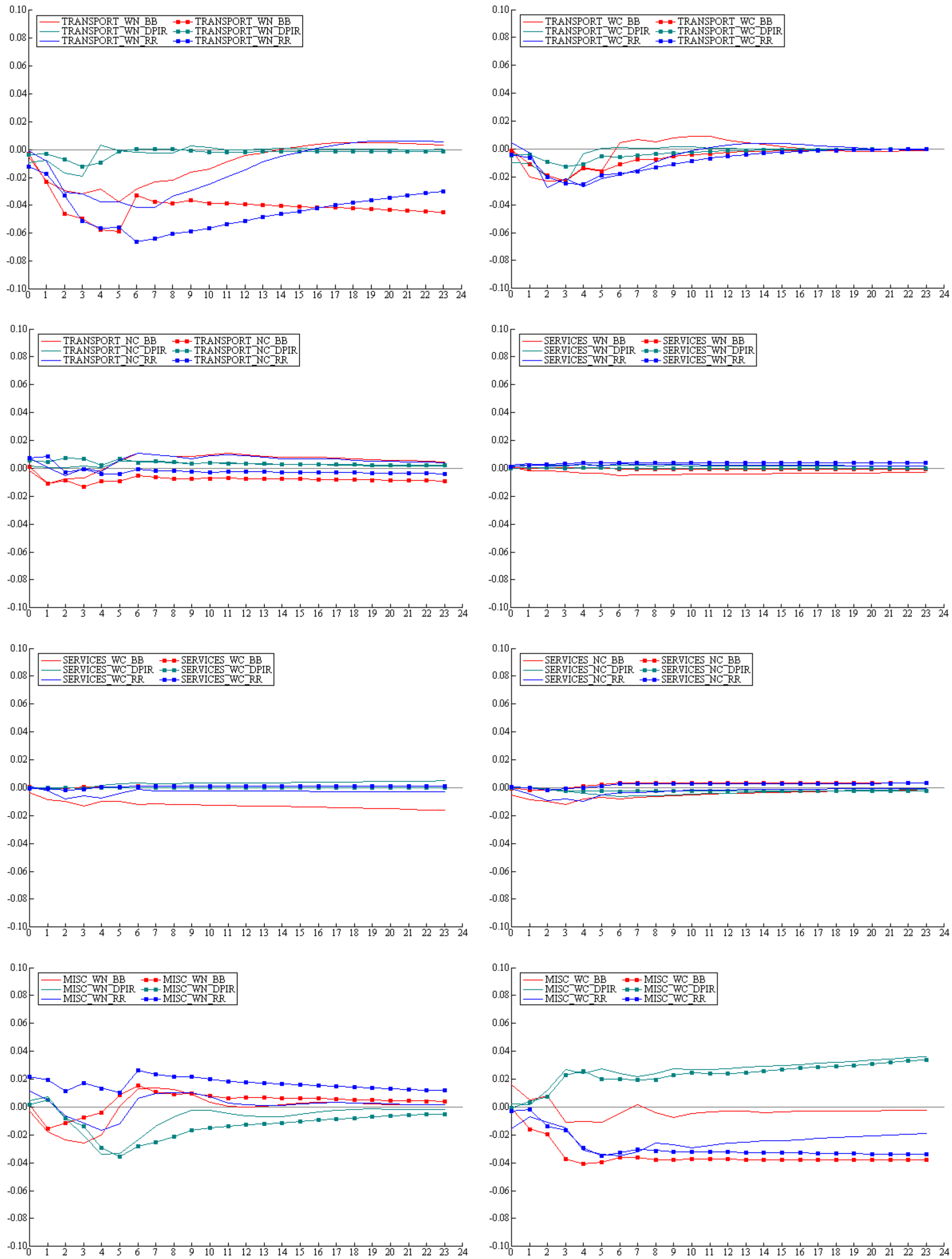
A.2.6 Table 22. Regional relative price response six months after the shock

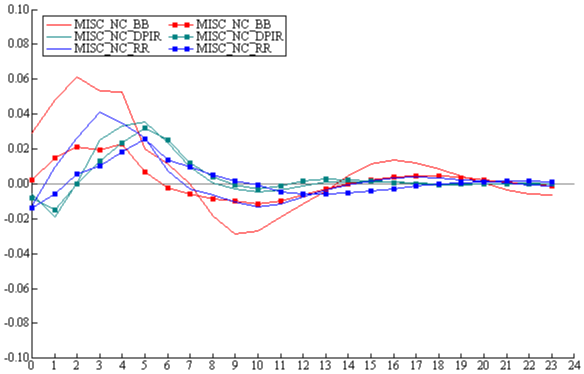
series	BB	SE	RR	SE	DPIR	SE
alcohol_nc	0.014	0.031	0.011	0.031	-0.004	0.007
alcohol_wc	0.001	0.024	0.011	0.024	0.006	0.007
alcohol_wn	-0.009	0.016	0.006	0.014	0.002	0.004
allitems_nc	-0.010	0.027	-0.008	0.026	0.003	0.008
allitems_wc	-0.022	0.026	-0.002	0.023	-0.005	0.006
allitems_wn	0.005	0.055	0.010	0.043	-0.015	0.009
clothing_nc	-0.014	0.026	-0.001	0.023	0.000	0.006
clothing_wc	-0.032	0.041	-0.012	0.040	0.003	0.009
clothing_wn	-0.022	0.035	-0.018	0.031	-0.001	0.008
durable_nc	0.001	0.027	-0.028	0.023	-0.009	0.007
durable_wc	0.005	0.034	-0.008	0.027	-0.013	0.009
durable_wn	-0.006	0.043	0.024	0.033	0.028	0.011
food_nc	-0.034	0.092	-0.010	0.095	0.020	0.027
food_wc	-0.025	0.045	-0.009	0.037	0.009	0.014
food_wn	0.018	0.085	0.009	0.074	-0.012	0.019
heating_nc	0.034	0.147	0.010	0.132	-0.020	0.029
heating_wc	0.051	0.055	-0.006	0.058	0.006	0.022
heating_wn	0.023	0.074	-0.074	0.086	-0.017	0.017
housing_nc	-0.001	0.024	0.005	0.022	-0.005	0.008
housing_wc	-0.025	0.024	-0.030	0.021	0.000	0.007
housing_wn	-0.024	0.031	-0.013	0.031	0.001	0.010
misc_nc	0.012	0.050	0.007	0.049	0.023	0.012
misc_wc	-0.036	0.044	-0.035	0.035	0.020	0.009
misc_wn	0.013	0.053	0.006	0.048	-0.023	0.009
services_nc	0.003	0.008	0.003	0.008	-0.003	0.003
services_wc	0.001	0.006	0.001	0.005	0.000	0.003
services_wn	0.000	0.005	0.004	0.005	0.000	0.002
transport_nc	0.011	0.032	0.011	0.030	0.004	0.006
transport_wc	-0.011	0.029	-0.018	0.027	-0.006	0.009
transport_wn	-0.033	0.040	-0.066	0.050	0.001	0.011

A.2.7 Table 23. Regional relative price response eighteen months after the shock

series	BB	SE	RR	SE	DPIR	SE
alcohol_nc	0.020	0.031	0.035	0.031	-0.004	0.007
alcohol_wc	0.006	0.024	0.017	0.024	0.010	0.007
alcohol_wn	0.000	0.016	0.000	0.014	0.000	0.004
allitems_nc	0.000	0.027	0.000	0.026	0.000	0.008
allitems_wc	-0.008	0.026	-0.002	0.023	-0.004	0.006
allitems_wn	0.003	0.055	-0.001	0.043	0.000	0.009
clothing_nc	-0.004	0.026	-0.001	0.023	0.000	0.006
clothing_wc	-0.019	0.041	-0.007	0.040	0.002	0.009
clothing_wn	-0.019	0.035	-0.016	0.031	-0.002	0.008
durable_nc	-0.003	0.027	-0.013	0.023	-0.003	0.007
durable_wc	0.000	0.034	-0.009	0.027	-0.004	0.009
durable_wn	-0.004	0.043	0.016	0.033	0.010	0.011
food_nc	-0.001	0.092	0.002	0.095	0.002	0.027
food_wc	0.000	0.045	-0.009	0.037	0.000	0.014
food_wn	-0.003	0.085	0.000	0.074	-0.002	0.019
heating_nc	0.017	0.147	0.002	0.132	-0.004	0.029
heating_wc	0.042	0.055	0.000	0.058	0.014	0.022
heating_wn	0.011	0.074	-0.037	0.086	-0.004	0.017
housing_nc	-0.002	0.024	0.004	0.022	-0.004	0.008
housing_wc	-0.021	0.024	-0.028	0.021	0.000	0.007
housing_wn	-0.021	0.031	-0.011	0.031	0.001	0.010
misc_nc	0.009	0.050	0.003	0.049	0.000	0.012
misc_wc	-0.038	0.044	-0.022	0.035	0.029	0.009
misc_wn	0.003	0.053	0.003	0.048	-0.001	0.009
services_nc	0.003	0.008	0.003	0.008	-0.002	0.003
services_wc	0.001	0.006	0.001	0.005	0.000	0.003
services_wn	0.000	0.005	0.004	0.005	0.000	0.002
transport_nc	0.007	0.032	0.006	0.030	0.003	0.006
transport_wc	-0.001	0.029	-0.001	0.027	0.000	0.009
transport_wn	-0.042	0.040	-0.038	0.050	-0.001	0.011

A.2.8 Figure 14. Comparison between the effects of the different monetary shocks calculated using LAD and OLS, on relative prices

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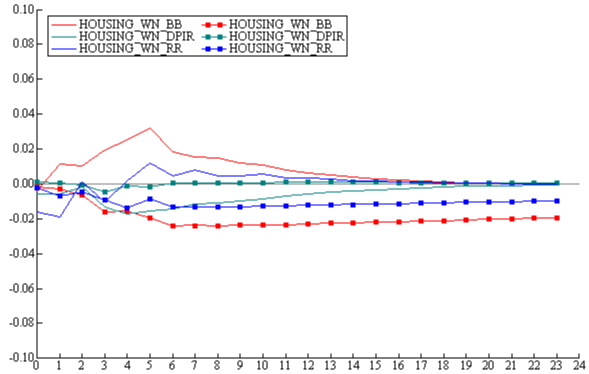
MISC_NC_DPIR
MISC_NC_RR
MISC_NC_BB
MISC_NC_DPIR
MISC_NC_RR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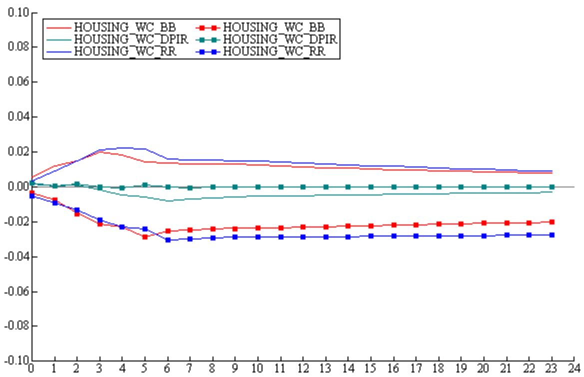
HOUSING_WN_DPIR
HOUSING_WN_RR
HOUSING_WN_BB
HOUSING_WN_DPIR
HOUSING_WN_RR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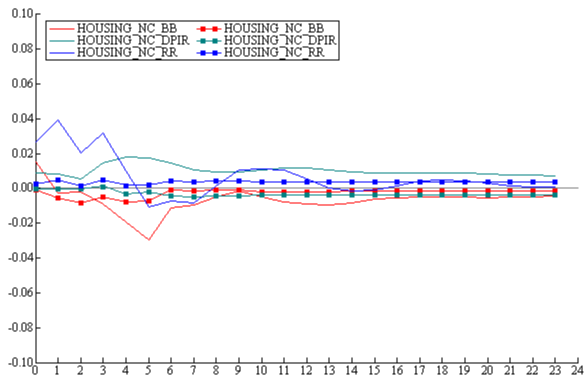
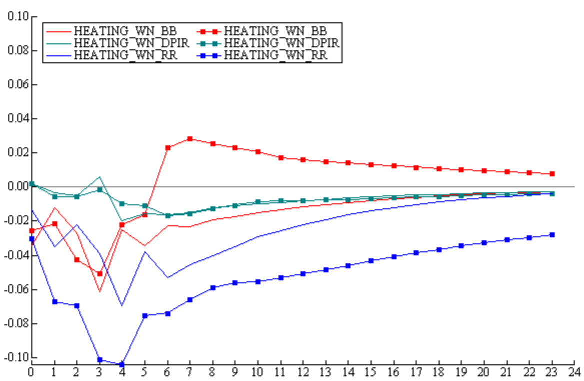
HOUSING_WC_DPIR
HOUSING_WC_RR
HOUSING_WC_BB
HOUSING_WC_DPIR
HOUSING_WC_RR


HOUSING_NC_BB
HOUSING_NC_DPIR
HOUSING_NC_RR
HOUSING_NC_BB
HOUSING_NC_DPIR
HOUSING_NC_RR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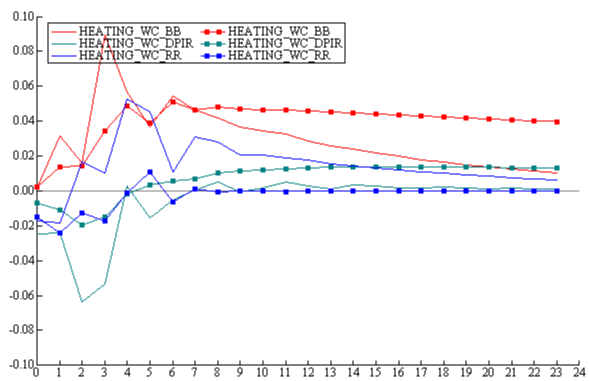
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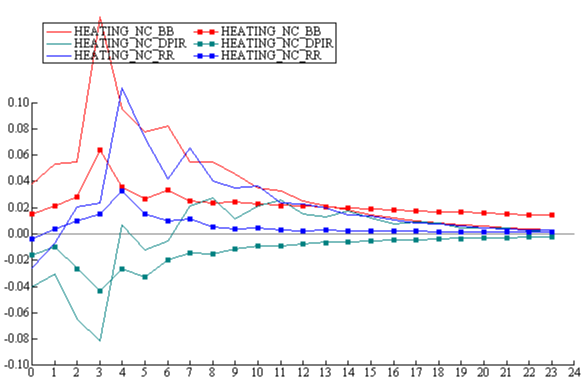
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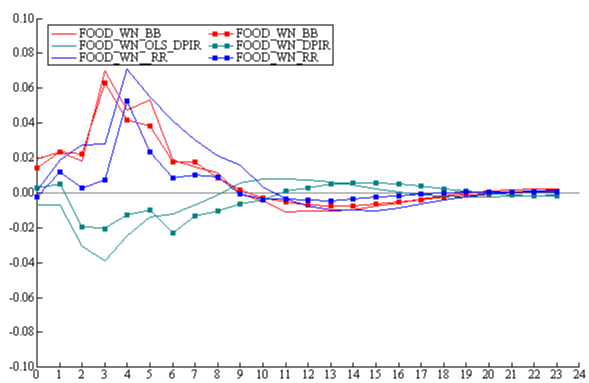
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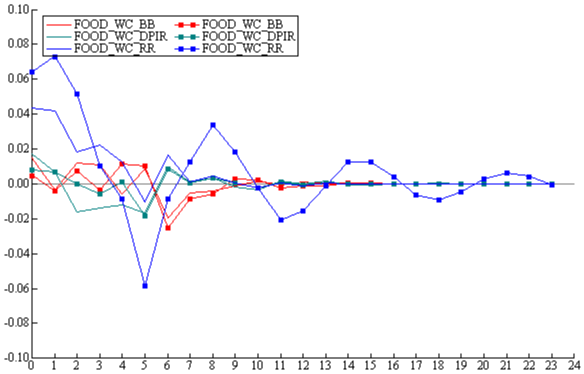
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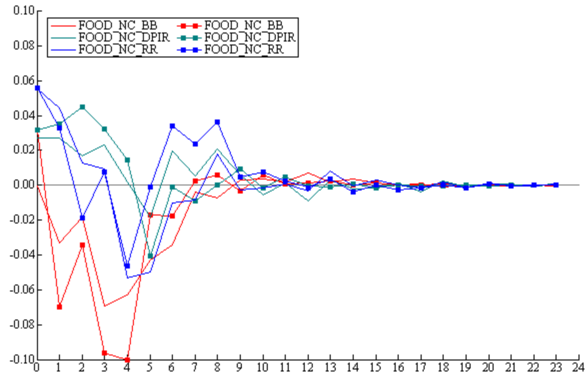
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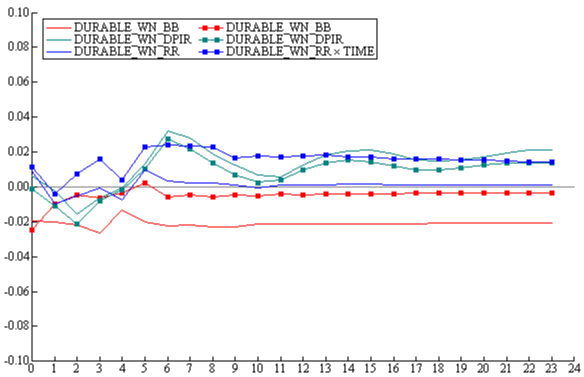
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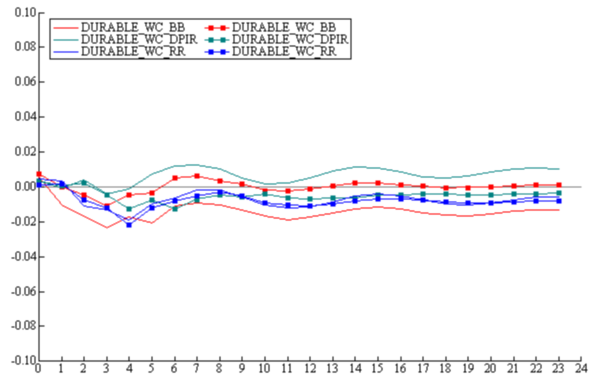
DURABLE_WN_RR
DURABLE_WN_RR × TIME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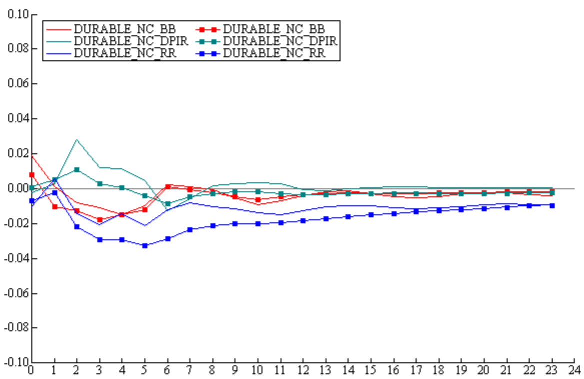
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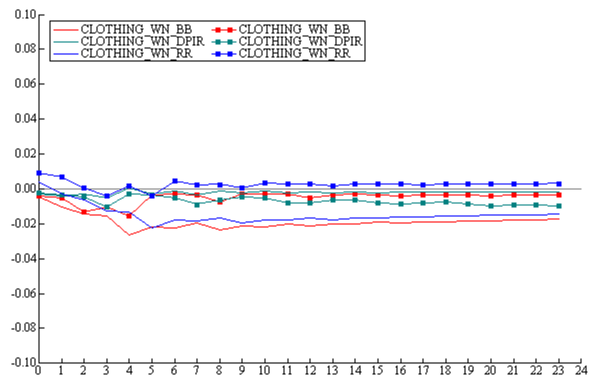
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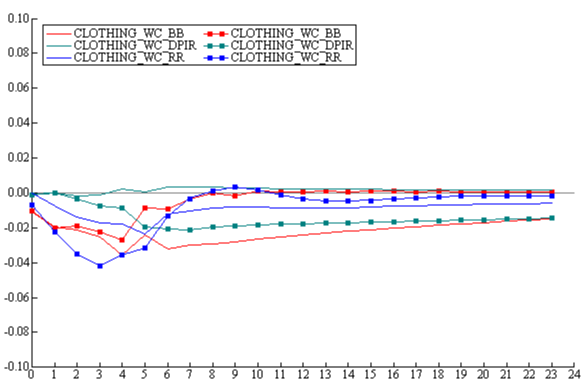
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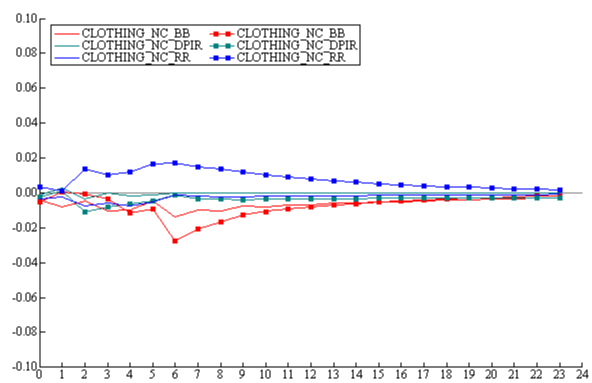
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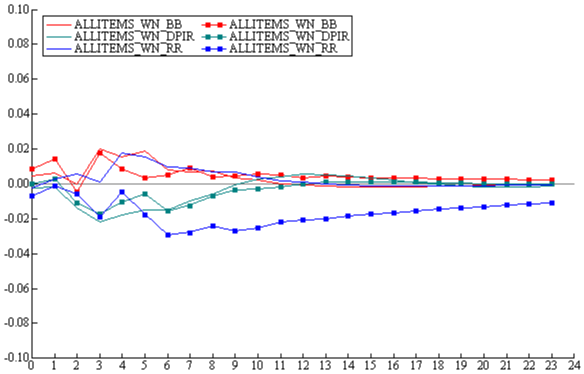
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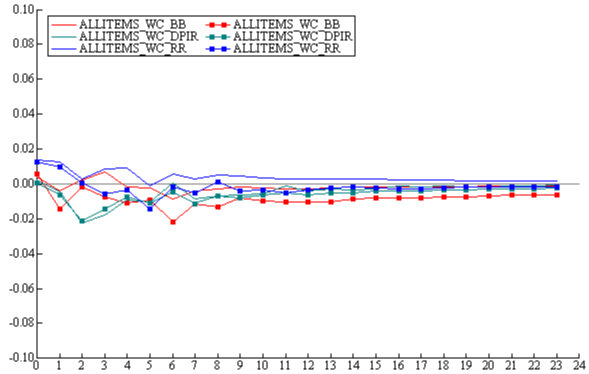
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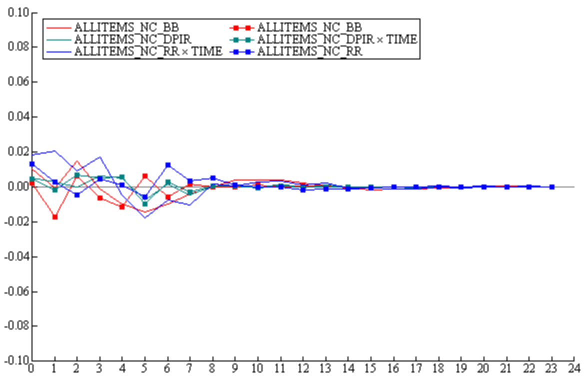
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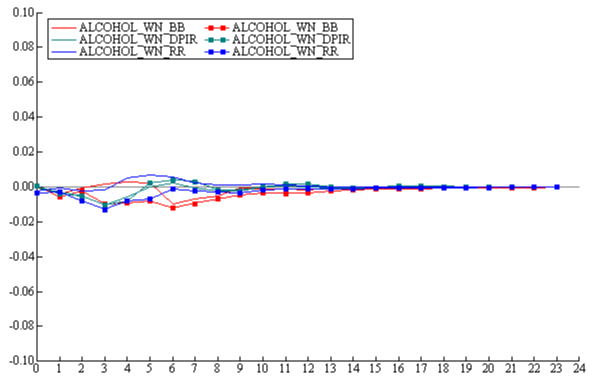
ALLITEMS_NC_BB
ALLITEMS_NC_DPIR × TIME
ALLITEMS_NC_RR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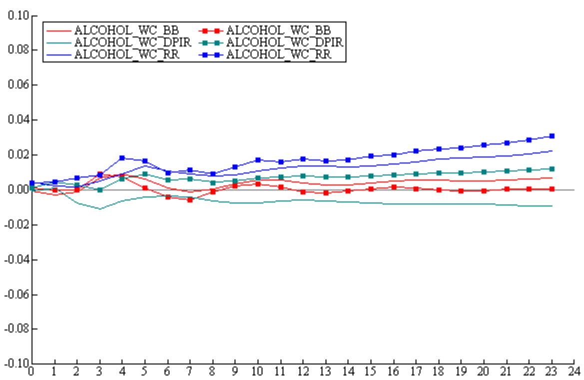
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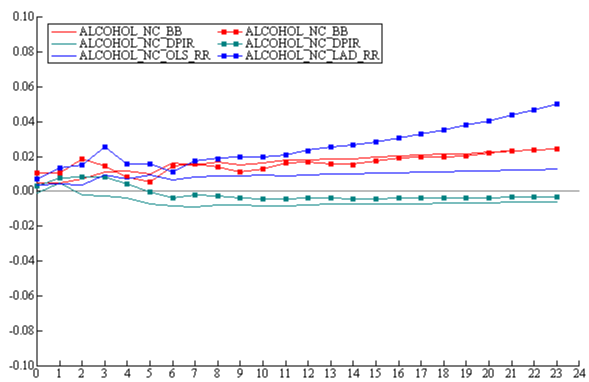
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ALCOHOL_NC_DPIR
ALCOHOL_NC_OLS_RR
ALCOHOL_NC_BB
ALCOHOL_NC_DPIR
ALCOHOL_NC_LAD_RR

A.2.10 Table 24. Regional inflation differential at three months after the initial shock

series	BB	SE	RR	SE	DPIR	SE
alcohol_nc	-0.004	0.009	0.010	0.008	0.000	0.004
alcohol_wc	0.008	0.011	0.004	0.009	-0.003	0.004
alcohol_wn	0.002	0.009	0.001	0.008	-0.005	0.003
allitems_nc	-0.016	0.023	0.008	0.018	-0.001	0.008
allitems_wc	-0.006	0.017	-0.006	0.014	0.007	0.006
allitems_wn	0.023	0.018	-0.005	0.016	-0.008	0.007
clothing_nc	-0.006	0.013	0.002	0.010	0.003	0.004
clothing_wc	-0.004	0.011	-0.003	0.011	0.000	0.004
clothing_wn	-0.001	0.011	-0.006	0.010	-0.002	0.004
durable_nc	-0.005	0.012	-0.007	0.010	-0.008	0.005
durable_wc	-0.006	0.012	-0.004	0.011	-0.007	0.005
durable_wn	-0.002	0.015	0.009	0.011	0.013	0.005
food_nc	-0.051	0.054	-0.004	0.044	0.006	0.018
food_wc	-0.011	0.040	-0.041	0.031	-0.006	0.015
food_wn	0.041	0.036	0.004	0.031	-0.009	0.015
heating_nc	0.036	0.032	0.005	0.031	-0.017	0.012
heating_wc	0.020	0.017	-0.005	0.016	0.005	0.012
heating_wn	-0.008	0.021	-0.032	0.024	0.011	0.010
housing_nc	0.003	0.006	0.004	0.006	0.002	0.004
housing_wc	-0.006	0.006	-0.006	0.006	-0.002	0.003
housing_wn	-0.010	0.008	-0.005	0.008	-0.004	0.005
misc_nc	-0.008	0.030	0.015	0.027	0.024	0.010
misc_wc	-0.018	0.014	-0.004	0.017	0.015	0.006
misc_wn	-0.002	0.017	-0.005	0.015	-0.012	0.006
services_nc	0.001	0.002	0.001	0.002	-0.001	0.002
services_wc	0.001	0.002	0.001	0.001	0.000	0.001
services_wn	0.000	0.001	0.001	0.001	0.000	0.001
transport_nc	0.001	0.011	0.005	0.009	-0.001	0.004
transport_wc	-0.004	0.011	-0.005	0.009	-0.003	0.005
transport_wn	-0.003	0.012	-0.018	0.013	-0.005	0.006

A.2.11 Table 25. Regional inflation differential at six months after the initial shock

series	BB	SE	RR	SE	DPIR	SE
alcohol_nc	0.009	0.010	-0.004	0.008	-0.003	0.004
alcohol_wc	-0.005	0.011	-0.003	0.009	-0.003	0.004
alcohol_wn	-0.012	0.009	-0.001	0.008	0.002	0.004
allitems_nc	0.004	0.024	0.010	0.019	0.012	0.010
allitems_wc	-0.013	0.016	0.013	0.013	0.007	0.006
allitems_wn	0.001	0.017	-0.006	0.016	0.000	0.008
clothing_nc	-0.010	0.012	0.004	0.010	0.001	0.005
clothing_wc	-0.008	0.011	0.011	0.009	0.003	0.004
clothing_wn	0.000	0.012	0.005	0.010	0.002	0.004
durable_nc	0.013	0.012	0.004	0.010	-0.005	0.006
durable_wc	0.009	0.013	0.004	0.011	-0.005	0.007
durable_wn	-0.008	0.014	0.001	0.011	0.017	0.007
food_nc	0.009	0.056	0.040	0.047	0.038	0.024
food_wc	-0.035	0.041	0.050	0.032	0.027	0.016
food_wn	-0.021	0.037	-0.015	0.031	0.002	0.017
heating_nc	0.007	0.030	-0.005	0.026	0.013	0.017
heating_wc	0.012	0.018	-0.017	0.013	0.002	0.014
heating_wn	0.039	0.020	0.002	0.021	-0.001	0.012
housing_nc	0.006	0.006	0.003	0.005	-0.002	0.004
housing_wc	0.004	0.006	-0.006	0.005	-0.001	0.003
housing_wn	-0.005	0.007	-0.005	0.007	0.002	0.005
misc_nc	-0.008	0.033	-0.019	0.028	-0.012	0.010
misc_wc	0.003	0.014	-0.001	0.017	0.000	0.007
misc_wn	0.013	0.018	0.018	0.014	0.010	0.007
services_nc	0.001	0.002	0.002	0.002	-0.001	0.003
services_wc	0.000	0.001	0.000	0.001	0.000	0.002
services_wn	-0.001	0.001	0.000	0.001	0.000	0.001
transport_nc	0.006	0.011	0.005	0.009	-0.003	0.005
transport_wc	0.006	0.011	0.001	0.009	-0.001	0.006
transport_wn	0.026	0.011	-0.011	0.012	0.002	0.007

A.2.12 Table 26. Regional inflation differential at twelve months after the initial shock

series	BB	SE	RR	SE	DPIR	SE
alcohol_nc	0.000	0.009	0.003	0.009	0.000	0.003
alcohol_wc	-0.001	0.011	0.001	0.010	0.001	0.003
alcohol_wn	0.000	0.009	-0.001	0.008	-0.001	0.002
allitems_nc	-0.002	0.022	-0.003	0.018	-0.001	0.005
allitems_wc	0.000	0.014	0.002	0.012	-0.001	0.003
allitems_wn	-0.001	0.017	-0.001	0.018	0.001	0.005
clothing_nc	0.000	0.012	0.000	0.010	0.000	0.003
clothing_wc	0.001	0.011	0.000	0.010	0.000	0.003
clothing_wn	-0.001	0.012	0.001	0.011	0.001	0.003
durable_nc	0.001	0.012	0.001	0.011	-0.001	0.003
durable_wc	0.002	0.012	0.000	0.011	0.000	0.003
durable_wn	0.000	0.014	0.001	0.011	0.006	0.004
food_nc	0.005	0.057	-0.004	0.046	-0.011	0.012
food_wc	0.001	0.037	0.005	0.029	-0.002	0.009
food_wn	-0.001	0.038	-0.001	0.031	0.000	0.010
heating_nc	0.000	0.030	0.000	0.026	0.001	0.009
heating_wc	-0.001	0.017	0.000	0.016	0.001	0.008
heating_wn	-0.002	0.021	0.002	0.021	0.001	0.007
housing_nc	0.000	0.006	0.000	0.005	0.000	0.002
housing_wc	0.000	0.006	0.000	0.005	0.000	0.002
housing_wn	0.000	0.008	0.000	0.007	0.000	0.003
misc_nc	0.007	0.028	0.004	0.025	0.003	0.006
misc_wc	0.000	0.015	0.001	0.016	0.000	0.004
misc_wn	0.000	0.018	-0.001	0.016	-0.002	0.004
services_nc	0.000	0.002	0.000	0.002	0.000	0.001
services_wc	0.000	0.002	0.000	0.001	0.000	0.001
services_wn	0.000	0.001	0.000	0.001	0.000	0.001
transport_nc	-0.001	0.011	-0.001	0.009	0.000	0.003
transport_wc	0.001	0.011	0.001	0.010	0.000	0.003
transport_wn	0.000	0.012	0.002	0.012	0.000	0.004

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