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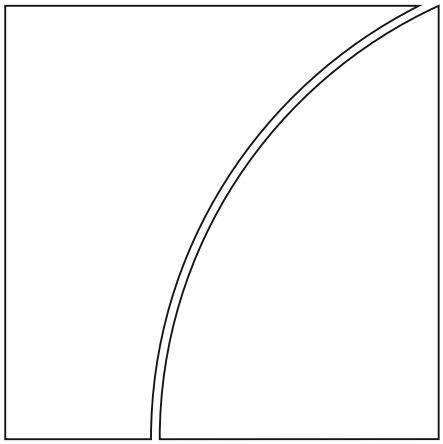

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Managing price and financial stability objectives – what can we learn from the Asia-Pacific region?*

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Abstract

The international financial crisis led many central banks to adopt explicit financial stability objectives. This raises the question of how central banks deal with policy trade-offs resulting from potential conflicts between price and financial stability objectives. We analyse this issue in the Asia-Pacific region, where many economies with inflation targeting central banks have adopted macroprudential policies in order to safeguard financial stability. Using structural vector autoregressions that identify both monetary and macroprudential policy actions, our results highlight similarities in the effects of monetary and macroprudential policies on the real economy. Tighter macroprudential policies used to contain credit growth have also had a negative impact on output and inflation. The similar effects of monetary and macroprudential policies could create challenges for policy, given the frequency of episodes where low inflation coincides with buoyant credit growth.

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1. Introduction

The international financial crisis provided a stark reminder that price stability is not sufficient to guarantee financial stability, leading many central banks to adopt explicit financial stability objectives or make changes to existing arrangements.[3] For the twelve central banks in the Asia-Pacific region that are members of the BIS[4], ten now have explicit financial stability objectives written in laws or statutes (Jeanneau (2014)).

Given that financial stability objectives have been adopted alongside the traditional price stability mandates (eg Filardo and Genberg (2010)), one pertinent issue relates to potential conflicts between price and financial stability objectives, at least in the short run. In the Asia-Pacific region as well as globally, authorities have increasingly used macroprudential tools as an additional instrument to safeguard financial stability, consistently with the Tinbergen principle. Macroprudential policies influence the availability and cost of credit, but by doing so, they also bring forward or postpone expenditure over time (see BIS (2015)). Thus, it cannot be ruled out that macroprudential policies have broader aggregate demand effects, similarly to monetary policy. Such effects could make policy calibration challenging, especially in an environment where low inflation coexists with strong growth in credit and asset prices.[5]

This paper empirically examines how central banks in the Asia-Pacific region have managed the objectives of price and financial stability, with a focus on identifying policy trade-offs and interactions that may have arisen over time. The analysis is done by means of structural vector autoregressions, estimated for inflation targeting economies. The empirical model identifies both monetary and macroprudential policy shocks and allows for rich interactions between policies and the assumed target variables. As in the case of monetary policy shocks in past studies, macroprudential policy shocks can be interpreted as the discretionary part (or a random part if any) of policy actions.

We define the central bank's financial stability objective as one of keeping credit relative to output below a "safe" threshold, consistently with the literature on early warning indicators of banking crises (eg Borio and Lowe (2002); Borio and Drehmann (2009)).[6] As to the indicator of macroprudential policy, we aggregate various macroprudential policy measures targeting credit growth into a single index, using the database by Shim et al (2013), and weighting the different policy actions identically. Thus, our results regarding the impacts of macroprudential shocks should be interpreted as average responses to the various policy shocks, acknowledging the limitation of the constructed policy measures.

[3] See BIS (2011) for a discussion about the various issues that financial stability objectives raise for policymakers, including in the areas of governance, accountability and the definition of objectives.

[4] These twelve economies are Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore and Thailand.

[5] Many central banks have highlighted policy trade-offs between countering disinflationary pressures and containing the increase in household indebtedness and property prices. See eg Bank of Korea (2015); Norges Bank (2014); Sveriges Riksbank (2014)

[6] Of course, other definitions of financial stability are possible in practice, as discussed further in Section 3.

We find that while macroprudential policies do indeed affect credit growth, they have also had a significant impact on inflation, with tighter macroprudential policies contributing to disinflationary pressures. The latter effect likely operates through changes in aggregate demand, as output falls significantly as a response to contractionary macroprudential shocks. We also find that periods with low inflation and buoyant credit growth are relatively common: for six inflation targeting economies in the Asia-Pacific region, 12% of the country-year observations are characterised by inflation below the mid-point of the central bank's target and the credit-to-GDP gap above 6 percentage points. Then, our empirical analysis unveils periods where contractionary (expansionary) macroprudential shocks have contributed to below-target (above-target) inflation. Finally, we find that interest rate policy shocks also affect credit growth, and the relative response of credit and prices to interest rate policy shocks is similar to their response to macroprudential shocks.

Our results thus suggest that – ex post – there may have been short-term policy trade-offs for central banks with both financial stability and price stability objectives. Such trade-offs may not arise if higher inflation pressures coincide with strong credit growth, as we find that monetary policy and macroprudential policy shocks have similar impacts on credit and the price level. They may also be less of a concern if the central bank's price stability objective does not strongly focus on short-term inflation stabilisation.[7] However, greater challenges could arise if a central bank focuses on stabilising short-run inflation dynamics at times when inflation is low but credit growth is strong.

A caveat to be borne in mind when interpreting the results also relates to the fact that various different macroprudential measures are included in the constructed macroprudential policy index. The results that we obtain are conditional on the type of policy actions undertaken and the intensity of these measures in the economies under study.[8] It is plausible that the effects of macroprudential measures on the real economy are strong only if used with sufficient intensity and they will also depend on the type of measures undertaken.

Our research is related to analyses about the effects of macroprudential policies and the channels through which they operate (eg Bruno et al (2015); Cerutti et al (2015); Kuttner and Shim (2013); Shin (2015); Tovar et al (2012)). The paper adds to the literature on the interconnectedness of monetary and macroprudential policies (eg Claessens (2013)) and research on monetary policy and financial stability that has discussed leaning against financial imbalances as a potential policy approach (Borio and Lowe (2004); Woodford (2012)). The paper is also linked to the rapidly expanding theoretical research incorporating both monetary and macroprudential policies in a unified framework, representing a shift from conventional sticky-price models that only include the interest rate instrument (eg Angelini et al (2014); Bailliu et al (2015)). Indeed, our work can be regarded as the empirical counterpart to such theoretical research. We contribute to the existing literature by analysing the effects of

[7] While we find that macroprudential policies affect both credit growth and inflation, we do not investigate whether measures taken against the build-up of financial imbalances reduce inflation volatility over long horizons. Arguably, central banks also need to weigh risks of future inflation and output volatility that could arise from financial distress against shorter-term costs of reacting to current financial imbalances. See also BIS (2015).

[8] This arises, as a one-time tightening in the loan-to-value ratio by 10 percentage points results in an identical increase in the constructed macroprudential policy index as a one-time tightening in the same instrument by 30 percentage points, for example.

macroprudential and monetary policy shocks in a unified empirical framework, which has rarely been done in past studies. We also present novel results about the frequency of (ex post) policy trade-offs related to price and financial stability objectives and the importance of interactions between interest rate and macroprudential policies in the Asia-Pacific region.

The paper is structured as follows. Section 2 provides a brief review of related literature. Section 3 discusses the objectives and instruments of Asia-Pacific central banks related to price and financial stability, while Section 4 documents stylised facts about the joint behaviour of inflation outcomes and credit growth in the region. Section 5 provides empirical evidence about the effects and interaction of interest rate and macroprudential policies, also documenting possible short-run trade-offs and discussing policy implications. Section 6 concludes.

2. Related literature

The international financial crisis stimulated a literature that incorporates financial stability objectives and macroprudential policies into macro models with monetary policy. With monetary policy in charge of price stability and macroprudential policy responsible for financial stability, such a set-up is in line with the Tinbergen principle.[9] Theoretically, it could even allow for interventions in opposite directions when required to achieve both objectives (eg Cesa-Bianchi and Rebucci (2013)).

But in practice, macroprudential policies and monetary policy are likely to have impacts on both objectives simultaneously. As an example, interest rates affect incentives for private sector risk taking and thus financial stability, as argued by Borio and Zhu (2012). The central bank can lean against a credit boom or other manifestations of financial imbalances with its interest rate instrument (Woodford (2012).[10] Jorda et al (2015) use a large dataset to document how loose monetary conditions have historically boosted real estate lending and house price bubbles, especially in the postwar period. Similarly, Hofmann and Peersman (2015) document that the impact of monetary policy shocks on credit and house prices in the United States has increased over time, making a policy of leaning against the wind now more potent than earlier.

Macroprudential tools may also have impacts on variables that are typically regarded to be in the domain of monetary policy. Recent literature has highlighted the similarities between monetary and macroprudential policies. Shin (2015) argues that changes to debt-service-to-income (DSTI) or loan-to-value (LTV) ratios work through similar mechanisms as monetary policy. As they influence the cost and

[9] Stabilising the output gap has also been important for central banks, and the literature on multiple objectives of monetary policy has traditionally focused on the trade-off between output and inflation volatility (see eg Fuhrer (1997)). One outcome from that literature is that when monetary policy is conducted so as to maximize the welfare of the population, output stabilisation typically obtains a small weight relative to inflation (eg Woodford (2003)). This is also the case when there is considerable uncertainty about the real economy (see Orphanides (2004); Orphanides and Williams (2005)).

[10] In contrast, Svensson (2010) argues that the impact of policy rates on financial stability is small but the impact on resource utilisation and inflation is large, implying that it is costly to use policy rates to safeguard financial stability.

availability of credit to households and firms, such tools help to bring spending forward or postpone it.[11] Kuttner and Shim (2013) show within an overlapping generations model how reductions in the DSTI and the LTV bring about lower demand for housing or lower consumption. And Cecchetti and Kohler (2014) use a theoretical macroeconomic model with a banking system to demonstrate that under some conditions increases in interest rates have identical effects on the macroeconomy as higher capital requirements. But the impacts of monetary and macroprudential policies may also differ. Macroprudential measures tend to be more targeted than monetary policy so that the latter may have a broader impact across the economy; but monetary policy may be more constrained by global conditions (Shin (2015)).

An important question is whether monetary policy and macroprudential policies are complements or substitutes – must they pull in the same direction or can they be used to pull in opposite directions? The literature so far appears to suggest complementarity. Bruno et al (2015) show empirically that the correlation between changes in the policy stance using monetary and macroprudential tools has been slightly positive in the Asia-Pacific region. Angelini et al (2014) demonstrate how the benefits of cooperation between monetary and macroprudential policies are particularly large in the context of large financial shocks. The central bank helps to stabilise output and the credit-to-GDP ratio – both are policy objectives of the macroprudential authority – albeit at the cost of greater inflation and policy rate variability. Bailliu et al (2015) similarly find that it is welfare enhancing to respond to financial imbalances, defined as deviations in credit growth from its steady state, using the policy rate and/or the macroprudential tool. And in a macro model with optimising banks that are subject to runs, Angeloni and Faia (2013) show that a simple policy rule with countercyclical capital ratios and a monetary policy response to asset prices or bank leverage would deliver favourable outcomes.

Financial stability considerations have also been argued to matter for exchange rate policies, especially in emerging economies. Central banks may want to prevent adverse balance sheet effects when there is widespread liability dollarisation (Calvo and Reinhart (2002)). Large real exchange rate appreciations have been important predictors of financial crises historically (Gourinchas and Obstfeld (2012)). Bruno and Shin (2015) outline a model in which local currency appreciation loosens financial conditions by strengthening borrowers' balance sheets, leading to greater bank risk-taking and lending to local borrowers. Ostry et al (2012) characterise an EME central bank policy as one of two objectives – price and exchange rate stability – and two instruments: interest rates and sterilised FX intervention. Filardo et al (2014) discuss the monetary policy of Asian central banks in a three-pillar framework, where the central bank has objectives for price stability, financial stability and avoiding excessive exchange rate volatility, using various instruments that affect all the objectives simultaneously.

The literature also raises broader questions about central banks' adoption of financial stability objectives. Smets (2014) notes that central banks have expertise in macroeconomic and financial surveillance and their lender of last resort function can help prevent crises; on the other hand, the reputation of the central bank even as a monetary policy maker may be damaged because macroprudential policy is unlikely to fully prevent financial crises. Moreover, as shown by Ueda and Valencia (2014) in

[11] See also BIS (2015).

the context of a theoretical model, there are time inconsistency problems. After a crisis monetary policy could resort to inflation to inflate away any debt overhang, because macroprudential policy tools cannot be used to reduce the stock of debt. The macroprudential authority is aware of this incentive, and will allow for greater debt accumulation ex ante, resulting in an inflation bias.

3. Financial stability objectives and instruments

Formal objectives in the Asia-Pacific region

The international financial crisis provided a further impetus for the adoption of financial stability objectives by central banks globally. In some cases, it triggered changes in the existing objectives. Based on a review of 114 central bank laws and statutes, 82% of central banks have explicit financial stability objectives (Jeanneau (2014)). Table 1 lists the economies where monetary authorities have such objectives in the Asia-Pacific region.

Central banks differ regarding the scope of activities that the financial stability objective applies to. For seven institutions in the region, the objective appears to pertain to all of the central bank's activities and functions. For three other Asia-Pacific central banks, a specific function or task is mentioned: payment system stability for Australia; settlement of funds among financial institutions and the lender of last resort function for Japan; and monetary and credit policies in the case of Korea. Yet, even within these activities, the objectives state that overall financial stability or financial system stability should be maintained (Japan); contributed to (Australia); or paid attention to (Korea), thus indicating rather broad objectives.

Financial stability objectives in laws or statutes in the Asia-Pacific region — Table 1

Objective appears to apply in principle to all the central bank's activities and functions			
China	Hong Kong SAR	Indonesia	Malaysia
New Zealand	Singapore	Thailand	
Objective is attached to a specific function or task			
Australia	Japan	Korea	

Source: Jeanneau (2014); BIS; central bank websites

The financial stability goals have been adopted alongside more conventional monetary policy objectives (Table 2). Eight out of twelve Asia-Pacific central banks are formally pursuing inflation targeting or follow a regime with an explicitly defined price stability target, whereas two have exchange rate anchors. Two central banks have no explicitly stated targeting regime in terms of inflation or the exchange rate. However, even for the non-inflation targeters, price stability typically plays a major role as a policy objective. Indeed, despite the exchange rate anchor, the primary objective of monetary policy in Singapore is the promotion of price stability. Stability of the value of the currency (objective in China) and monetary stability (Malaysia) can also be interpreted as emphasising the importance of price stability (see eg Filardo and Genberg (2010)).

Given the existence of multiple objectives, a relevant issue for policy trade-offs relates to the ranking of the different objectives. In the case of New Zealand, for example, financial stability is explicitly subordinated to the primary objective of price stability.[12] For most economies the law is silent on the relative ranking of the objectives. The case of Malaysia is noteworthy in that the financial stability objective ranks equally with monetary stability, with law granting Bank Negara Malaysia wide-ranging powers to intervene in the financial system to promote financial stability.[13]

Monetary policy frameworks in the Asia-Pacific region — Table 2

Inflation targeting framework or similar	Exchange rate anchor	Other regimes[1]
Australia	Hong Kong SAR (US dollar)	China
India	Singapore (composite)	Malaysia
Indonesia		
Japan[2]		
Korea		
New Zealand		
Philippines		
Thailand		

[1] Includes countries that have no explicitly stated targeting regime in terms of inflation or an exchange rate. [2] Japan is not formally an inflation targeter, but follows a monetary policy regime with a "price stability target" of 2 percent.

Source: Central bank websites.

Of course, even when no explicit objective is mentioned in law, central banks can have financial stability as an implicit objective and may even have in place a formal financial stability policy framework. Ravalo (2013) mentions that while financial stability is not explicitly mentioned in the charter of Bangko Sentral ng Pilipinas, the central bank formally pursued the policy objective of financial stability in 2010. That year, a Financial Stability Committee was created in order to set up a financial stability framework within the central bank.

Defining and quantifying financial stability

The difficulties in defining and quantifying financial stability objectives are sometimes illustrated by a comparison with price stability objectives. The latter are well established, and tend to be characterised by an exact numerical target for a specific price index and a time horizon during which the target should be attained. In contrast, few central banks elaborate on the exact meaning of financial stability. The central bank law of Malaysia provides a definition, characterising risks to financial stability as

[12] The Reserve Bank of New Zealand Act 1989 states that "The primary function of the Bank is to formulate and implement monetary policy directed to the economic objective of achieving and maintaining stability in the general level of prices" and that "In formulating and implementing monetary policy the Bank shall have regard to the efficiency and soundness of the financial system" (Sections 1A and 10, respectively).

[13] The Central Bank of Malaysia Act 2009 states that "The principal objects of the Bank shall be to promote monetary stability and financial stability conducive to the sustainable growth of the Malaysian economy" (Section 5). See also Caruana (2014).

disruptions to financial intermediation or reduced public confidence in the financial system (or risks of either of the two occurring).

In this study, we use a leverage-based measure of financial stability, constructed using the amount of total credit extended to the private sector. In particular, we use the total credit-to-GDP gap, capturing the deviation of total credit-to-GDP from its long-run trend. This variable effectively measures risks to financial stability, in the form of a build-up of financial imbalances. Previous research has demonstrated the favourable performance of the credit-to-GDP gap as an early warning indicator of banking system distress (see Borio and Lowe (2002); Borio and Drehmann (2009)).[14] It has been adopted as a reference point for the use of countercyclical capital buffers under the Basel III framework (BCBS (2010); Drehmann and Tsatsaronis (2014)). Moreover, *total* credit that includes all sources of credit to the private sector has been found to predict systemic crises better than bank credit alone – banks suffer the consequences of excessive credit growth even if credit did not originate in the banking sector (Drehmann (2013)).

Focusing on leverage as an indicator of financial stability risks is arguably appropriate here, as we analyse potential conflicts between the central bank's policy objectives. Monetary policy affects the incentives for the private sector to lever up. An important mechanism is the risk-taking channel (Borio and Zhu (2012)). Lower interest rates increase asset and collateral values, reducing perceptions of risk. They encourage search for yield, given sticky rates-of-return targets of pension funds and insurance companies, which could be particularly relevant in a low interest rate environment. A leverage-based measure of financial stability may also be preferable from an operational perspective to one based on asset prices, as the latter requires policymakers to determine the degree of overvaluation of various assets (see eg Woodford (2012)). At the same time, we acknowledge that the joint behaviour of credit and asset prices, in particular property prices, has been found to provide useful information regarding the risk of future banking crises (eg Borio and Drehmann (2009); Borio (2014)).

The credit gaps are calculated as deviations of the credit-to-GDP ratios from their long-term trend. The trend is computed by a one-sided HP filter, thus using only available information up to each point in time, proxying the real-time nature of the policymaker's problem. The smoothing parameter lambda is set at 400,000 with quarterly data – much higher than the typical value in business cycle analysis. This stems from the low frequency nature of financial cycle as opposed to business cycle fluctuations. In our analysis, we use a threshold of 6 percentage points for the credit-to-GDP gap as an indication of financial stability risks. This draws on previous literature (eg Borio and Drehmann (2009)) that considers the trade-offs between minimising the noise-to-signal ratio (summary statistic of false versus correct signals) on the one hand, and predicting a large share of crises on the other hand.

The credit gap serves in our framework to identify periods with potential risks to financial stability, with the purpose of analysing policy trade-offs at those times. But it is also of interest to compare the message conveyed by the credit gap with the debt

[14] In emerging economies undergoing rapid transformation, credit gaps may be affected by structural changes such as financial deepening. However, evidence suggests that credit gaps are relevant indicators also for such economies (Drehmann and Tsatsaronis (2014)), but it is also argued that vulnerabilities should not be assessed by relying on a mechanical rule. Within our framework, a straightforward alternative way to measure vulnerabilities would be to focus on credit growth rates instead of gap measures.

service ratio, defined as interest payments and debt repayments divided by income. This measure is directly affected by monetary policy, through the impact of interest rates on the debt service burden. Drehmann and Juselius (2014) show the advantageous properties of this indicator in predicting banking system distress at forecast horizons close to one year. This very short horizon and the direct link with interest rates imply that when the credit gap is high and the debt service ratio close to its peak, monetary policy may actually need to lower interest rates to prevent financial distress and a sharp slowdown in aggregate demand – it may be too late to lean against the wind. The debt service ratios are computed by using data on total credit to the private sector as the measure of debt, gross disposable income augmented with gross interest payments and dividends to measure income, average interest rates on the stock of debt based on national accounts data, and estimates on average remaining maturities for the credit stock.[15]

Previous literature has also proposed other indicators of financial stability risks. Stein (2014) suggests using an indicator of excess bond premia, ie measures of credit spreads less the expected default losses on bonds. This is motivated by their predictive power in terms of GDP and unemployment.[16] However, there are data challenges with regard to measuring excess bond premia in an emerging market context.

Instruments for promoting financial stability

We include macroprudential policies in our empirical model (Section 5) as the primary tool for achieving financial stability objectives. This reflects their widespread adoption to mitigate systemic financial risks. However, this allocation of tools to objectives in the model does not imply the irrelevance of interest rates for safeguarding financial stability. Indeed, interest rates set the universal price of leverage in a given currency and thus affect all financial market players and institutions, differently from prudential measures (eg Stein (2013)). And as interest rates affect credit, macroprudential policies can also have effects on aggregate demand and inflation. Interest rate and macroprudential policies work through similar channels, bringing spending forward or postponing it (Bruno et al (2015); Shin (2015)). Note that the flexibility of our estimation framework allows us to assess the impact of both interest rate and macroprudential tools on prices *and* credit and thus on outcomes related to both monetary and financial stability.

As a source of data for macroprudential policy measures, we use the database for policy actions on housing markets by Shim et al (2013) that includes both non-interest rate monetary policy measures and prudential tools. The monetary policy measures, ie reserve requirements, credit growth limits and liquidity requirements, affect the amount of funds that are available for lending to the private sector. The prudential tools, ie maximum loan-to-value ratio, maximum debt-service-to-income ratio, risk weights on housing loans and loan-loss provisioning on housing loans, are used by authorities to target housing credit.

[15] See Drehmann et al (2015) for details

[16] As documented by Gilchrist and Zakrajsek (2012) for the United States, a peak in the non-default related component of credit spreads has been followed by a decline in activity and employment about a year later.

The focus on policy actions targeting credit growth is consistent with the use of the credit gap as an indicator of financial stability risks. And while the policy actions focus on housing markets, credit booms have frequently been associated with large increases in property prices. Indeed, analysis presented in BIS (2014) placed Asian economies in the "boom" phase of the financial cycle in terms of both real credit growth and residential property price growth during end-2010 – end-2013.[17]

As an important caveat, the measures of macroprudential policy actions used in the empirical analysis exclude capital flow measures, such as those targeted at cross-border bank, bond and equity flows. As cross-border capital flows have typically provided the marginal dollar during emerging market credit booms, we are omitting changes in the policy stance that may have had a non-negligible impact on credit. Another caveat is that the macroprudential measures in our analysis may have been taken by authorities other than the central bank. As an example, while the Bank of Korea has a financial stability mandate, macroprudential policies are shared between multiple agencies, including the supervisory authorities. This is not likely to affect the magnitude of estimated policy impacts, such as the effect of macroprudential policies on inflation, that are the focus of our analysis. But it could affect the interaction between monetary and macroprudential policies (eg Ueda and Valencia (2014)).

4. Some stylised facts

The joint behaviour of inflation and credit yields information about the potential policy trade-offs that central banks may have faced. In Graph 1, we plot inflation gaps, defined as actual inflation less the inflation target, jointly with credit gaps, computed using data on total credit to the private sector and the methodology described in Section 3. The threshold of 6 percentage points for the credit gap variable is used as an indicator of financial stability risks. The graph uses annual data for the six inflation targeting economies in the Asia-Pacific region where inflation targets were adopted in the mid-2000s or earlier. As inflation targeting frameworks typically feature explicit numerical targets for inflation, they are the focus of our analysis.

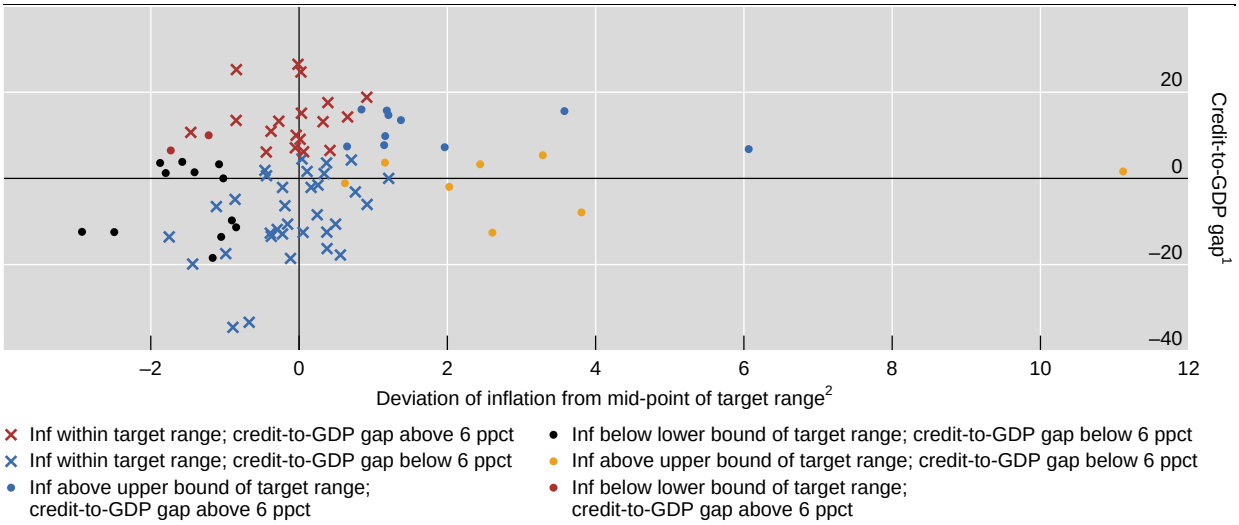
Graph 1 shows that there are several instances of relatively low inflation coinciding with rapid credit growth. Using annual data, 12% of the country-year observations are characterised by inflation below the mid-point of the central bank's target range but the credit gap exceeding 6 percentage points (subset of the red dots and crosses). The high variation in credit gaps, shown in the graph, is a feature of the data both across and within the individual economies.

Low inflation and strong credit growth could occur simultaneously, as the timing of business cycles does not coincide with financial cycles (Borio (2014)). Alternatively, it could result from the "paradox of credibility", whereby monetary policy is able to anchor inflation expectations so that the build-up of financial imbalances is not reflected in inflation outcomes (Borio and White (2004)). And it could stem from the nature of shocks, with a supply shock driving credit up and pushing prices down (Jonsson and Moran (2014)).

[17] In BIS (2014), the Asian aggregate is comprised of Hong Kong SAR, Indonesia, Malaysia, the Philippines, Singapore and Thailand.

Inflation outcomes and credit gaps

Australia, Indonesia, Korea, New Zealand, Philippines and Thailand, 2000-Q3 2014 Graph 1



[1] Yearly total credit-to-GDP gaps. As at the end of third quarter for 2014. For New Zealand and Philippines, bank credit-to-GDP gaps. [2] Deviation of inflation is expressed as the difference between actual inflation and the mid-point of inflation target (average of lower and upper bound of target range), based on yearly data (defined as year-on-year inflation rate at the end of the year; inflation rates at the end of the third quarter for 2014). For Thailand, core inflation and target; for Korea, core inflation and target for 2000-2006 and headline CPI inflation and target for 2007-2014; headline CPI inflation and target for other countries.

Sources: DataStream; national data; BIS calculations.

The adoption of financial stability objectives by central banks could at times lead to increasing deviations of inflation from target, at least in the short run. For instance, if central banks decided to lean against financial imbalances by monetary policy, they may trade off short-term inflation volatility against the prevention of financial booms and busts, with the aim of safeguarding price stability over longer horizons.[18] The trade-off is clearer when the central bank is only equipped with an interest rate instrument. But challenges could also arise with two instruments, if tighter macroprudential policies have sizeable effects on aggregate demand and the inflation rate.[19] When inflation is already low, leaning against the credit boom may push inflation below target.

The data shown in Graph 1 provide some informal evidence in this direction. In particular, considering only those country-year observations where the credit gap is positive and increasing, arguably signalling the build-up of financial risks, inflation is below the mid-point of the target range in one third of cases. To the extent that the deviations from target were caused by policies to counter financial imbalances and were not persistent, they may have represented a way to reconcile financial stability

[18] Similar trade-offs have been empirically analysed for inflation and output volatility. Cecchetti and Ehrmann (1999) argue that inflation targeting economies as well as European countries about to enter the monetary union increased their aversion to inflation variability, which likely led to higher output volatility as a result.

[19] We quantify such effects in Section 5.

with *longer-term* price stability objectives, even if the annual inflation targets were missed.[20]

Finally, we document the use of policy instruments – other than interest rates – to safeguard financial stability from 2000 onwards. Comparing geographical regions, Shim et al (2013) show that Asia-Pacific economies were the largest users of prudential tools during the past two decades. And they were also frequently applying non-interest rate monetary measures to curb the growth in housing credit, second only to central and eastern Europe. Among the six inflation targeting economies in Asia and the Pacific, Korea undertook the highest number of measures since 2000 (Table 3). Out of the 27 total domestic macroprudential actions carried out in Korea, only one was of the monetary policy category and all others prudential. Moreover, 21 measures were in the form of tightening and 6 in the direction of expansion. The Philippines came second with a total of 23 macroprudential measures.

The intensity in the use of macroprudential measures increased in some of the economies after central banks adopted explicit financial stability objectives. For instance, in Thailand and Malaysia that adopted the objectives in 2008 and 2009, respectively, the average number of measures undertaken annually increased from 0.2 to 2 (Malaysia) and from 0.4 to 1.1 (Thailand). As a caveat, note that the phase of the financial cycle has obviously played a role, and that many measures have been taken by authorities other than the central bank.

Macroprudential policy actions in inflation targeting Asia-Pacific economies Table 3

	Monetary		Prudential		Total	
	Tightening	Loosening	Tightening	Loosening	Tightening	Loosening
Australia	0	0	1	0	1	0
Indonesia	3	2	1	0	4	2
Korea	1	0	20	6	21	6
New Zealand	2	0	0	0	2	0
Philippines	12	6	1	4	13	10
Thailand	1	2	4	1	5	3

[1] Q1 2000 – Q2 2012. Monetary measures include reserve requirements, credit growth limits and liquidity requirements. Prudential measures include maximum loan-to-value ratio, maximum debt-service-to-income ratio, risk weights on housing loans and loan-loss provisioning on housing loans.

Source: Shim et al (2013).

5. Empirical evidence

The model

In this section, we construct a structural vector autoregressive (SVAR) model to identify monetary and macroprudential policy actions, analyse interactions between policies and policy trade-offs, and examine the effects of interest rate and macroprudential policy actions on price and financial stability.

[20] See also BIS (2015).

Five endogenous variables are included in the VAR model. This includes the two policy instruments. In our framework, the interest rate (*R*) is the monetary policy instrument, while the measure of macroprudential policy (*PP*) from Shim et al (2013) is the macroprudential policy instrument.[21] In addition, the assumed target variables for both policies are included. The consumer price index (*CPI*) represents the target variable for monetary policy and total credit to the private sector (*CRD*) is used as the target for macroprudential policy. While such a separation of target variables and instruments may not always hold in actual policymaking, it is in line with previous theoretical modelling incorporating both macroprudential and monetary policies within a unified framework (see eg Smets (2014)). At the same time, our empirical framework is flexible so as not to unduly restrict the interactions between instruments and their assumed targets. Finally, real GDP (*RGDP*) is included to capture economic activity that also interacts with the other endogenous variables, including the two policy instruments.

The contemporaneous and lagged values of the Federal Funds rate and real GDP in the United States are included in the model as exogenous variables. This is motivated by the potential impact of monetary policy and real activity in the United States on the real economy, financial conditions and monetary policy in the Asia-Pacific economies.[22]

A recursive structure on contemporaneous structural parameters is assumed, following Sims (1980). In particular, we assume that the three macro variables (*RGDP*, *CPI*, *CRD*) are contemporaneously exogenous to the two policy instruments. This implies that the policy stance is set after observing the current economic condition as reflected by the macro variables, and policy shocks are identified as residuals of the equations where policy instruments endogenously respond to the state of the economy in such a way. Our model structure may be regarded as an extension of the model by Christiano et al (1999) that identifies monetary policy shocks.[23]

Regarding the identification, the monetary authority is likely to set the interest rate considering not only the recent values of two traditional objective variables (output and prices) but also credit conditions, in line with the increased prominence of financial stability objectives (see eg Bailliu et al (2015)). Our model allows for this possibility, as the interest rate can react to all three variables contemporaneously. Macroprudential policy is likely to be set by considering recent financial conditions such as credit, but it may also react to recent output conditions as stated in CGFS (2010) and modelled in some recent studies (see eg Angelini et al (2014); Gelain and Ilbas (2014)). Further, we cannot exclude the possibility that macroprudential policy

[21] Our modelling does not investigate the potentially asymmetric effects of expansionary and contractionary macroprudential policies. Such asymmetries are explored eg in Kuttner and Shim (2013) and McDonald (2015).

[22] See eg McCauley et al (2015) for evidence regarding linkages between the Federal Reserve's monetary policy and dollar credit outside the United States; Kim and Shin (2015) for the transmission of US or global liquidity to emerging markets; Kim and Yang (2012) for the transmission of US monetary policy to Asian economies; and Chen et al (2015) on the international spillovers of US unconventional monetary policy. In the individual country VAR estimations for Indonesia and Thailand, we exclude the two exogenous variables due to a short sample period.

[23] As long as our indicators for monetary and macroprudential policy represent policy actions – which arguably is the case – the identified shocks are likely to be close to policy actions. On the other hand, while examining the effects of changes in systematic parts of policy is important, we leave such exercises for the future research agenda, partly because such counter-factual exercises in the VAR framework may be subject to the Lucas critique.

takes into account price stability, especially in the case where the monetary authority is in charge of setting macroprudential policy. Our model allows for all these possibilities by letting macroprudential policy react to all three variables contemporaneously.

Regarding the ordering between two policy instruments, the measure of macroprudential policy is assumed to be contemporaneously exogenous to the interest rate in the baseline model, but we consider the alternative ordering in an extended model.

We estimate both a panel VAR model incorporating four economies, and individual VAR models for each country separately. The estimated impulse responses from the panel VAR allow us to analyse typical dynamic interactions among variables in the four inflation targeting economies. In contrast, the VAR models estimated separately for each country yield estimates about the impacts of policy actions in each country at different points of time; for example, at times of risks to price or financial stability.

We consider those four inflation targeting economies in the Asia-Pacific region for which data on total credit to the private sector are available. This results in a sample comprised of Australia, Indonesia, Korea and Thailand.[24] Quarterly data are used in the estimation. The estimation period spans Q1:2000–Q2:2012 for Australia and Korea; Q1:2002–Q2:2012 for Thailand; and Q1:2005–Q2:2012 for Indonesia, so that all four economies were pursuing inflation targeting during our sample periods. For the individual country VAR estimation for Indonesia, the sample period is extended to Q1:2002, as the official inflation targeting period is too short to produce meaningful results.

Measures of macroprudential policy actions are included in the VAR estimation as an index, accumulated over time. Thus, a macroprudential policy tightening (loosening), regardless of the type of measure undertaken or its intensity, will increase (decrease) the level of the index by one unit, with the new value maintained until another policy action is taken.[25] For instance, a one-time increase in reserve requirements by any magnitude would lead to an increase in the level of the index by one unit, as would a tightening of the loan-to-value ratio by any magnitude. If both tightening measures were undertaken during the same quarter, the level of the index would increase by two units during that quarter, ceteris paribus.

Due to such a definition of the index, the effects of policies should be interpreted as average responses to the various policy actions, acknowledging that there may be considerable uncertainty as regards the impacts of individual measures. However, as discussed later, we also experiment with an alternative macroprudential index using a different source of macroprudential policies (although applying an identical methodology to construct the index), and find that the results are similar.[26] Another caveat also relates to the way the macroprudential policy index is constructed. The

[24] Total credit series are not available for New Zealand and the Philippines (bank credit only).

[25] The impulse responses of the other variables in the system are unchanged if we change the way the index is scaled; for instance, if every change in macroprudential policy is set to change the index value by 0.5 units instead of one unit.

[26] Of course, there are alternative ways to construct macroprudential policy indices. Cerutti et al (2015) use an index that takes into account whether or not certain macroprudential instruments were in place, but that does not capture changes in the level of each instrument.

results that we obtain are conditional on the type of policy actions undertaken and the intensity of these measures in the economies under study.[27] It is plausible that the effects of macroprudential measures on the real economy are strong only if used with sufficient intensity and they will also depend on the type of measures undertaken.

The VAR is estimated in levels, with a logarithmic transformation applied for the series on consumer prices, real GDP and credit.[28] Two lags are included. The individual fixed effect is assumed in the panel VAR, to capture country-specific factors that are not explicitly considered in the empirical model.

Evidence from panel VAR

Commencing with results from the panel VAR, impulse responses with 90% probability bands are shown in Graph 2. Each column shows the responses of the five endogenous variables to a different shock. Our focus is on the responses to macroprudential and monetary policy shocks, shown in the fourth and fifth columns, respectively. Both policy shocks are contractionary: *PP* increases in response to macroprudential policy shocks and *R* rises in response to monetary policy shocks. Both result in a statistically significant fall in *CPI* and *CRD*. That is, monetary policy contraction reduces not only the price level but also the level of credit. Similarly, contractionary macroprudential policy decreases not only credit but also the price level. The latter finding is likely to arise, as macroprudential policies affect aggregate demand. Indeed, we find a significant negative effect from tighter macroprudential policies on real GDP.

The relative effects of the two policies on credit and the price level are also similar. In response to a monetary policy shock of one standard deviation, the declines in *CRD* and *CPI* are 0.55% and 0.18%, respectively, at two year horizon, producing a ratio of 3.0. In response to a macroprudential policy shock of one standard deviation, the declines in *CRD* and *CPI* are 0.45% and 0.20%, respectively, yielding a ratio of 2.2.[29] Although the ratio of credit responses to price responses is slightly different, the probability that the ratio under monetary policy shocks is larger than the ratio under macroprudential shocks is only 64.9% based on simulation exercises, which suggests that the difference is not significant at a conventional significance level.[30] Comparing similarly the relative responses of *CRD* to *RGDP*, the corresponding ratios are 4.2 in the case of monetary policy shocks and 2.2 in the case of macroprudential policy shocks. Although the difference in the ratios is larger in this case, the

[27] A one-time tightening in the loan-to-value ratio by 10 percentage points results in an identical increase in the constructed macroprudential policy index as a one-time tightening in the same instrument by 30 percentage points, for example.

[28] Our statistical inference is not problematic in the presence of unit roots and cointegrating relations because we follow Bayesian inference. We use the Monte-Carlo integration method, described in RATS (2013), to construct posterior probability bands for impulse responses. See Sims (1988) and Sims and Uhlig (1991) for general discussion on Bayesian inference in the presence of unit roots and cointegrating relations.

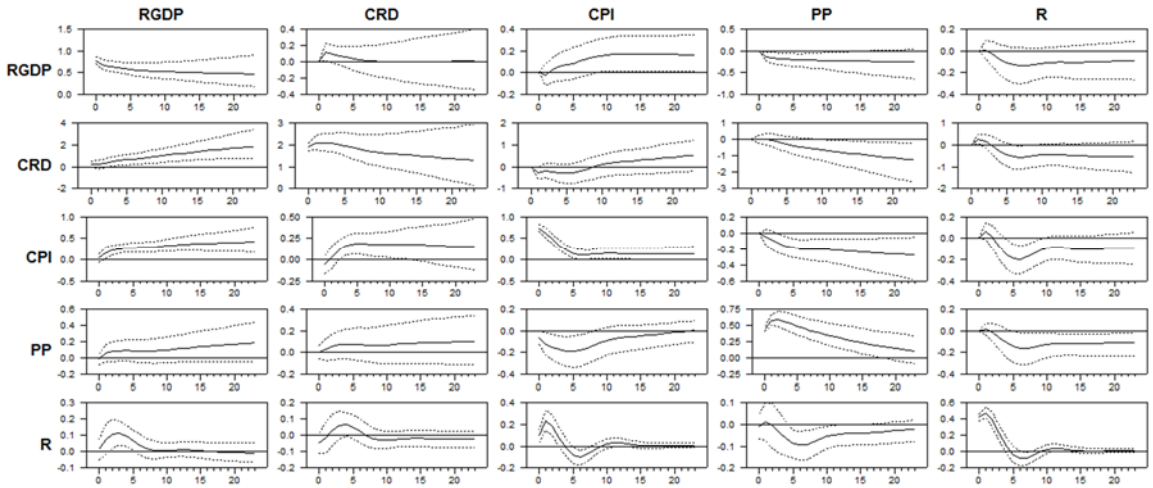
[29] The nature of two policy shocks is different so it is not so easy to compare the effect on each variable separately. Therefore, we compare the relative size of *CRD* and *CPI* responses, instead of the size of the responses of each variable.

[30] The probability is calculated by comparing the ratios for 10,000 draws from simulations. At other horizons, the results are similar in that the difference is not significant at a conventional significance level.

probability is 67.4% based on simulation exercises, which suggests that the difference is still not significant.

Impulse responses from panel VAR model

Graph 2



Note: The column headings denote the shocks and the row headings the responses of the indicated variable to each shock. *RGDP* = real GDP, *CRD* = total credit, *CPI* = consumer price index, *PP* = macroprudential policy measure, *R* = policy interest rate. For example, the impulse response in the first row, fifth column, shows the response of real GDP to an interest rate shock.

Sources: authors' calculations.

Some interesting interactions can be observed between the policy instruments. In response to contractionary macroprudential shocks, the interest rate declines after a few quarters. This monetary expansion may be interpreted as an endogenous policy action to stabilise the price level that has declined after a contractionary macroprudential shock. Similarly, contractionary monetary policy shocks lead to expansionary macroprudential policy, which can be interpreted as an endogenous policy response to changes in the credit condition following monetary policy shocks. We note that Bruno et al (2015) show a positive correlation between the levels of interest rate and cumulated macroprudential policy actions – our results suggest that there may additionally exist a lagged endogenous policy response that partly counters the impact of *shocks* to the other policy instrument.

To infer the relative importance of the policy instruments in explaining the volatility of target variables, a forecast error variance decomposition is computed. We find that macroprudential policy shocks tend to play a more important role in explaining the fluctuations in prices and credit than monetary policy shocks. At a 16 quarter horizon, macroprudential policy shocks explain 12.5% of CPI fluctuations and 6.1% of credit fluctuations, while monetary policy shocks explain 5.9% and 3.9%, respectively. Thus, the role of monetary policy shocks in explaining credit fluctuations is somewhat limited, but the contribution of macroprudential shocks to CPI fluctuations is rather strong. The latter finding is again likely to stem from the aggregate demand impacts of macroprudential policies – shocks to the macroprudential instrument explain 9.4% of output fluctuations at a 16 quarter horizon. As tighter macroprudental policies lead to a fall in current expenditure, the output gap falls, putting downward pressure on prices.

Robustness and further evidence

We construct four extended models to further investigate relevant dynamics and to check the robustness of the results. First, we examine the aggregate demand impact of the two policy shocks. As suggested in Section 2, macroprudential policy shocks could affect both consumption and investment, through their impact on credit. Increasing the dimension of the VAR to include private consumption and gross fixed capital formation one by one as an additional endogenous variable, both ordered before the policy instrument in the model, suggests that this is indeed the case.[31] In particular, we find that contractionary policy shocks lead to declines in both private consumption and investment (Appendix Graph A1), although the statistical significance of the results falls in some cases as the number of variables in the VAR increases.[32]

Second, we consider an alternative ordering of the policy instruments in the VAR by assuming that the interest rate is contemporaneously exogenous to the measure of macroprudential policy. The results are robust to changes in ordering (Appendix Graph A2). Although a positive correlation is found between two instruments as reported in Bruno et al (2014), this seems to be partly generated as an endogenous policy response in the presence of other structural shocks. For example, a positive correlation between the two policy instruments is found as a response to shocks to real GDP. By excluding the correlation conditional on shocks to macro variables, the remaining correlation between the two policy instruments is small. In such a case, the ordering between the two policy instruments does not change the results much.

Third, we use a different dataset of macroprudential tools. We use the data in Lim et al (2013) collected by the IMF, covering loan-to-value and debt service-to-income ratios, capital requirements and risk weights, provisioning requirements, foreign currency lending limits, credit growth limits, reserve requirements, limits on maturity mismatch and net open position and restrictions on profit distributions. The measures used in the estimation are constructed similarly to the benchmark model, ie accumulating the values to an index over time. As shown in Appendix Graph A3, the results are robust to using this alternative data source, even if the types of macroprudential measures included in the two databases partly vary.

Fourth, note that our baseline model does not include exchange rates, allowing for greater degrees of freedom. We extend the baseline model to include the bilateral exchange rate against the US dollar because exchange rate changes might be an important transmission channel. All variables in the model are assumed to be contemporaneously exogenous to the exchange rate, as the exchange rate is likely to reflect all possible information instantaneously. The results, shown in Appendix Graph A4, suggest that the impacts of the two policy shocks remain robust to the inclusion of the exchange rate variable, albeit with reduced statistical significance. Both contractionary policy shocks appreciate the exchange rate in the short run. Interestingly, a depreciation shock to the domestic currency (a rise in X) indeed leads to a fall in the level of credit, consistent with Bruno and Shin (2015). To the extent that

[31] See Kim (2001) for such exercises.

[32] Our result is consistent with Sonoda and Sudo (2015) who study the impacts of Quantitative Restriction (QR) policies that asked banks to limit lending to the real estate sector in Japan from the 1970s to the 1990s. The authors find that QR policy shocks had broader impacts on the macroeconomy, including on consumption and investment.

exchange rate appreciation has coincided with credit booms, the credit growth observed in the data may have been amplified by underlying exchange rate movements.

Evidence from individual country VARs

Next, we consider results from the VAR models estimated for individual economies. Here, historical decomposition is applied to investigate the role of policy shocks in explaining the dynamics of the target variables at different points in time. We are particularly interested in finding episodes where macroprudential policy actions could have negatively affected price stability in the short run – so that inflation was pushed away from target – or when monetary policy shocks may have added to financial stability risks – defined here as excessive growth in credit. For this purpose, first, we identify the quarters during which inflation was off the target range and analyse the historical decomposition of consumer prices to infer how macroprudential shocks contributed to price dynamics during those periods. Second, we identify the sample periods in which the estimated credit gaps exceeded 6 percentage points and analyse the historical decomposition of credit to infer how monetary policy shocks contributed to credit growth at those times.

In what follows, we consider only sample periods during which inflation was off the target range or the credit gap exceeded 6 percentage points for at least three consecutive quarters.[33] Moreover, given the focus of the paper, we only report the results that indicate (ex post) policy trade-offs. In the estimation, we also uncover various episodes where macroprudential policy shocks helped get inflation back into target, or contractionary monetary policy shocks dampened strong credit growth.

Table 4 shows the results from the historical decomposition of CPI. To quantify the role of policy shocks, we report the average size of the forecast error, the average size of the forecast error due to policy shocks, and the ratio of the latter to former. The ratio gives us the relative contribution of policy shocks to the forecast errors of CPI, reported in the last column of Table 4.

Historical decomposition of CPI, contribution of macroprudential shocks — Table 4

Country	Period	CPI forecast error	Macroprudential policy	Ratio
Korea	Q1:2008-Q1:2009 (high)	1.39	0.06	0.04
	Q3:2005-Q3:2007 (low)	–3.27	–0.68	0.21
Indonesia	Q1:2005-Q3:2006 (high)	5.00	0.63	0.13
	Q3:2010-Q1:2011 (high)	1.49	0.20	0.13
	Q3:2009-Q1:2010 (low)	–1.75	–0.12	0.07

Source: authors' calculations.

[33] We exclude three sub-periods (two for Thailand and one for Indonesia) during which inflation was above (or below) the target range but the forecast error of CPI was negative (or positive) or the credit gap exceeded 6 percentage points but the forecast error of credit was mostly negative because it is difficult to interpret such cases meaningfully. We also exclude two sub-periods of off-target inflation for Australia during which the contribution of macroprudential policy shocks was zero or negligible.

The analysis unveils some episodes where inflation was off the target range and macroprudential policy shocks played a non-negligible role (Table 4). For example, in the case of Indonesia during Q3:2010-Q1:2011, the sum of the CPI forecast errors was 1.49, while the CPI forecast error due to macroprudential policy shocks was 0.20. This suggests that 13% of the CPI forecast error during that period was due to macroprudential policy shocks. In other words, macroprudential policy shocks contributed to the deviation of inflation from the target range. There are other similar cases, including the period of Q3:2009-Q1:2010 in Indonesia and Q3:2005-Q3:2007 in Korea.

The contribution of macroprudential policy shocks in pushing inflation away from the target range may be less worrisome if inflation was expected to revert back to target relatively quickly. In such a case, even if inflation was currently away from target, the central bank may have been able to use monetary tools to counter financial imbalances. Alternatively, it could let regulatory authorities undertake prudential measures without a counteracting policy interest rate response, as long as expected inflation remained on target.

To investigate the issue, we focus on the periods of inflation gaps identified in Table 4. Then, we use monthly inflation expectations for the next calendar year from Consensus Economics during those periods (median expectation across forecasters), to investigate whether there were risks to price stability in a forward-looking sense. In Table 5, we show the share of months (in %) when expected inflation was away from the target, while macroprudential policy shocks exerted a non-negligible impact on inflation.

Inflation expectations for next year during periods of current off-target inflation Table 5

Current inflation above target				
Country	Period	Expectations above both the mid-point and upper bound of target range	Expectations above mid-point but below upper bound of target range	Expectations below mid-point of target range
Korea	Q1:2008-Q1:2009	20%	40%	40%
Indonesia	Q1:2005-Q3:2006	14%	43%	43%
Indonesia	Q3:2010-Q1:2011	67%	33%	0%
Current inflation below target				
Country	Period	Expectations below both the mid-point and lower bound of target range	Expectations below mid-point but above lower bound of target range	Expectations above mid-point of target range
Korea	Q3:2005-Q3:2007	0%	100%	0%
Indonesia	Q3:2009-Q1:2010	0%	0%	100%

Note: The table shows the share of months (%) during which inflation expectations for the next year were below or above the inflation target, based on dates identified in Table 4. Inflation expectations are for the next calendar year from Consensus Economics®, using the expectations published each month during the period shown in the table.

Source: Consensus Economics®; authors' calculations.

Table 5 shows that macroprudential policy shocks have at times had an impact on inflation also when near-term inflation expectations were deviating from target. During periods where inflation was above the target range and macroprudential policy shocks were expansionary, over 50% of months were characterised by next-

year inflation expectations exceeding the mid-point of the central bank's target as well. In contrast, the picture is mixed when current inflation was below the target range. In Indonesia, while inflation was below target and macroprudential policy shocks contractionary during Q3:2009-Q1:2010, inflation was still expected to revert back to target relatively quickly.

We also use historical decomposition to evaluate the contribution of monetary policy shocks to credit growth during episodes of potential financial stability risks (Table 6). Expansionary monetary policy shocks appear to have added to credit growth in Australia during a period when the credit gap exceeded 6 percentage points, although the contribution of monetary policy shocks only amounts to 3%.[34] An inspection of the debt service ratio during this period (not shown) provides a more nuanced view. In particular, in Australia, the debt service ratio crossed a "critical" threshold identified in Drehmann and Juselius (2012) as providing an indication of an impending crisis. Given that lower interest rates directly reduce debt service ratios, expansionary monetary policy may reduce the risk of imminent banking system distress when debt service ratios are high, ceteris paribus.

Historical decomposition of credit, contribution of monetary policy shocks — Table 6

Country	Period	CRD forecast error	Monetary policy	Ratio
Australia	Q2:2002-Q3:2009	32.0	0.98	0.03

Source: authors' calculations.

6. Conclusion

Central banks have increasingly adopted explicit financial stability objectives, often in the context of well-established price stability mandates. In this paper, we have analysed potential trade-offs and interactions between price and financial stability policies in the Asia-Pacific region, where many economies have used macroprudential instruments with the aim of safeguarding financial stability. The empirical analysis is done by means of structural vector autoregressions that identify both interest rate and macroprudential policy shocks. The financial stability objective for the central bank is assumed to be one of containing credit relative to output below a "safe" threshold, drawing on the literature on early warning indicators of banking system distress. The indicator for macroprudential policy is constructed by aggregating various policy measures targeting credit growth into a single index, based on data from Shim et al (2013).

We find that while macroprudential policies do indeed affect credit growth, they have also had a significant impact on inflation. Using estimates of historical decomposition, the analysis unveils episodes where macroprudential policy shocks have contributed to pushing inflation away from the target range. The estimated model dynamics suggest that macroprudential and monetary policies work through

[34] As Graph 1 suggests, there are many periods of high credit gaps in the data, but their duration is often long – as an example, the one for Australia reported in Table 6 lasts for over seven years. During such episodes the estimated contribution of monetary policy shocks mainly turned out to be very small, partly due to the fact that positive and negative shocks may cancel each other out over longer horizons.

related channels, affecting aggregate demand. The results could also indicate potential policy challenges during periods when low inflation coincides with buoyant credit growth.

These results should be seen as one of the first steps in a broader research agenda to quantify the macroeconomic effects of macroprudential policy and investigate its interaction with monetary policy. Future research on the interaction between monetary and macroprudential policies may usefully consider differentiating between the various measures of macroprudential policy; analysing a larger sample of economies; and shedding more light in the systematic part of macroprudential policy.

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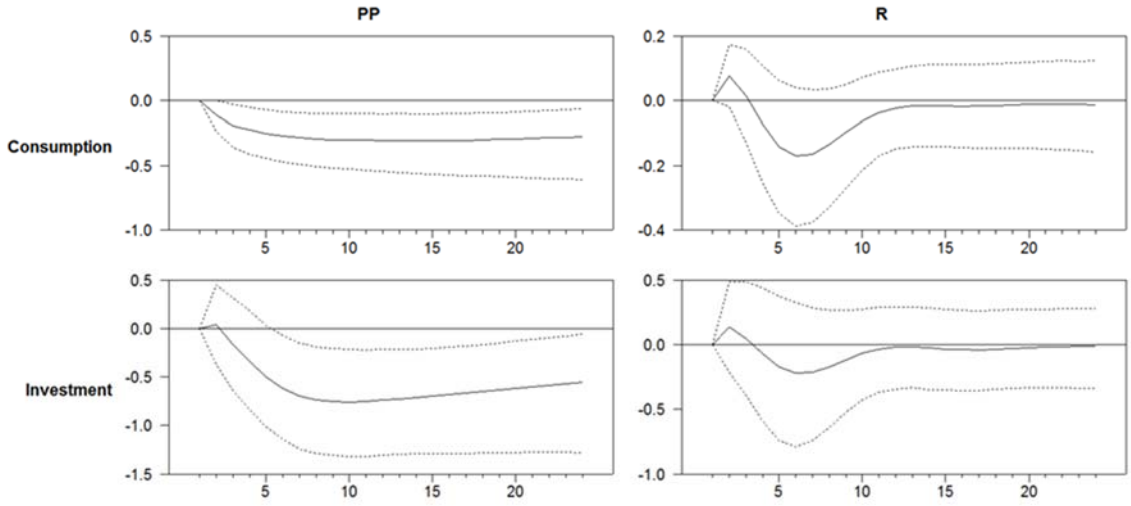
Appendix

Consumption and investment response to policy shocks

Graph A1

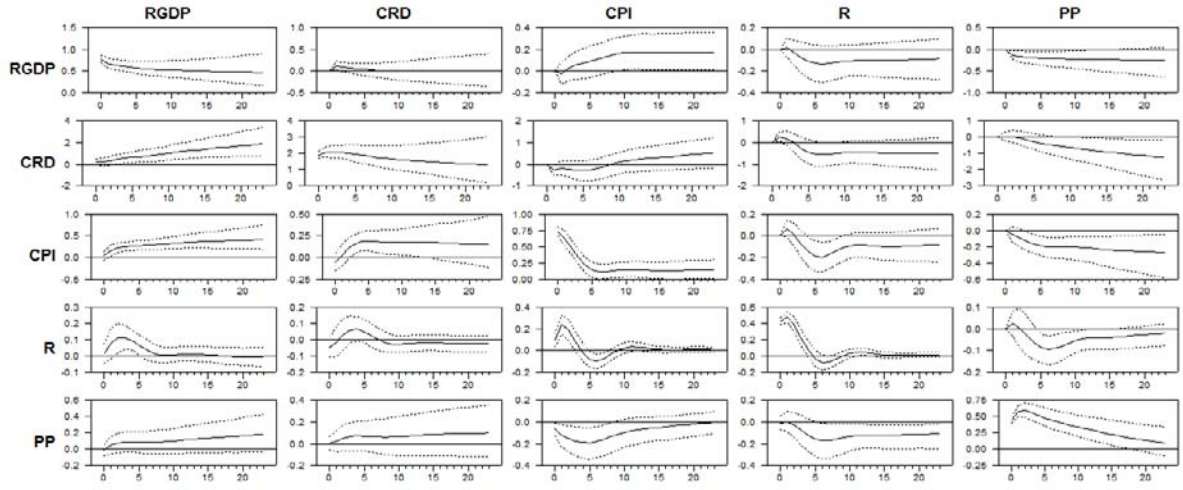


Note: The column headings denote the shocks and the row headings the responses of the indicated variable to each shock. *PP* = macroprudential policy measure, *R* = policy interest rate. For example, the impulse response in the first row, second column, shows the response of private consumption to an interest rate shock.

Sources: authors' calculations.

Impulse responses from panel VAR, alternative ordering of instruments

Graph A2

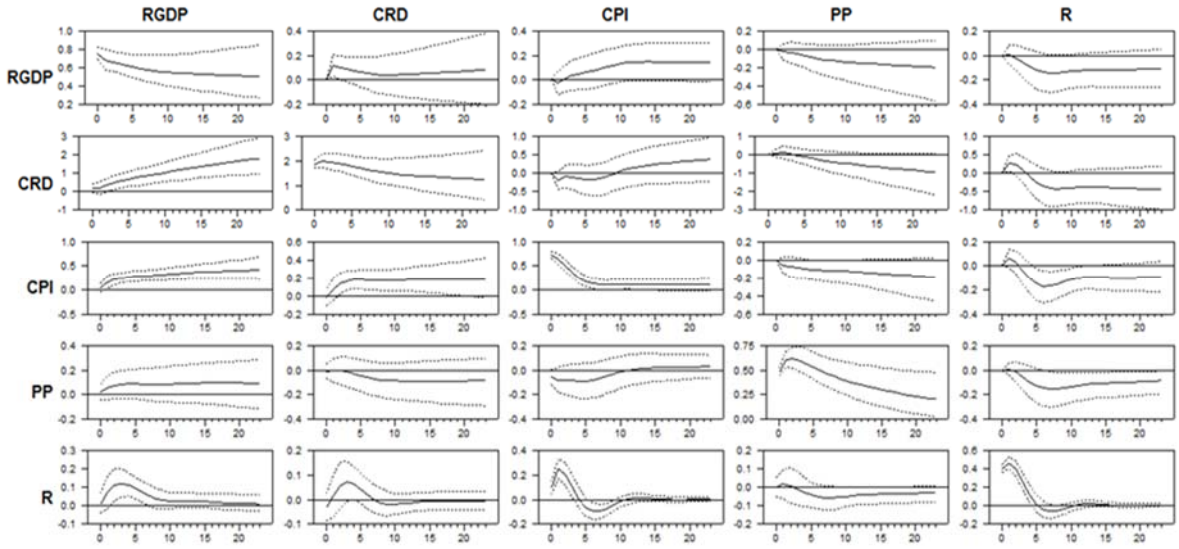


Note: The column headings denote the shocks and the row headings the responses of the indicated variable to each shock. *RGDP* = real GDP, *CRD* = total credit, *CPI* = consumer price index, *PP* = macroprudential policy measure, *R* = policy interest rate. For example, the impulse response in the first row, fourth column, shows the response of real GDP to an interest rate shock.

Source: authors' calculations.

Impulse responses from panel VAR, alternative macroprudential measures

Graph A3

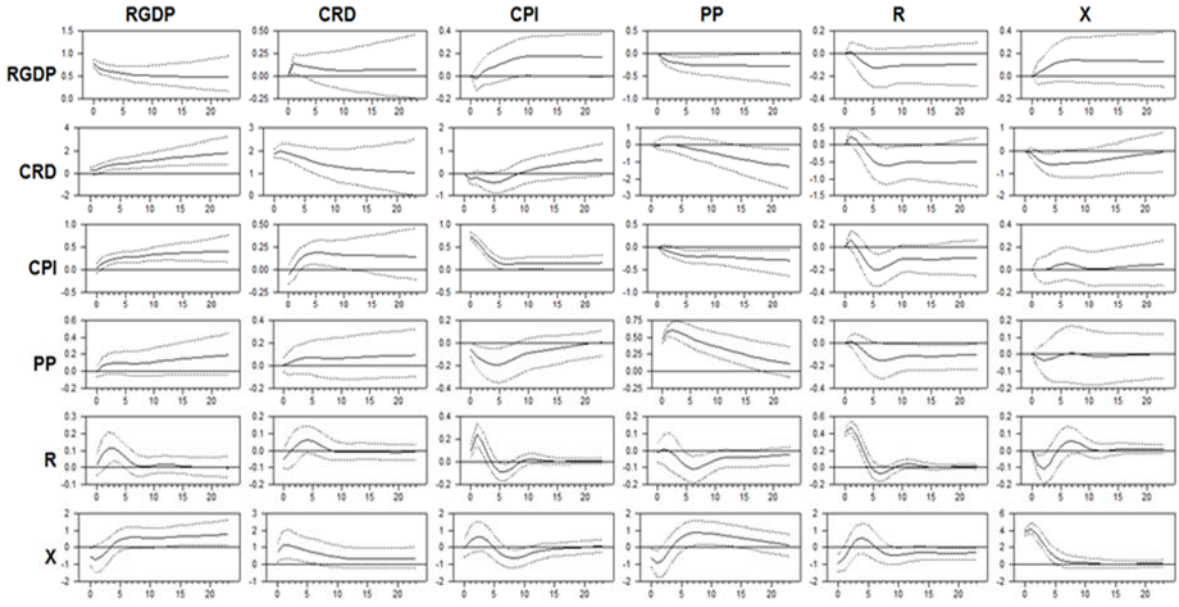


Note: The column headings denote the shocks and the row headings the responses of the indicated variable to each shock. *RGDP* = real GDP, *CRD* = total credit, *CPI* = consumer price index, *PP* = macroprudential policy measure, *R* = policy interest rate. For example, the impulse response in the first row, fifth column, shows the response of real GDP to an interest rate shock.

Source: authors' calculations.

Impulse responses from panel VAR, including the exchange rate

Graph A4



Note: The column headings denote the shocks and the row headings the responses of the indicated variable to each shock. *RGDP* = real GDP, *CRD* = total credit, *CPI* = consumer price index, *PP* = macroprudential policy measure, *R* = policy interest rate, *X* = exchange rate. For example, the impulse response in the first row, fifth column, shows the response of real GDP to an interest rate shock.

Source: authors' calculations.

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