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Dear readers,

The first issue of Sveriges Riksbank Economic Review for 2018 contains articles covering a broad range of central bank issues – from the fundamental tasks of central banks and cooperation with central banks in emerging markets to analyses of Sweden's international dependence, the advantages and disadvantages of fixed and floating exchange rates and the significance of the financial sector for economic developments.

- **The role of central banks in societal development – challenges in emerging economies**

    Stefan Ingves, Pernilla Meyersson and *Cecilia Kahn* write about central banks' overall tasks and activities, with a particular focus on central banks in emerging market economies. The article highlights some of the most important challenges faced by central banks in emerging economies and the role of the central bank as agent for development. The article also describes the Riksbank's cooperation with some other central banks in the form of technical assistance.

- **Is the Swedish neutral interest rate affected by international developments?**

    Sweden is a small open economy that is very much affected by international developments. In recent decades, global real interest rates have fallen and *Hanna Armelius, Martin Solberger* and *Erik Spånberg* study how this has affected interest rates in Sweden. They use a simple model to calculate a Swedish "neutral" interest rate and find that it has fallen in recent decades and that it is currently negative. They also find that the downturn is largely explained by falling neutral interest rates abroad, where the main impact comes from interest rates in the United States.

- **The case for flexible exchange rates after the Great Recession**

    Giancarlo Corsetti, Keith Kuester and *Gernot Müller* revisit a classical question in international macroeconomics – the choice between a fixed or a floating exchange rate. Following the financial crisis the case for fixed exchange rates gained ground again, partly with reference to their function as a nominal anchor during times of major macroeconomic shocks. The authors of this article argue that the question is just not that simple. They use theoretical arguments to show that a floating exchange rate protects small open economies from shocks originating abroad. They also argue that their conclusions are supported by developments in the Nordic countries following the financial crisis, when growth in both Norway and Sweden, which have floating exchange rates, recovered faster than growth in Denmark and Finland, which both have fixed exchange rates.

- **Financial frictions, financial regulation and their impact on the macroeconomy**

    In this survey article *Daria Finocchiaro* and *Anna Grodecka* write about the importance of having a good understanding of financial frictions – departures from the assumption of perfectly functioning financial markets – in analyses of economic developments. Prior to the financial crisis, it was common that macro models disregarded financial frictions. However, this has changed in recent years, and the article contains a review of the latest research on this subject. They also write about how different types of regulation can counteract the negative effects of financial frictions.

Read and enjoy!

Jesper Lindé and Marianne Nessén

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The role of central banks in societal development – challenges in emerging economies

Stefan Ingves, Pernilla Meyersson and Cecilia Kahn*
The authors are the Governor of the Riksbank, the deputy head of the General Secretariat at the Riksbank, and a member of staff currently on leave of absence from the Riksbank to complete a PhD in Economic History at Uppsala University.

Central banks have, through the years, been regarded as a prerequisite for an efficient economic system and for economic growth. In brief, one can say that their main task is to ensure that a country has liquidity in the form of banknotes and coins – to issue legal tender, to conduct monetary policy to ensure that money retains its value, to maintain an efficient system for payments and credits and to provide liquidity support in a crisis.

A central bank's fundamental tasks are similar all around the world, but in this article we would like to illustrate some of the challenges that central banks are facing in emerging markets and the role of the central bank as agent for development. We also describe the Riksbank's work on supporting central banks in some emerging markets with funding from Sida.

The challenges for central banks in emerging markets comprise a lack of legislative framework, an excess of tasks and objectives, undeveloped financial markets, a lack of competence and transparency. These are ingredients that are important for creating confidence in the central bank, its currency and the financial system as a whole.

1 Introduction

When a new national state is formed, the central bank becomes an important part of the political sovereignty. Founding a central bank is therefore high on the agenda, not as high as designing a flag perhaps, but higher up than establishing a national airline. This is because of the central role played by a central bank with regard to economic stability and growth.[1]

   Central banks' tasks in the political and economic system have varied over time and between countries, and there have been several attempts to define what central bank tasks are.[2] In brief, one can say that the main tasks for a central bank are to issue legal tender, to maintain a smoothly functioning system for payments and credit, to act as bank to the banks and to provide emergency liquidity assistance in a crisis and to conduct monetary policy with the aim of creating price stability. All of these tasks are necessary for the economy to function smoothly and for economic growth. The central bank's tasks and functions in society are similar all over the world, but for emerging economies, the conditions are more challenging. This affects the central bank's capacity to carry out its tasks and may also require different working methods.

   In this article we highlight some of the challenges faced by many central banks in emerging markets. These concern, for instance, the lack of or shortcomings in basic

1   Capie, Goodhart and Schnadt (2012), page 91; Georgsson, Vredin and Åsberg-Sommar (2015) and Lindé and Vredin (2016).
2   For instance, Kisch and Elkin (1932); Price (1998); Bruni (2001); Viotti and Vredin (2000); McKinley and Banaian (2005) and Singleton (2010).

legislative frameworks needed by a central bank to be able to conduct its operations and less developed financial markets that make it difficult for monetary policy to function. A lack of or shortcomings in statistics and analytical competence are other difficulties. Transparency regarding the central bank's tasks, objectives and means are a further area that often needs developing. Characteristic for many emerging markets is that they are more often subjected to major shocks, partly as a result of heavy dependence on energy and commodity prices. This in turn entails challenges for a monetary policy aimed at price stability.

The Riksbank cooperates with central banks in a number of emerging markets (currently Ukraine, Kenya, Palestine and Namibia). One of the purposes of this article is also to describe the Riksbank´s work in this field.

2   The central bank in the economy

A central bank has several fundamental functions that are important to the economy. Here is a brief run-through of the most important central bank tasks.

2.1   Credible means of payment and smoothly functioning payments

One of a central bank's basic functions is to provide a country with a standardised product for the exchange of goods and services, which is to say money. Most central banks have a statutory mandate to supply the country with banknotes and coins and have the exclusive right to issue them.

It is essential to the development of a social economy that payments function properly. An economy has difficulty developing if there is no access to a credible means of payment or an infrastructure for making payments. Exchanging goods and services without money and credit impedes the development of the economy.[3] Many problems can arise when the population and the surrounding world lose confidence in a currency; in countries with hyperinflation it has a particularly severe impact on households with low income.

Giving central banks a monopoly on the issuing of banknotes and coins, along with a certain degree of autonomy, has been seen as an effective and credible way of supplying cash. Before central banks were given a monopoly on issuing money, commercial banks were able to issue their own cash. This did not work very well.[4] Trade was made more difficult with several different 'products' for exchanging goods and services. The effect was often that too much money was printed and that the bank suffered an acute liquidity shortage when there was a crisis of confidence in the banknotes the bank had issued.[5]

Technological advances, globalisation and innovations on the financial markets have led to competition for banknotes and coins from other means of payment, particularly different types of accounts with related payment services offered by banks and other financial institutions. Today, payments are made electronically to a large extent; both households and companies, for example, pay invoices and transfer money on-line or by mobile phone. Developments in payment services move rapidly and the central bank often plays an important role here.[6]

For payments to work, one also needs a functioning financial infrastructure. Central banks are often describes as the 'plumber' in the financial system with overall responsibility for several functions that are necessary for the financial system to function. The financial

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3   See, for instance Tobin (1965) for a theoretical model and Levine (1997) for the role played by financial developments in economic growth.

4   Wetterberg (2009).

5   Stockholms Banco, Sweden's first bank in the 17th century, met this fate before it was converted into what is now Sveriges Riksbank.

6   One example is the development of payments in real time using, which in Sweden is through the mobile phone service known as Swish.

infrastructure includes, for instance, the system for large-value payments between financial agents and the system for retail payments between private individuals and companies. The Riksbank's system for payments between banks and a number of other financial institutions; the RIX system, is the hub of the Swedish payment system.[7] In many countries, and in particular emerging economies, the central bank manages the domestic system for retail payments between private individuals and companies.[8,9]

2.2 Crisis management

The central bank is the 'banks' bank' and plays the role of 'lender of last resort', that is supplies emergency liquidity assistance in the event of a financial crisis.

There are good reasons to believe that the function of banks in society – facilitating payments, mediating credit and enabling risk diversification – is more efficient as a result of competition among private players rather than being run by the state. But banking activities can contribute to vulnerabilities in the financial system. The banks' funding is based to a considerable degree on short-term loans, for example deposits from the general public and short-term borrowing on the capital market. Their assets, on the other hand, often comprise lending of a more long-term nature. This imbalance in maturity and liquidity between debts and assets is typical for traditional banking operations and normally functions without any major problems, as long as confidence is maintained in the banks' debt-servicing ability. But if doubts arise, depositors may quickly try to withdraw their money – money that the bank cannot obtain in the short term. This causes liquidity problems.[10]

This type of inherent risk is the reason why there are special rules for banks, banking supervision and often a state deposit guarantee protecting depositors against losses. When a liquidity crisis arises, the central bank can alleviate the effects by lending money to a bank in crisis when no one else wants to lend money. This function as lender of last resort is based on the central bank's unique ability to create unlimited amounts of liquid funds in its own currency. In practice, the central bank can give generous ELA at a high rate of interest and against good collateral.[11]

2.3 Monetary policy

A central bank is 'the banks' bank', not just in financial crisis situations but also under normal circumstances. The banks make payments between themselves via the central bank's infrastructure for large-value payments, and they can borrow or deposit money there in the short term. The terms determined by the central banks for these transactions affect interest rate-setting and credit flows in the economy. This is how monetary policy is carried out in advanced economies.

Price stability means in brief that those who use a means of payment shall be able to rely on its value not being undermined quickly or unpredictably. It is a logical consequence of issuing banknotes and coins to also be responsible for maintaining their value, that is, ensuring prices are stable or increase at a predictable pace. This work is known as monetary policy. Most central banks conduct what is usually referred to as flexible inflation targeting. This means that their monetary policy is aimed at attaining a particular inflation target, but that it also gives consideration to how the rest of the economy is developing.[12] This is today regarded as the most effective means of conducting monetary policy, also in many emerging

7   Through RIX the Riksbank can also implement monetary policy and provide liquidity assistance in crisis situations. In addition, there is also an infrastructure for issuing and trading in securities.

8   For instance, Belgium, China, India, Russia, Italy and South Africa, see: Bank for International Settlements [BIS] (2016) p. 494.

9   In Sweden the dominant system for retail payments, Bankgirot, is owned by the banks.

10   Diamond and Dybvig (1983).

11   Bagehot (1873) and Calomiris (2016).

12   Apel et al. (1999).

economies,[13] although the conditions differ in several important aspects (read more about this in Section 3.3).

Even if the inflation-targeting regime in Sweden has been much debated in recent years, it has been positively rated in the evaluations of the Riksbank conducted by the Riksdag (the Swedish parliament).[14] The experiences are roughly the same in other countries that have followed the same strategy. In the countries that have introduced inflation targets, the inflation rate has been low and inflation expectations have been anchored around the target without causing greater volatility in GDP growth.[15]

2.4 Central bank independence

At the beginning of the 1990s, the view was established that central banks should be relatively independent public institutions kept at arm's length from political pressures.[16] The tasks of a central bank could in principle be managed by a ministry of finance, or the ministry of finance could have direct control over the central bank, but that would not be appropriate. This has partly to do with the possibility that governments would be tempted to finance budget deficits by printing more money. But it is also connected with it being considered risky to use monetary policy too actively in cyclical policy.[17] Experience has shown that this can lead to lastingly high and volatile inflation without any positive effects on employment and output.[18]

For these reasons, many countries have chosen to delegate a monopoly on issuing money and taking monetary policy decisions to a central bank with a high degree of independence. How great this independence should be depends on the functions the central bank receives from its principals. Its principal can be either the parliament or the government. The law or laws that govern the central bank's functions and its independence vary from country to country. In general, one can say that when a central bank's tasks are clearly delimited and defined by law, it allows for greater independence and vice versa.

Today, central banks often have a high degree of independence. However, this does not mean that the central bank is 'independent' of political decisions. Democratically elected politicians should, of course, take the decision on how independent the central bank is to be and which tasks it should be assigned.

3   The challenges of central banks in emerging economies

Over the last two decades, many emerging economies have improved their control of fiscal policy, deregulated their financial markets and stabilised inflation at lower levels. This is largely due to them adopting sounder economic policy with better frameworks for both fiscal and monetary policy, greater independence for central banks, reduced fiscal policy dominance and more substantial elements of market-based processes. Moreover, many countries are on the way towards a more forward-looking monetary policy in which transparency and implementation have also come more into focus. Financial developments and globalisation have accelerated this process, although many emerging economies still have plenty to do.[19]

The problems faced by central banks include weak legal frameworks and ensuing lack of independence from the political system, ineffective internal process and insufficient

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13 International Monetary Fund [IMF] (2015c).
14 Goodfriend and King (2016).
15 Berg et al. (2013) and Loungani and Sheets (1997).
16 Singleton (2010).
17 Barro and Gordon (1983).
18 Georgsson, Vredin and Åsberg-Sommar (2015).
19 IMF (2015c).

transparency, which has a negative effect on confidence among the general public and politicians. Central banks are therefore exposed to more short-term political pressures and are finding it difficult to implement their monetary policies. Other fundamental problems are a lack of statistics and the statistics that do exist being unreliable. It is, of course, more difficult to conduct inflation targeting if the background material on which forecasts for employment and output is inadequate. Furthermore, less developed financial markets make it more difficult to use the interest rate to affect price formation in the economy.

The principles for conducting central bank operations and what functions a central bank should have are approximately the same for emerging economies and more developed or advanced economies although there are major differences in conditions.

3.1 The central bank's framework must be clear

Successful central banks mostly have a consistent and transparent monetary policy framework with a clear-cut mandate to achieve price stability in the medium term. Without disregarding this overall goal, however, they also have the objective to promote growth, employment and a stable financial system. A problem for many central banks in emerging economies is, however, that they receive too many and often contradictory objectives. It is not unusual for central banks to be expected to maintain price stability, low interest rates and a fixed exchange rate as well as promote general economic development all at the same time. Achieving all these objectives at the same time is virtually impossible. Too many objectives often lead to the inflation target being overshadowed if, for example, concerns about exchange rate movements, lending or unemployment increase and become the subject of political discussions. In combination with weak legal frameworks, this does not make it easier for central banks to withstand political pressure to, for example, cut the policy rate to increase lending. But this causes inflation to soar and central banks to lose their credibility.

Moreover, it is not unheard of for central banks in emerging economies to run institutions like universities, libraries, TV channels and hospitals. They sometimes also take on too many roles, conducting central government and commercial banking operations as well.[20]

To develop strong and clear central bank legislation and implement other necessary reforms, the central bank itself must often provide impetus. The central bank may also need to contribute to greater consensus among various groups in society, including politicians. Political support is essential in order to have an independent and efficient central bank. Politicians must set the framework and then work to support an independent central bank. It is a question of building strong institutions. If there is no political confidence in the central bank, it will be unable to achieve its objective or targets and contribute towards economic development.

The legal framework should also specify the central bank's institutional frameworks and describe how management and governance, decision-making processes and democratic accountability are to work. The workings of a central bank are complex and also require an effective strategy to guide internal operations.

Central bank independence is a key aspect and it, too, requires clear forms of accountability and transparency. History, academic theory and empirical data show that central banks can best contribute towards general economic development and secure confidence in their operations, monetary policy, the currency and the financial system when they have a clear mandate that is formulated by elected representatives and are at a certain distance from the political system. Many central banks in emerging economies currently

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20 Countries with three or more monetary policy objectives include Ethiopia, Vietnam, the Solomon Islands, Bangladesh, Malawi, Myanmar, Nigeria, Yemen, the Gambia, Rwanda, Mongolia, Pakistan and Zambia. Examples of countries that have two objectives include Liberia, Cambodia, Nicaragua, Bolivia, Honduras, Afghanistan, Tanzania, Indonesia, India, Romania and Uganda. (IMF (2015c). See also the table in Appendix 1.)

have judicial independence and an increasing number of them are also getting closer to independence in practice.[21]

Independence also strengthens public confidence in central banks, making it easier for them to run their operations effectively. Economic transactions and financial services are largely a question of pledges about future commitments. The higher the confidence, the lower the transaction costs. Confidence in a society functions like a lubricant, making it easier for everyone. There are numerous examples in history of countries where confidence in the central bank's ability to maintain the value of the country's currency has fallen so low that households and companies start using dollars or some other reserve currency instead. Several countries in Latin America have experienced this, including Argentina, Peru, Ecuador and El Salvador.

If a central bank with an inflation target fails to instil confidence in the target, it risks creating the wrong expectations, and it will be virtually impossible for it to achieve its objective. Zambia and Ghana are two examples of countries that have tried to establish an inflation target over the last five years but where inflation has repeatedly either overshot or undershot the target.[22] This undermines confidence in the central bank, even if the causes of the missed target are beyond its control. Confidence in the central bank's operations is, of course, extremely important when it comes to the financial system. If the general public do not trust the central bank and other authorities to be able to maintain stability in the financial system, there is a risk of them withdrawing their money, and hence of their concerns materialising.

3.2 Greater transparency is crucial to building confidence

Over the last few decades, central banks around the world have become increasingly transparent. This can be explained by stronger demands for transparency from the general public and by the fact that independence sets requirements for accountability and hence openness. Accountability is important since the central bank should be independent of politicians. A well-functioning process for being able to present the central bank's work promotes independence and facilitates democratic control. Openness and transparency can build confidence in the central bank's activities among politicians and the general public. Confidence can also be achieved by the central bank being clear about what it spends its resources on, how policies are drafted and how decisions are taken.

For central banks that have started to apply a forward-looking monetary policy, communication and transparency are also a monetary policy tool. By communicating their forecasts and their forthcoming interest rate policy, the central bank can influence expectations and make it easy for financial market participants to react to the policy.

However, emerging economies still have a much lower degree of transparency and openness than advanced economies. Central banks in emerging economies often lack a communication strategy for their inflation forecasts and communication is further exacerbated by the fact that it is given several objectives that are incompatible.[23] When problems arise, there is a tendency for central banks in emerging economies to take a step back when it comes to transparency instead of communicating and opening up more. One of the most common questions that emerge when the Riksbank works with communication issues in emerging economies is how the central bank should communicate in a crisis or when it receives criticism.

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21 Laurens, Arnone and Segalatto (2009) and Lucotte (2009).
22 IMF (2014, 2015a, 2015c).
23 Crowe and Meade (2008) and Dincer and Eichengreen (2014). According to Crowe and Meade, progress towards greater transparency has come to a standstill in emerging economies, although Dincer and Eichengreen find that development is still moving forward.

3.3 Varying conditions for monetary policy

For a central bank to be able to conduct monetary policy, several conditions need to be in place. One such condition is a well-functioning financial system through which the central bank can influence the interest rate and thereby economic development, as well as political support in the form of a responsible fiscal policy. An increasing number of emerging economies are trying to follow an inflation-targeting policy that requires a forward-looking monetary policy, which imposes further demands. A forward-looking monetary policy contains a complete assessment of the economic outlook, a way forward for the policy in line with the inflation target, while attention can be paid to financial stability and other macroeconomic variables, as well as an appraisal of future risks and plans for how to tackle potential shocks.[24]

But even when the conditions for conducting monetary policy are in place, challenges remain for emerging economies as regards policy design, as the external factors influencing monetary policy differ from more developed economies. In particular, these factors include the size and frequency of external price shocks to commodities and assets. Other aspects may also need to be taken into consideration that more developed economies need not consider to the same extent, such as inadequate statistics, corruption and low confidence.

3.3.1 Basic conditions for monetary policy

Sweden and other countries that came through the financial crisis of 2008–2009 relatively well are characterised not only by an efficient regulatory framework for central bank operations but also by the fact that they have been implementing reforms for a long time that have improved the functioning of the economy, above all with respect to fiscal policy. It is difficult to believe that a central bank can independently guarantee low and stable inflation, and financial stability, irrespective of how fiscal policy is designed and vice versa. A central bank, no matter how independent, will not succeed with its monetary policy if the political system does not support it via a sound and stable fiscal policy with a clear framework. Monetary policy cannot bear the whole burden of stability in the economy. This is a problem that currently occupies many emerging economies.[25]

Throughout the history of central banks, there has been an inbuilt conflict between their desire to maintain stable prices and their function as the government's bank. Governments have a natural preference for cheap funding from their own bank, printing extra banknotes, particularly in the event of various types of crisis and, ultimately, in times of war.[26] Funding budget deficits by printing money or conducting a fiscal policy that is so expansionary that the central can no longer control the interest rate is normally called 'fiscal policy dominance'. The successful implementation of monetary policy requires a responsible fiscal policy with a clear framework. It implies that fiscal policy must underpin monetary policy objectives and not revert to funding via the banknote printing press or an all-too-expansionary policy that undermines confidence in the price stability objective. An all-too expansionary fiscal policy that leads to a growing deficit and high, volatile inflation has been common in emerging economies, but the problems have eased somewhat in recent years.[27]

Many emerging economies have or have had a fixed exchange rate as their monetary policy regime, as Sweden had until we abandoned it in 1992. Nowadays, most emerging economies have a certain degree of flexibility in their exchange rate regime even though none of them has a completely floating exchange rate (in accordance with the IMF definition).

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24 IMF (2015c).
25 Sims and Del Negro (2016) and Leeper (2016).
26 Georgsson, Vredin and Åsberg-Sommar (2015).
27 IMF (2015c).

A forward-looking monetary policy demands a clearly defined target and tools for the central bank. But in addition to the legal framework, a forward-looking policy also sets higher demands on the central bank, which pose a number of other challenges for emerging economies. Inflation targeting is based on forecasts and analyses of the economy. In many emerging economies, the capacity for policy analysis is often weak. Recruiting competent staff can be difficult and the statistics are inadequate.[28] Inflation targeting also sets higher demands on transparency and existing communication channels, which are lacking in most emerging economies.[29]

It is often unclear which monetary policy is being conducted. Several of the countries that have a flexible exchange rate have, in practice, a money supply target[30] with some elements of inflation targeting (Albania and Armenia, for example). A target for money supply or the monetary base, i.e. banknotes and coins plus a liquidity surplus, can be controlled by the central bank via 'market operations'. Market operations involve the central bank buying or selling domestic currency, or borrowing or lending domestic currency against collateral. A money supply target can be seen as an intermediate goal, while the main goal is to achieve stable prices. An inflation target is therefore a final goal where the central bank adjusts its instruments (the money supply or a policy rate) to achieve a specific inflation target. Most people agree that there is a correlation between money supply and price level. However, there is not complete agreement on how strong this correlation is or how quickly changes in the money supply have an impact on prices. As a result, most central banks have decided instead to set targets directly for the final target variable, i.e. inflation.

The majority of emerging economies are in the process of modernising and introducing some form of inflation targeting but with a more flexible application, for example a broader interval (see Appendix 1). Those emerging economies that despite everything stick to both exchange rate and inflation targets reflect problems with undeveloped financial markets and an inadequate transmission mechanism. An efficient transmission mechanism enables the central bank to disseminate its monetary policy in the economy. Undeveloped financial markets and fixed exchange rates or capital controls weaken the transmission mechanism, which is often the case in emerging economies.[31] There are studies, however, that identify well-functioning transmission mechanisms in many emerging economies, especially in those cases where the central bank has communicated its policy clearly and followed it up with actions.[32]

Another common problem for less developed economies is the government's poor management of its daily liquidity flows. This concerns, for example, tax receipts and payments of different transfers from the central government budget. In most countries (although not in Sweden), these payment flows are taken care of via the central bank. The central bank must therefore manage and take these liquidity flows into account when they are required to satisfy their counterparties' need for liquidity on a daily basis. Central banks normally conduct monetary policy by determining the price at which counterparties may deposit or borrow central bank money. The worse the government manages its cash flows, the more difficult it is for the central bank to make reliable forecasts. Accordingly, it may also be difficult to assess when they need to supply or withdraw liquidity from financial agents. This leads to difficulties for the central bank to control the general conditions for liquidity in the economy and may thereby reduce the effectiveness of monetary policy.

28 Levy and Misch (2014) and Grigoli et al. (2015).
29 IMF (2015c).
30 Reserve Money Targeting Regime, TMTR.
31 Mishra, Montiel and Spilimbergo (2012).
32 Berg et al. (2013).

3.3.2 Particular challenges to design monetary policy

Even when designing the monetary policy itself, there are factors that differentiate emerging economies from advanced economies. For example, there is a greater need for flexibility in emerging economies and the central bank needs to take greater account of other factors such as employment or financial stability. The appropriate target level for inflation can also be affected by the way the economy works or the central bank may have low credibility.[33]

Just as in advanced economies, situations sometimes occur that require a trade-off between price stability and other political goals such as employment or financial stability. These can be difficult to handle but, the more confidence a central bank has acquired, the greater the latitude it will have when conflicts of interest like this arise in an economy.[34]

Emerging economies are often harder hit by various shocks, such as major fluctuations in the price of commodities and food and different types of demand and supply shocks.[35] The effects are different depending on whether the countries are commodity importers or exporters. Volatility in inflation and growth, as well as large out and inflows of capital, often arise in the wake of this. Central banks cannot influence fluctuations in commodity prices, but they can exert some influence on the secondary effects of rapidly rising oil prices, for example. A well-anchored inflation target can, for example, help to mitigate the effects of major changes in commodity prices and the exchange rate on inflation.[36]

4   The Riksbank's Technical Assistance

The Riksbank has worked with technical assistance for about 15 years to support a number of countries as they build up and develop a functioning central bank. Today this work is carried out within the framework of an agreement with Sida. This cooperation is called the Staff Exchange Programme and, as the name suggests, it concerns cooperation and an exchange between colleagues at the Riksbank and in the collaborating countries.

As already mentioned, the central bank plays a decisive role in the development of society. In emerging markets, the central banks face special challenges. The Riksbank wishes to contribute with its technical assistance to developing central banks in emerging economies. It is assessed as efficient to use the Riksbank's internal competence to work on concrete issues that the central bank in the cooperating country chooses itself, and which are important to the development stage in which the central bank finds itself.

4.1 Flexible cooperation and results-based management

The contents of the technical assistance are largely governed by demand from the central banks in the cooperating countries. But the Riksbank must of course have the competence that is in demand and the work should not overlap what is being done by, for instance, the World Bank or the IMF in the country. No two cooperation projects are the same, and they can focus on a range of issues, such as cash management and electronic payments to monetary policy with an inflation target, governance and management and communication. The Riksbank tries to help these countries' central banks to clarify their objectives and means, to build up and develop their analytical capacity and their decision-making processes and, from their varying starting points, to open up and create dialogue with important target groups to build confidence. It is important to be able to flexibly adapt the content to the needs for the cooperation to be successful.

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33 Huang and Wei (2003).
34 Dincer and Eichengreen (2014).
35 Zambia, Angola and Mozambique are examples of countries that are often adversely affected by these fluctuations.
See further IMF (2015a, 2015b, 2016).
36 Mishkin and Schmidt-Hebbel (2007).

The Riksbank determines in consultation with Sida which countries it will cooperate with. Demand partly steers the choice of cooperating country. One important factor is that the central bank in the country can make use of the Riksbank's assistance and competence. Some infrastructure needs to be in place already, in the form of statistics, analytical competence and a functioning governance and management of the central bank. Most often, these have been countries that aim to introduce inflation targeting. The cooperation must also be in line with Swedish foreign policy in general.

Evaluating the technical assistance is of course very important, although it may be difficult. It often takes many years to reach a result. At present, the evaluation of technical assistance is aimed more at the results than the output, for instance, the IMF works with results-based management to an increasing degree.[37] The Riksbank also works on results-based management that is designed in a flexible manner and easy to follow up. Sida and the Riksbank have jointly produced a results framework that is adapted to the conditions of the cooperation.

The results chain covers planning, implementation, follow-up of results and evaluation of the programme. The results to which the activities refer are assessed on three time horizons, where the two first ones must be measurable: immediate (output), 1–2 years ahead (outcome) and long term (impact). The Riksbank works continuously with the results framework and the results chain and with cost efficiency. Each activity is planned and followed up according to the results chain. During 2018, some of the first follow-ups will be made, of activities carried out in 2015 and 2016.

4.2 Towards greater focus

The Riksbank's various cooperation projects begin at different points in time and they continue for different lengths of time. The current agreement with Sida runs between 2015 and 2019 and covers cooperation with the central banks in Ukraine, Kenya, Palestine and Namibia.[38]

The number of countries included in the agreement has varied, but in recent years the Riksbank has chosen to focus most of its resources on the Ukraine, Kenya and Palestine. Since the cooperation with the National Bank of Ukraine began in 2015, the Riksbank has contributed technical assistance more or less every month. The regular contacts between colleagues in Sweden and the Ukraine has led to better continuity and better results because the measures in the various areas that have been discussed in the cooperation are implemented more quickly.

Focussing on one or a couple of countries at a time leads to a greater pay-off from the activities, at least judging by the rapid development of the Ukrainian central bank. Regular and focused exchange increases the pressure to change. The actual activities are of course important, but things don't get really good until ongoing contact is established between colleagues via email, for example. Then one knows that they are continuing to work on the issues and that their competence is increasing. The Riksbank has also tried to develop operations by stationing a researcher in the field of monetary policy at the Ukrainian central bank for six months for the purpose of further deepening the collaboration.

The Riksbank has also chosen to focus the resources in the cooperation with Palestine. There the cooperation is not as comprehensive as in the Ukraine. Instead, the Riksbank has focused on electronic payments and management and governance issues. For the Riksbank, this delimitation has meant that one can have a greater impact and really contribute a comparative advantage. It has also been a simple matter to coordinate with the IMF and communicate what activities the Riksbank is undertaking.

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37 Crandhall (2009).
38 Previous cooperation countries have included Albania, Sri Lanka, Uganda and Vietnam.

4.3 Colleagues – one size doesn't fit all

The Riksbank's stance is to behave as colleagues and in various areas communicate how we work today, but also how developments in Sweden have looked historically and what potential paths one can take. It is important that the country in question builds up its operations on the basis of its own history, culture and its conditions with regard to organisation, technology and competence. It is often a question of explaining what the Riksbank did when it introduced an inflation target, the processes when the Riksbank reduced the number of offices issuing cash and how Sweden has succeeded in reducing the use of cash in society. Electronic payments and a reduction in the use of cash are at the top of the agenda in many emerging economies, partly because it is socio-economically efficient and contributes to financial integration, and partly because it can reduce corruption in many of these countries.

The Riksbank does not claim to be able to offer the best solutions to all of the cooperating countries' various problems. Instead, the Riksbank acts as a sounding board for ideas and demonstrates how we work on these issues in Sweden or how we have dealt with them historically. There may also be more technical exchanges that are based on domestic data and aim to construct simple forecasting models. If collaboration is to be productive and lead to long-lasting results, it is necessary that this work is based on peer collaboration and on each collaboration partner finding their own way of working that suits them.

The Riksbank's method of working with regard to technical assistance is slightly different from how many other central banks in advanced economies work. Often these have specific organisations devoted to technical assistance, or they channel funds via the IMF or the World Bank. Norway has its own model in which, together with the IMF, it appoints a single country to work with for 4–5 years. They work in approximately the same way as the Riksbank does, but also base a member of staff in the partner country for the entire period.

The Riksbank's technical assistance is popular and more requests are received for an exchange than can be met. The Riksbank is in the forefront in many fields, such as transparency, electronic payments and in the monetary policy field. Moreover, the Riksbank is considered to be one of the most cost-efficient central banks. The international community expresses a high level of confidence in the Riksbank and its work. This contributes to many emerging economies seeking to cooperate with the Riksbank.

The activities are also appreciated by the Riksbank's own members of staff. They provide an opportunity for development within the employee's own area of expertise and are seen as a challenging and rewarding experience. The Riksbank's employees mostly travel to Frankfurt, Basel or Washington, so the opportunity to learn how things work in countries like Ukraine or Kenya is particularly educational.

The Riksbank's work on technical assistance also receives some international appreciation, as the IMF and the World Bank are familiar with the work and the Riksbank's staff are asked to take part in so-called technical assistance missions together with the IMF.

In the field of technical assistance, the Riksbank thus works across the entire spectrum of issues that a central bank must manage. But each central bank has its own problems and issues. As mentioned earlier, no two assistance cooperation projects are the same. On the other hand, many of the central banks the Riksbank cooperates with have some challenges in common, primarily management and governance issues, as well as transparency and communication.

4.4 Key issues and practical development work

In Ukraine, Palestine and Kenya the multinational organisations, primarily the World Bank and the IMF, contribute substantial technical assistance. It is important that the Riksbank does not overlap their work but instead builds on or fulfils unmet needs. In Ukraine, the central bank also has a number of other bilateral collaborations. There it is important to have

a good contact with the Ukrainian coordinator of the technical assistance and sensitivity to what needs they express, for the purpose of making a difference and avoiding any overlap. In Palestine, the Riksbank has direct contact with the IMF's person responsible for the country and conducts a dialogue regarding the Riksbank's cooperation with Palestine and what assessments the IMF makes.

A good way of coordinating with the IMF and the cooperating countries is via the IMF's Annual and Spring Meetings. At these meetings the Riksbank meets the IMF's staff responsible for the countries and central bank governors of the respective cooperating countries to discuss the ongoing exchange, the IMF's work in the country and their assessment of the situation and needs there.

In Ukraine, the central bank has made considerable progress in recent years in cleaning up its financial sector. More than 60 banks have been liquidated and in 2016 one of the largest banks was nationalised, as it had been a major problem for a long time. The central bank is reviewing its entire organisation with the aim of focusing on core activities. Furthermore, great efforts have been made to open up and to communicate clearly and openly on a large scale. In the Ukraine, as in Kenya, the major multilateral institutions are contributing a lot of technical assistance, but, in practice, a certain degree of courage is required from top management to break old habits. This applies of course to corruption, which is widespread in all of the countries with which the Riksbank cooperates. It is also important to ensure that he central bank focuses on its core business.

4.4.1 Organisational issues, management and governance

When a partnership is initiated, it is almost always clear that there are shortcomings in the central bank's management and governance. The internal processes do not function properly, they are bureaucratic and hierarchical, which creates inefficiency and slow decision-making processes. As a result, the central bank governors are weighed down by a burden of thousands of small decisions and cannot get the ship to move forwards. The employees in their turn often feel they do not receive the information they need to be able to do their jobs properly.[39]

The cooperation therefore has to start with discussions on organisational matters, operational management and communication, both external and internal. For instance, the Riksbank can share its experiences of organisational development. The Riksbank has gone from being a central bank with over 1,000 employees in 1995 to the current level of about 330 people. Many of our cooperation partners are interested in this journey. For instance, over the last two years, the National Bank of Ukraine has gone from having 12,000 employees to 5,000. Its target is around 2,000. The central bank management says they have the Riksbank as one of their role models. Palestine is also asking for assistance with regard to organisational matters and management and governance. There the exchange will be directly between the top management of the Palestine monetary authority and the Executive Board of the Riksbank.

Closely related to this are the working areas of the risk division and the internal auditing division. They are crucial for a modern central bank. In recent years, the demand for technical assistance in these areas has increased, and the Riksbank is working to meet this demand.

4.4.2 Communication and openness

Another area in which we often carry out initiatives is communication and transparency. The Riksbank is a world leader with regard to transparency, as is usually shown in various studies, for instance, regarding the extent to which the central bank publishes its decisions, minutes

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39 IMF (2015c), p. 17.

of meetings and decision-making processes.[40] The central banks the Riksbank cooperates with often request an exchange within communication and openness, otherwise this is something the Riksbank is happy to suggest as a cooperation area. Of course, openness and communication are not secondary activities, they are core operations for a central bank. Transparency leads to confidence in what we do, which is completely decisive for both monetary policy and financial stability.

In all of the Riksbank's current cooperation countries they have invested considerable resources in increasing transparency and communicating more in society. Kenya's central bank is producing a communication plan and they are working intensively on organising their internal communication as a tool for management and governance. In Namibia, the central bank is the local leader in the field of plain language, that is, communicating in a clear and easy-to-understand manner, partly due to the exchange with the Riksbank in this field.

A cooperation usually starts with a number of workshops in the partner country, allowing us to reach a broad cross-section of managers and heads. Then a couple of representatives are invited to the Riksbank to attend the monetary policy meetings and see the processes regarding an interest-rate decision, or alternately the process regarding the Financial Stability Report. This is highly appreciated and a good way of sharing knowledge – showing what we do in practice.

During 2016 and 2017 the Riksbank worked together with the central bank of Kenya in a number of areas, including communication and monetary policy. This process provides a good example of how the technical assistance works in practice. Three people from the communication department of Kenya's central bank came to the Riksbank and attended and watched and listened to all preparations for the monetary policy decision, the actual decision-making meeting and subsequent press conference, chats and everything else we do. A few weeks after the visit, they sent a concrete plan and strategy for how they plan to move forwards, both internally and externally, with a request for opinions and comments. They had quickly picked up on a lot of what was discussed during their visit, reworked it into a form that works for them and then asked for the Riksbank's feedback. During the next step, two representatives from the Riksbank's communication division travelled to Kenya and discussed the central bank's new communication plan. In April, employees from the monetary policy department at Kenya's central bank came to the Riksbank and followed the monetary policy process again, but this time with more of a focus on technical issues, such as forecasts and background data, how the Riksbank's Monetary Policy Department works together with the Executive Board and how decisions are finally reached. In this way, a whole chain is formed regarding the monetary policy work, which includes both communication and the technical aspects.

4.4.3 Payments

Payments issues, cash management and electronic payments are also areas where the Riksbank's competence is increasingly in demand. When it comes to electronic payments and reduced use of cash, Sweden has come further than many other advanced economies.[41]

Both Palestine and Ukraine are requesting cooperation on payments issues. Common to both of these central banks is that they wish to increase efficiency and facilitate financial integration with the aid of electronic payments. Moreover, it is an important factor to reduce corruption and increase tax income. The more traceability and the less cash usage there is, the less latitude there will be for the black economy.

In Palestine, a decision has been taken for a national strategy for electronic payments, which is taking shape with the Riksbank's experts acting as sounding board. In collaboration with the Ukrainian central bank, the Riksbank has over the past year held a number of

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40 Dincer and Eichengreen (2014).
41 BIS (2016).

seminars in Kiev on this subject and experts from the Ukrainian central bank have visited the Riksbank to learn from the Swedish process towards a cashless society. Going forward, it is likely that demand in the payments area will increase further.

5   Summary

Central banks are a key part of society and one of the first institutions that need to be established when a new nation is formed. As new states have come into being, the number of central banks has also increased; in 1950, there were 59 central banks in the world, now there are almost 180.[42] The functions of a central bank in society are necessary in order to safeguard economic stability and growth. In emerging economies, however, central banks are faced with several complex challenges that place particular demands on the central bank.

The work to strengthen the central bank and ensure that it can carry out its tasks in society starts with the establishment of a legal framework for an independent central bank that prioritises price stability in the medium term. The law should also define a transparent and democratic process for accountability. Greater transparency is important and central banks themselves need to work to be more open and communicate their policy to the general public. Being the linchpin of the payment system and with its role as the bankers' bank, the central bank will always have a responsibility for financial stability. The central bank's most important task is to ensure that the country's own currency maintains its value – the price stability objective – which is normally referred to as monetary policy. For central banks in emerging economies, the conditions for monetary policy differ in several respects compared to advanced economies.

The Riksbank cooperates with central banks in emerging economies to contribute competencies and technical know-how in these countries. So far, the experience of such technical assistance is overwhelmingly positive, even if it takes a long time to bring about change in some cases. One lesson learned is that central banks can act as agents for development in the national economy. Central banks around the world, even in emerging economies, often have staff in core activities who have higher-than-average skills. In those emerging economies were corruption is widespread, it is not unusual for central banks to functions better in this respect. The colleagues whom the Riksbank meets are often knowledgeable and ambitious, they demonstrate courage and can lead development. This has been particularly apparent in Ukraine. Central banks can therefore often act as 'white knights' among other public institutions. They often have a higher standing and are more respected than other institutions and the rest of the political system. Central banks and their employees can be perceived more as technical experts who many times, if not always, stand above their own self-interest and corruption. Central bank executives often possess a high level of competence and are internationally educated economists. Of course, this doesn't say so much about their competence in governing and leading a central bank. But it means that they want to deliver what they say they will deliver and are open and clear about their operations.

The key role of central banks in price stability and financial stability, which in turn constitute the conditions for healthy economic development in general, is a cornerstone of all societal development. Sveriges Riksbank – the world's oldest central bank – has a great deal of experience and know-how to contribute. We try to do this in the form of technical assistance. Our experience is that this provides results even if it often takes many years and there may be setbacks along the way.

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42 Capie, Goodhart and Schnadt (2012).

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Appendix A

Table 1. Monetary policy objectives in emerging economies

		Exchange rate regime	Target for money supply	Inflation target	Other
One objective	**Price stability**	Burundi Morocco Sao Tome and Principe	Congo Mozambique Sierra Leone Sudan Ukraine Uzbekistan	Armenia Georgia Ghana Guatemala Kenya Moldavia Zambia	Egypt
	Exchange rate	Cape Verde			
Two objectives	**Price and exchange rate**	Liberia Tajikistan	Afghanistan Madagascar	Indonesia	Kyrgyzstan
	Price and growth	Cambodia	Guinea	India Philippines	
	Exchange rate and other	Nicaragua			
	Price and other	Bolivia Guyana Honduras East Timor	Tanzania	Paraguay Romania Uganda	Vanuatu
Three or more objective	**Price, growth, exchange rate**	Ethiopia	Bangladesh		
	Price, growth, other	Vietnam	Malawi Burma		Mongolia Papua New Guinea
	Price, exchange rate, other		Nigeria Yemen		
	Price, other	Solomon Islands			Pakistan Zambia
	Price, growth, exchange rate, other		Gambia Rwanda		

Source: IMF (2015c).
Note. 'Other' refers to one or more of the following objectives: stability in the financial sector, promoting macroeconomic development, maintenance of external reserves and support to general economic policy.
The regime classification is based on responses from IMF country managers.

Is the Swedish neutral interest rate affected by international developments?

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In this study we use a small scale macroeconomic model to estimate a Swedish 'neutral' real interest rate. The word 'neutral' here refers to the interest rate that according to the model is consistent with a closed output gap, which means that one can compare the level of the actual interest rate with that of the neutral interest rate to see whether monetary policy is expansionary or contractionary. In line with other recent international studies, we find that the Swedish neutral real rate has fallen in recent decades and that it is currently negative. Another important conclusion is that the decline in Swedish interest rates over the past couple of decades can be largely explained by the decline in neutral interest rates abroad, where the greatest influence comes from interest rates in the United States.

1 Introduction

Global interest rates are currently very low, while inflation is below target in many countries. However, today's low interest rates can be viewed in the light of a decline in both nominal and real interest rates that has been going on for some decades now. In the United States, the Federal Reserve has recently begun to raise its policy rate, but the interest rate is still unusually low, given the low rate of unemployment. One possible explanation for today's low interest rates is that neutral real interest rates have fallen, a subject which has received considerable international attention in a number of studies (see, for instance, Rachel and Smith, 2015; Williams, 2016; Holston, Laubach and Williams, 2017, and Christensen and Rudebusch, 2017). According to the so-called New Keynesian theory, which is the most common model for monetary policy analysis in the academic literature, the neutral interest rate is usually defined as the interest rate that is neither expansionary nor contractionary when the economy is close to its potential. The concept of a neutral interest rates goes back to the prominent Swedish economist Knut Wicksell (1936), who in his most influential work defined the neutral real interest rate as the interest rate consistent with stable prices and balanced resource utilisation (that is, when production is at its potential level and unemployment is at its equilibrium level). In the popular textbook 'Interest and Prices', Michael Woodford (2003) shows how Wicksell's concept of a neutral real interest rate can be defined and used in modern models. It is therefore not surprising that the former Chair

of the US Federal Reserve, Janet Yellen, has explicitly referred to the low US neutral interest rate as an explanation for the current unusually low interest rates (see, for instance, Yellen, 2015). In Sweden, the Riksbank has in a number of publications referred to the global decline in interest rates to explain the extraordinarily low Swedish interest rates (see, for instance, Sveriges Riksbank, 2017b).

According to the New Keynesian theory, it is thus necessary to have an estimate of the level of the neutral interest rate to be able to determine whether monetary policy is expansionary or contractionary. When the policy rate is above the neutral level, monetary policy is contractionary, and conversely, the policy rate must be below the neutral level for monetary policy to be expansionary (see, for instance, Giammarioli and Valla, 2004, for an overview). If the neutral interest rate has shown a falling trend, it may therefore imply that the repo rate needs to be set lower to attain the same stimulus to the economy. By estimating the neutral interest rate, we can obtain a quantitative measure of how large a part of the decline in Swedish interest rates is due to monetary policy and how large a part is due to structural factors. According to the estimate we present in this article, monetary policy is currently expansionary in Sweden, but a very low policy rate is needed to make this the case. We also analyse the international influence on the Swedish neutral real interest rate. Our results indicate that the Swedish neutral interest rate is strongly influenced by international neutral interest rates, particularly the US one.

The outline of the article is as follows: In section 2 we describe our model, in section 3 we report the estimation results, in section 4 we analyse the international influences and in section 5 we summarise our conclusions. Details regarding the method of estimation and some associated results have been put into an appendix at the end.

2 The neutral interest rate must be estimated using models

In accordance with the New Keynesian theory we mentioned in the previous section, we assume that there exists an interest level that is consistent with a balanced resource utilisation, but that this 'neutral' level for the interest rate can vary over time. The neutral interest rate cannot be observed directly, which means that it can be difficult to know its level at any given point in time. We therefore use statistical methods to estimate it, in a similar way as we would estimate the potential level of GDP to form an opinion of the size of the output gap.

Laubach and Williams' (2003) method has become something of a standard for estimating the neutral interest rate. Their approach is based on a long-term relationship, which can be derived from the consumers' utility function, between the real neutral interest rate (r^*) and potential growth (g) according to

$$(1) \qquad r^* = \tfrac{1}{\sigma} g + \rho,$$

where σ is the intertemporal elasticity of substitution and ρ measures time preference (the subjective discount rate).[1] As neither the neutral interest rate nor the potential growth rate is observable, one has to make certain theoretical assumptions on how they affect inflation, GDP and the nominal policy rate. In this way, the neutral interest rate is linked to the observed economy.

Our model has the same theoretical starting point as Laubach and Williams' model. However, in line with Berger and Kempa (2014), we make two additions to the basic model. Firstly, we add an exchange rate channel to capture the fact that Sweden is a small, open

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1   We disregard population growth here.

economy. Secondly, we use Bayesian methods of estimation, which can facilitate the identification of links between the model's potential, or unobserved, variables (which are estimated) and the variables that are observable (see, for instance, Pedersen, 2015).

2.1 Data

We use quarterly data for seasonally adjusted real GDP, CPIF inflation[2], the repo rate and the exchange rate index KIX[3]. We define the real interest rate as the nominal repo rate minus expected inflation one year ahead. As in Laubach and Williams (2003), we estimate inflation expectations at a given point in time by the forecast for inflation four quarters ahead from a simple regression on past inflation.[4] The estimation period begins in the last quarter of 1995 and extends to the second quarter of 2017. Data is shown in Figure 1, together with the estimated inflation expectations and the real interest rate.

Figure 1. GDP, exchange rate, repo rate, inflation and estimated inflation expectations
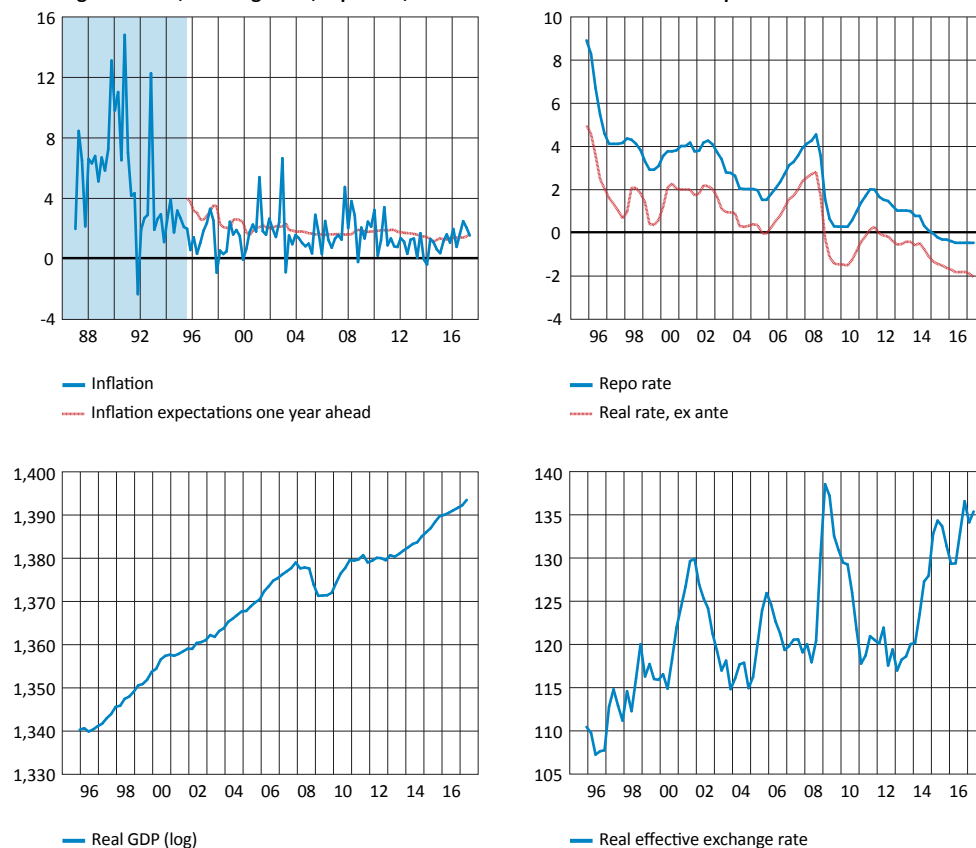
2.2 Model

We assume that real GDP (y_t), the real interest rate (r_t) and the real effective exchange rate (q_t) consist of two components: an equilibrium level (or a *potential* level) that is expressed with an asterisk, and a gap that is expressed with a tilde according to

(2) $y_t = y_t^* + \tilde{y}_t,$

(3) $r_t = r_t^* + \tilde{r}_t,$

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2   The CPIF is the consumer price index with a fixed interest rate, which as of September 2017 is the Riksbank's official target variable, and was also the implicit target variable for some time prior to this (Sveriges Riksbank, 2017a).

3   For descriptions of KIX, see Erlandsson and Markowski (2006) and Alsterlind (2006). We create a real effective exchange rate by deflating KIX with a series which expresses the relative difference between international consumer prices and consumer prices in Sweden, where the international price is a weighted average (using the same weights as is used in constructing KIX) of consumer prices in different countries.

4   The regression is defined according to an AR(3) process with a rolling estimation window of 40 quarters.

(4) $\qquad q_t = q_t^* + \tilde{q}_t,$

where y_t^* is potential GDP (in logarithmic form), r_t^* is the neutral real interest rate and q_t^* is the equilibrium exchange rate. Based on equation (1), we assume that there is a relationship between the neutral real interest rate and potential growth g_t (defined in the model as the first difference of y_t^* plus a disturbance term, see equation (8)), but where deviations from this relationship are allowed. The deviations are modelled with another non-observable and time-varying series z_t. The component z_t could consist of factors that affect the interest rate but are not directly linked to domestic potential growth, such as increased global saving, an increase in global demand for safe assets, structural changes in fiscal policy, etc. (see Armelius et al., 2014, Rachel and Smith, 2015, and Bean et al., 2015, for more detailed discussions). In line with Laubach and Williams (2003), we assume the following relationship between the neutral real interest rate r_t^*, potential growth g_t and the component z_t:

(5) $\qquad r_t^* = c\, g_{t-1} + z_{t-1},$
(6) $\qquad z_t = z_{t-1} + \varepsilon_t^z,$

where c is a parameter and ε_t^z is a disturbance term. The component z_t is thus assumed to follow a process where the change from the previous period is determined by another, independent, random variable. Such a process is usually referred to as a random walk.

As we do not have any strong opinion regarding the equilibrium exchange rate, it is also modelled using a random walk,

(7) $\qquad q_t^* = q_{t-1}^* + \varepsilon_t^q,$

where ε_t^q is a disturbance term. Like Laubach and Williams (2003), we also assume that potential GDP follows a trend, but that there can be random disturbances ($\varepsilon_t^{y^*}$ and ε_t^q) both to the level and growth rate according to

(8) $\qquad y_t^* = y_{t-1}^* + g_{t-1} + \varepsilon_t^{y^*},$
(9) $\qquad g_t = (1 - \varphi_2)\varphi_1 + \varphi_2\, g_{t-1} + \varepsilon_t^g,$

where φ_1 and φ_2 are parameters.[5]

The different gaps in the model are assumed to affect each other dynamically. When the output gap $\tilde{y}_t$ is positive, for instance, it is expected to lead to a stronger exchange rate and a higher interest rate. The interaction between the gaps is estimated by a vector autoregressive model (hereinafter referred to as a VAR),

(10) $\qquad \tilde{x}_t = \Psi\, \tilde{x}_{t-1} + \tilde{\varepsilon}_t,$

where $\tilde{x}_t = (\tilde{y}_t, \tilde{r}_t, \tilde{q}_t)'$ is a time series vector of the gaps, Ψ is a 3×3-matrix of parameters that capture the way the variables are dynamically impacted by the previous period's gap and $\tilde{\varepsilon}_t = (\varepsilon_t^{\tilde{y}}, \varepsilon_t^{\tilde{r}}, \varepsilon_t^{\tilde{q}})'$ is a vector of error terms. The first equation in this system can be regarded as a form of dynamic demand curve, or IS curve,

$\tilde{y}_t = \psi_{11} \tilde{y}_{t-1} + \psi_{12} \tilde{r}_{t-1} + \psi_{13} \tilde{q}_{t-1} + \varepsilon_t^{\tilde{y}},$

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5   This means that log-GDP in level follows a random walk with a stochastic drift g_t, but that the growth rate is stationary. This is also in line with what is usually expected in the euro area (see, for instance, Mésonnier and Renne, 2007). We therefore expect that φ_2 is less than 1 i absolute value, so that g_t is a stationary process with mean φ_1. In Armelius, Solberger and Spånberg (2018) a sensitivity analysis is performed for some different specifications of both g_t and z_t, which lead, for instance, to log-GDP being integrated of second order. The results of the sensitivity analysis suggest that the different specifications are of minor importance in estimating the neutral interest rate.

where the output gap is influenced by the exchange rate gap and the interest rate gap from the previous period.[6] When the policy rate is higher than the neutral interest rate, monetary policy is contractionary, which gradually reduces the output gap. We therefore expect that the output gap will have a negative correlation with lagged values of the interest rate gap. In the same way, a stronger exchange rate should gradually lead to lower exports and thereby also lower output. The neutral interest rate is thus the interest rate that is compatible with a balanced resource utilisation (that is, a closed output gap) where the exchange rate is neither over-valued nor under-valued, in the absence of other shocks.

Finally, we use a Philips curve that describes how inflation and resource utilisation are assumed to be linked,

(11) $\pi_t = \delta_1 + \delta_2 \pi_{t-1} + \delta_3 \Delta q^n_{t-1} + \delta_4 \tilde{y}_t + \varepsilon^\pi_t,$

where π_t is inflation at time t, which apart from being backward-looking (that is, it depends on the previous period's inflation) also depends on changes in the nominal exchange rate (q^n_t) and the output gap.[7] Here, the nominal exchange rate captures changes in international prices and thus the contribution from imports. Equation (11) contains several important details. To begin with, inflation should not have any trend if it is firmly anchored around the Riksbank's inflation target. We therefore expect that δ_2 is greater than 0 but less than 1 so that inflation is stationary around the target, but that it also takes some time to bring inflation back to the target when a deviation has occurred. Furthermore, a depreciation of the exchange rate (that is, $\Delta q^n_t > 0$) means that foreign goods become more expensive, which with some time lag will lead to increased inflation in Sweden. We therefore expect that the sign of δ_3 is positive. As economic activity should covary with inflationary pressures, we finally expect δ_4 to be positive, but not particularly large. Note that the exchange rate affects inflation directly in the Phillips curve (11) in nominal terms, and the GDP gap in the VAR system (10) in real terms as the output gap and the interest rate gap are expressed in real terms. Monetary policy, on the other hand, only affects inflation via the output gap in our model.

3 The results show a low neutral Swedish interest rate at present

We estimate the model which consists of equations (2) to (11) using Bayesian methods (see Appendix A). In Bayesian methodology, the user starts out from his or her own priors on what is to be estimated, and then updates these priors using data.[8] Figure 2 shows the means and 90 percent probability intervals for the estimated time series r^*_t, $\tilde{r}_t$, z_t and g_t (see section 2.2). In the upper left-hand panel of Figure 2 it is clear that the Swedish neutral real interest rate has had a declining trend since the middle of the 1990s and that it is currently very low. There are also no signs that the neutral interest rate would have bottomed out and be on the way up at the end of the estimation period. Thus, even though we only use Swedish data in our estimation, we find that the Swedish neutral real interest rate seems to follow the same pattern as a number of studies have shown for neutral interest rates in other countries (see, for instance, Rachel and Smith, 2015; Laubach and Williams, 2016; and Holston, Laubach and Williams, 2017).

If we study the estimated real interest rate gap in the upper right-hand panel of Figure 2, we see that monetary policy according to the model was clearly contractionary during the

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6   Our modelling of the gaps differs somewhat from those in Laubach and Williams (2003) and Berger and Kempa (2014). They let the gaps interact more restrictively.

7   Here, Δ denotes the difference operator such that $\Delta x_t = x_t - x_{t-1}$, for a time series x_t.

8   The priors are expressed as probability distributions, which are then updated using Bayes theorem, given the data (see, for instance, Gelman et al., 2013).

years prior to the international financial crisis in 2008, and then turned clearly expansionary after the crisis. When the interest rate was then raised in 2010, the interest rate gap became slightly positive once again. We can also see that, according to our estimates, monetary policy has been expansionary in Sweden since 2014. However, it should be noted that the uncertainty surrounding these estimates is fairly large, which is common for this type of model.[9] This was, for example, one of the main conclusions by Laubach and Williams (2003).

In the lower panels of Figure 2 we can see that the component z_t has a clear downward sloping trend, while potential growth g_t is more stable. In total, the neutral interest rate has fallen from 3 per cent at the end of 1995 to −1.8 per cent at the beginning of 2017. By far the largest part of the decline (corresponding to around 4 percentage points) is explained in the model by the component z_t. The trend fall in the neutral interest rate is thus due to a decline in structural factors that are independent of both monetary policy and domestic potential growth (we will return to this in the next section). This indicates that the Riksbank has been right when claiming in its analysis of Swedish interest rates that the trending decline in the real interest rate is caused by structural global factors (see, for instance, Sveriges Riksbank, 2017b).
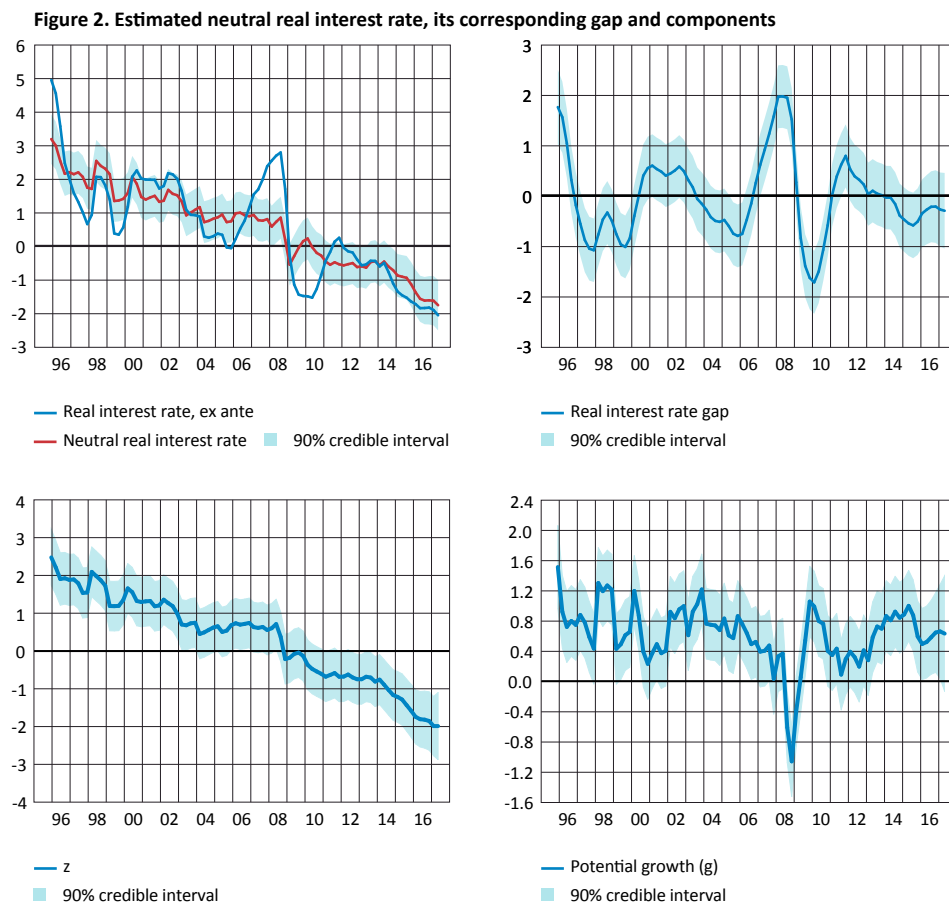
Figure 2. Estimated neutral real interest rate, its corresponding gap and components

— Real interest rate, ex ante
— Neutral real interest rate   ▨ 90% credible interval

— Real interest rate gap
▨ 90% credible interval

— z
▨ 90% credible interval

— Potential growth (g)
▨ 90% credible interval

Figure 3 shows how the estimated output gap $\tilde{y}_t$ and the interest rate gap $\tilde{r}_t$ interact according to the dynamics given by the model.[10] When an output gap opens up, the Riksbank responds by changing the direction of monetary policy. This creates an interest rate gap,

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9   It is worth pointing out that in the academic literature there are those who think that one should be cautious in using inflation as a good signal of the size of the output gap, which is what we do indirectly in our model. Juselius et al. (2016) and Borio (2017) consider, for instance, that financial imbalances can make the macroeconomic relationships more complicated. According to them, output cannot be considered to be balanced as long as financial imbalances are being built up.

10   Unlike Berger and Kempa (2014), we have not set our priors such that the interest rate gap is assumed to have an effect on the output gap (see Table A1 in Appendix A). We do, however, find such an effect in our estimates (see also the impulse response analysis in Armelius, Solberger and Spånberg, 2018).

which in turn will make production gradually return to its potential. For instance, a severely negative output gap was created during the financial crisis in 2008, which was immediately followed by the previously contractionary interest rate gap instead becoming expansionary. In recent years, both the output and the interest rate gaps have been relatively small according to these estimates. Moreover, as changes in the output gap often seem to occur prior to changes in the interest rate gap, our estimates indicate that monetary policy has not been a major driving force in creating output gaps in Sweden, despite keeping this possibility open in the model. Monetary policy appears rather to have reacted after the output gap was opened for other reasons.[11]

Figure 3. Estimated output and interest rate gaps

■ Output gap   ■ Real rate gap
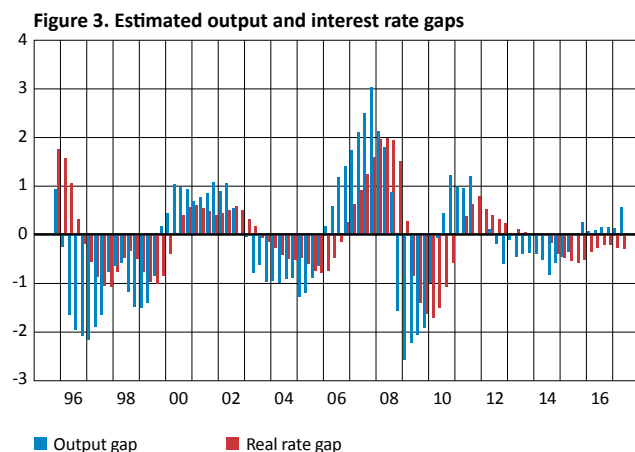
4 International influences are important for Sweden's neutral interest rate

In the previous section, we were able to observe that a large part of the decline in the Swedish neutral real interest rate seems to depend on structural factors that, in our model, are captured by the component z_t. For a small, open economy, it is possible that these factors come from abroad, particularly considering that real interest rates are low in many other advanced economies. Consequently, in this section, we analyse the international influence on the Swedish neutral interest rate. To do this, we use estimated neutral interest rates for the euro area and United States from a new study by Holston, Laubach and Williams (2017).[12] These interest rates are shown in Figure 4, together with our estimate of the Swedish neutral interest rate.

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11 Lindé (2003), for example, shows that shocks from abroad can explain a substantial part of the Swedish business cycle.
12 The estimated neutral interest rates for the United States and euro area can be downloaded from John Williams' personal page on the San Francisco Fed's website: http://www.frbsf.org/economic-research/economists/john-williams. It also includes interest rates for Canada and the United Kingdom, but not for Sweden.

Figure 4. Neutral real interest rates in the United States, euro area and Sweden
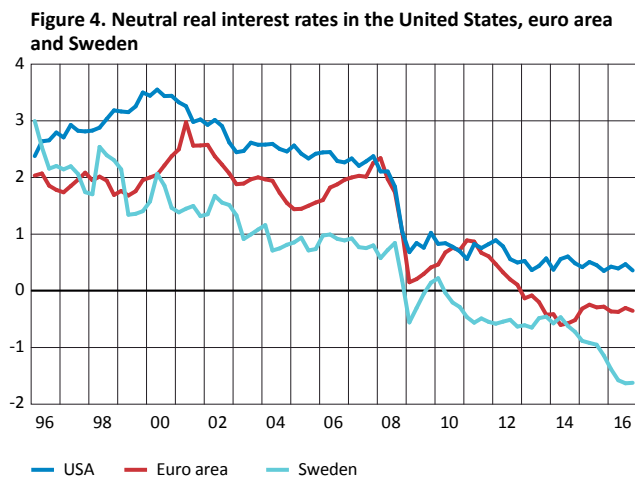
The neutral interest rates show trends throughout the entire period. Therefore, we cannot rely on simple statistical methods such as correlation analysis or principal component analysis to capture any covariation between the interest rates, as those methods assume that the time series are stationary and move around stable mean values. Instead, the natural choice is to use error correction models, which allow the time series to be characterised by trends.[13] In this article, we use a simple approach based on Engle and Granger (1987). The method proceeds from the following time series regression:

$$(12) \qquad r^*_{SE,t} = \beta_0 + \beta_{US} r^*_{US,t} + \beta_{EA} r^*_{EA,t} + \varepsilon^J_t,$$

where β_j are parameters, $r^*_{SE,t}$ is our estimated neutral real interest rate for Sweden, $r^*_{US,t}$ and $r^*_{EA,t}$ are the estimated neutral real interest rates for the United States and euro area respectively and ε^J_t is a disturbance term. Equation (12) can be re-written so that the disturbance term is placed on the left hand side according to

$$(13) \qquad \varepsilon^J_t = r^*_{SE,t} - \beta_0 - \beta_{US} r^*_{US,t} - \beta_{EA} r^*_{EA,t},$$

which describes the deviation from a possible equilibrium standardised on the Swedish neutral interest rate. If the neutral interest rates in equation (12) are each non-stationary but the disturbance term ε^J_t is stationary, then the neutral interest rates are said to be *cointegrated*. This would involve at least one of the interest rates adjusting (making an error correction) to deviations from the equilibrium that arises when $\varepsilon^J_t = 0$. Table 1 shows a test to determine whether the neutral interest rates are cointegrated. We see that, using a unit root test, we cannot reject that the neutral interest rates are separately non-stationary, whereas we can reject that the disturbance term is non-stationary. This suggests that the neutral interest rates are cointegrated.[14]

Table 1. Unit root tests

	$r^*_{SE,t}$	$r^*_{US,t}$	$r^*_{EA,t}$	ε^J_t
P value	0.968	0.959	0.810	0.019

Note. The null hypothesis is that the time series has a unit root, which is to say it is non-stationary.

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13 As the interest rates themselves are estimates, we should interpret further estimation with some caution. However, we expect that the statistical analysis we perform is valid in sufficiently large samples.

14 We use the Dickey-Fuller test, with critical values that are calculated based on the results in MacKinnon (1996).

Using the equation (13), we can now move on and estimate an error correction equation for the Swedish neutral interest rate according to

(14) $\Delta r^*_{SE,t} = \mu + \gamma_{SE}\,\Delta r^*_{SE,t-1} + \gamma_{US}\,\Delta r^*_{US,t-1} + \gamma_{EA}\,\Delta r^*_{EA,t-1} + \alpha\,\varepsilon^J_{t-1} + v_t,$

where $\Delta r^*_{SE,t}$ is the change in the Swedish neutral real interest rate, μ is a constant, γ_j are short-term parameters that relate to changes in the respective neutral interest rates in the previous period, α is an error correction coefficient that determines how a change in the Swedish neutral interest rate depends on deviations from the equilibrium in the previous period (that is, how the interest rate relates to deviations in ε^J_{t-1} from 0) and v_t is a disturbance term.

Error correction models based on equations (12)–(14) thus estimate a long-term equilibrium between the time series and deviations from the long-term equilibrium in a short-term relationship.[15] Using these models, we can measure how great an impact the time series have on the equilibrium, as well as how rapidly a time series reverts to this equilibrium when there is a deviation.[16] If our hypothesis is correct and the Swedish neutral interest rate has fallen due to factors originating abroad, we should be able to find statistical support for a relationship between the Swedish neutral interest rate and foreign neutral interest rates. Examples of such factors could include an increased global propensity to save or decreased demand for investment in the world economy. We test the relationship between the Swedish neutral interest rate and the neutral interest rates in the euro area – where the greatest share of Swedish exports go – and the United States, as the US dollar is an important currency for international financial flows.

The error correction estimation results are shown in Table 2. The upper part of the table shows a statistically significant relationship in the long run between changes in the US neutral interest rate and changes in the Swedish neutral interest rate. In addition, the lower part of the table shows a short-run significant relationship, in which about 40 per cent of changes in the US neutral interest rate spill over onto the Swedish interest rate in the short term (the estimated γ_{US} is 0.393). The Swedish interest rate also compensates for about one-fifth of deviations in level against the international interest rates each quarter (the estimated α is −0.181). Normally then, after just over one year, the Swedish neutral rate has returned to the level implied by the estimated equilibrium.

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15 We only examine the short-term relationship for the Swedish interest rate. A more detailed analysis with short-term relationships also for the international interest rates can be found in Armelius, Solberger and Spånberg (2018), who also consider that there may be more than one equilibrium.

16 The interconnected concepts cointegration and error correction are described in more detail in, for example, Hatanaka (1996). A more accessible description (in Swedish) can be found in Englund, Persson and Teräsvirta (2005).

Table 2. Cointegration analysis of neutral real interest rates

	Parameter	Estimate	Standard error	P value
Cointegrating equation	β_0	−1.127	0.114	0.000
	β_{US}	0.815	0.124	0.000
	β_{EA}	0.158	0.135	0.244
Error correction equation	μ	−0.043	0.048	0.084
	γ_{SE}	0.083	0.109	0.449
	γ_{US}	0.393	0.172	0.025
	γ_{EA}	−0.116	0.142	0.418
	α	−0.181	0.054	0.001

Figure 5 shows the estimated equilibrium from equation (13) together with the estimated Swedish neutral interest rate.[17] We see that the Swedish neutral interest rate since 2015 is slightly lower than what can be explained by the international model. However, the largest part of the decline in the Swedish neutral interest rate is still due to the decline in neutral interest rates internationally.

Figure 5. Estimated Swedish neutral real interest rate against estimated long-term equilibrium driven by the surrounding world

— Estimated neutral real rate in Sweden
— Estimated equilibrium, driven by the surrounding world
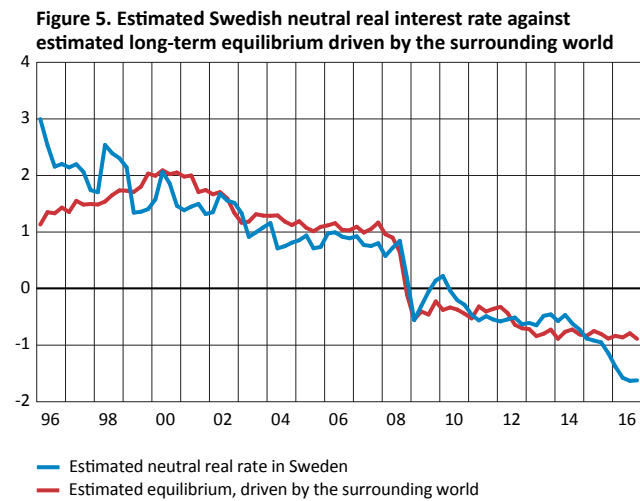
Lastly, and to provide further perspective on how Swedish and international neutral interest rates are connected, we investigate whether there exist Granger causality (Granger, 1969) between the neutral interest rates, that is, whether changes in one of the interest rates precede (and thereby can be used to predict) changes in the other interest rates. For example, we say that the US neutral interest rate *Granger-causes* the Swedish neutral interest rate if at least one of the coefficients $\phi_1, \phi_2, \ldots, \phi_k$ are significantly different from zero in the regression

$$(15) \qquad r^*_{SE,t} = \lambda + \phi_1 r^*_{US,t-1} + \ldots + \phi_k r^*_{US,t-k} + \theta_1 r^*_{EA,t-1} + \ldots + \theta_k r^*_{EA,t-k} + \omega_1 r^*_{SE,t-1} + \ldots + \omega_k r^*_{SE,t-k} + u_t$$

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17 The equation (13) describes deviations in the cointegrated system $r^*_{SE,t} - \beta_0 - \beta_{US} r^*_{US,t} - \beta_{EA} r^*_{EA,t}$ from its equilibrium 0. As the relationship is normalised on the Swedish neutral interest rate, we can express the deviations from equilibrium in terms of deviations in the Swedish neutral interest rate $r^*_{SE,t}$ from the time series $m_t = \beta_0 + \beta_{US} r^*_{US,t} + \beta_{EA} r^*_{EA,t}$. The latter time series is therefore shown together with the Swedish neutral interest rate in Figure 5.

where λ is a constant, θ_1, θ_2, …, θ_k are coefficients for lagged values of the neutral interest rate in the euro area, ω_1, ω_2, …, ω_k are coefficients for lagged values of the Swedish neutral interest rate and u_t is a disturbance term.

To take into account that the interest rates are potentially non-stationary, we use the robust methods of Toda and Yamamoto (1995).[18] Their method implies that for instance the null hypothesis that 'the US neutral interest rate does not Granger-cause the Swedish neutral interest rate', that is, that $\phi_1 = \phi_2 = … = \phi_k = 0$ in equation (15), can be tested with a conventional Chi-square test.

The result of this test is shown on the first row of Table 3. As we can see, the US neutral interest rate has a statistically significant influence on the Swedish neutral interest rate. Table 3 also shows tests of a few other Granger causality hypotheses in which, in certain cases, we have exchanged the left-hand series in equation (15) for one of the international neutral interest rates. None of the other null hypotheses in Table 3 can be rejected, which means that we find no statistical support that the euro area's neutral interest rate Granger-causes the Swedish neutral interest rate, or that the Swedish interest rate Granger-causes either of the other two interest rates. It may seem odd that the influence of the euro area's neutral interest rate is not significant in these tests. However, if we study Figure 4, we can see that it has had large fluctuations that did not directly precede fluctuations in the Swedish neutral interest rate. For example, the euro area's neutral interest rate has had a tendency to rise more in the upturns that started around 2000, 2005 and 2009.

Table 3. Granger causality analysis of neutral real interest rates

Null hypothesis	Chi-square statistic	P value
$r^*_{US,t}$ does not Granger-cause $r^*_{SE,t}$	8.740	0.003
$r^*_{EA,t}$ does not Granger-cause $r^*_{SE,t}$	0.216	0.642
$r^*_{SE,t}$ does not Granger-cause $r^*_{US,t}$	0.221	0.638
$r^*_{SE,t}$ does not Granger-cause $r^*_{EA,t}$	0.013	0.911

All in all, the analysis in this section indicates that the Swedish neutral interest rate is influenced in both the short and long run by fluctuations in international neutral interest rates, in particular that of the US.

5 Conclusions

In this article we have estimated the Swedish neutral real interest rate in a small scale macroeconomic model using Swedish data. Our results indicate that the Swedish neutral interest rate has had a downward sloping trend in recent decades and that it currently is negative. According to our estimates, a very low repo rate is required at present for monetary policy to be expansionary, which it has been since 2014. The greater part of the decline in the neutral interest rate is explained in the model by components that are independent of both monetary policy and domestic potential growth. The Swedish neutral interest rate has thus followed roughly the same pattern as most studies have found for neutral interest rates in other developed economies.

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18 The method involves fitting a VAR model of the interest rates in which an extra lag is used in the estimation, while the Granger causality hypotheses are tested under the ordinary number of lags. By using this method, conventional statistical inference can be performed regardless of whether the series are stationary or non-stationary. We select the number of lags according to the Schwarz information criterion.

We have also investigated whether the decline in the Swedish neutral interest rate can be explained by international relationships. Real interest rates have fallen around the world and, in its communication, the Riksbank usually claims that the decline in the level of Swedish interest rates can be traced to structural factors abroad. We have therefore analysed the international influence by estimating a long-term relationship between our estimated Swedish neutral interest rate and estimated neutral interest rates for the United States and the euro area. Our results indicate that structural factors can explain the greater part of the decline in the level of interest rates in Sweden. We find statistical support for a global influence on the Swedish neutral interest rate in both the long and short run. The Swedish neutral interest rate follows fluctuations in, above all, the US neutral interest rate, while the influence from the euro area is smaller.

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Appendix A

In this appendix, we report prior and posterior distributions of the model's parameters. The equations (2)–(11) in section 2.2 can be written as a state-space model and estimated using the Kalman filter.[19] Our estimation methods, which largely follow Berger and Kempa (2014), are described in detail in Armelius, Solberger and Spånberg (2018). Each disturbance term is assumed to have a variance designated by a sigma, σ_j, in which j takes the associated series notation. For these variance parameters, we use gamma distributions. For the other parameters in the model, we use normal distributions. The prior and posterior distributions are summarised in Table A1.

The prior expected value for the growth coefficient c in equation (5) is set to 4, which approximates a 1-to-1 relationship between the neutral real interest rate and the annual potential growth. In equation (9), the prior expected value for the parameter φ_1 is set to 0.57, which corresponds to an annual equilibrium growth rate of about 2.3 per cent (φ_1 is the mean of the process), and the prior expected value for φ_2 is set to 0.8, in line with a persistent potential growth rate. For all gaps in the VAR system (10), the prior expected values are set to 0.5 for own lags and 0 for remaining lags, so that the gaps are dynamically independent a priori. In the Phillips curve (11), the prior expected value for the slope δ_2 is set to 0.5 and, for the other coefficients, the prior expected values are set so that the 90 per cent intervals cover 0.

The posterior distributions are largely in line with our expectations. For example, the posterior mean values for the coefficients in the Phillips curve (11) have signs that, in advance, may be considered to be reasonable (see section 2.2). The 90 per cent probability intervals are fairly wide. At the same time, the posterior distributions for the disturbance terms' variance parameters are considerably more condensed than their prior distributions, which suggests that data provide valuable information to our model.

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19 See, for example, Durbin and Koopman (2012) for a detailed review of state-space models and underlying methods of estimation such as the Kalman filter.

Table A1. Prior and posterior distributions

Equation	Parameter	Prior distribution		Posterior distribution	
		Expected value	90 per cent interval	Expected value	90 per cent interval
Potential production and growth	σ_{y*}^2	0.50	[0.06, 1.28]	0.146	[0.061, 0.304]
	φ_1	0.57	[0.41, 0.73]	0.569	[0.504, 0.634]
	φ_2	0.80	[0.64, 0.96]	0.687	[0.627, 0.746]
	σ_g^2	0.25	[0.11, 0.43]	0.147	[0.102, 0.241]
Neutral interest rate	c	4.00	[2.34, 5.65]	0.333	[0.231, 0.441]
	σ_z^2	0.25	[0.11, 0.43]	0.063	[0.048, 0.082]
Equilibrium exchange rate	σ_q^2	0.25	[0.11, 0.43]	0.236	[0.160, 0.346]
Output gap	ψ_{11}	0.50	[0.09, 0.91]	1.011	[0.937, 1.086]
	ψ_{12}	0	[−0.41, 0.41]	−0.389	[−0.492, −0.290]
	ψ_{13}	0	[−0.41, 0.41]	0.011	[0.002, 0.020]
	$\sigma_{\tilde{y}}^2$	0.50	[0.06, 1.28]	0.245	[0.167, 0.354]
Interest rate gap	ψ_{21}	0	[−0.41, 0.41]	0.306	[0.243, 0.370]
	ψ_{22}	0.50	[0.09, 0.91]	0.627	[0.557, 0.697]
	ψ_{23}	0	[−0.41, 0.41]	-0.016	[−0.024, −0.009]
	$\sigma_{\tilde{r}}^2$	0.50	[0.06, 1.28]	0.006	[0.001, 0.029]
Exchange rate gap	ψ_{31}	0	[−0.41, 0.41]	−0.114	[−0.290, 0.073]
	ψ_{32}	0	[−0.41, 0.41]	0.257	[0.095, 0.419]
	ψ_{33}	0.50	[0.09, 0.91]	0.916	[0.882, 0.949]
	$\sigma_{\tilde{q}}^2$	1.00	[0.13, 2.57]	5.727	[5.165, 6.350]
Phillips curve	δ_1	1.00	[0.18, 1.82]	1.298	[1.154, 1.444]
	δ_2	0.50	[0.09, 0.91]	0.120	[0.043, 0.193]
	δ_3	0.25	[−0.16, 0.66]	0.050	[0.012, 0.086]
	δ_4	0.25	[−0.16, 0.66]	0.180	[0.094, 0.272]
	σ_π^2	2.00	[0.68, 3.88]	1.419	[1.277, 1.578]

The case for flexible exchange rates after the Great Recession

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The Great Recession has revived interest in the question of the optimal exchange rate regime. This debate is of immense practical importance: we argue that the exchange rate regime may be a key element in explaining the different experiences of the Scandinavian countries in the Great Recession and their recovery experience thereafter. The recent literature has shown that, according to standard monetary models, fixed exchange rates can provide reasonable insulation against severe demand shocks of domestic origin. We show that, according to the same model, shocks that originate abroad, as arguably was the case for the Scandinavian countries in the Great Recession, seem to be best served by a regime of flexible exchange rates. We conclude that the classic case for flexible exchange rates appears to be alive and well.

1 Introduction

Going back at least to Friedman (1953), the classical case for flexible exchange rates rests on two arguments: first, exchange rate movements are an efficient way to adjust international relative prices in response to macroeconomic shocks; second, with flexible exchange rates, policymakers are free to choose and pursue their own inflation target, rather than shadowing the inflation rate abroad. In a world of high capital mobility, a country foregoes these options if, instead, it commits to an exchange-rate peg or joins a monetary union. These arguments have been debated ever since.

Before the Great Recession, there were two main arguments against this case for flexible exchange rates. A first counterargument is that the exchange rate may not help correct international relative prices. Then, perhaps, there is no great social loss in giving up flexibility (see, for example, Devereux and Engel, 2003 and Engel, 2011). A case in point is that of local currency pricing: if export prices are set in the export market's currency to start with, a nominal depreciation will not change international relative prices. Subsequent literature has pointed out, however, that flexible exchange rates may be valuable whether or not the exchange rate aligns international relative prices correctly. Indeed, a flexible rate regime allows a country to maintain monetary autonomy, and with that the ability to stabilize the economy using monetary policy (see for example Corsetti, 2006; Duarte and Obstfeld, 2008 and, more recently, Schmitt-Grohé and Uribe, 2016).[1]

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1   Most importantly, even in the standard workhorse two country, two good monetary model of the open economy, under the optimal stabilization policy, exchange rate volatility may well be higher when export prices are sticky in the foreign currency (hence the exchange rate cannot correct relative prices appropriately), than when prices are sticky in the currency of the producers (Corsetti et al., 2010, pp. 906). These results hold independently of the presence of nontraded goods.

The second counterargument against Friedman's case for flexible exchange rates was practical in nature. Namely, there seemed to be little benefit left from choosing one's own long-run inflation target if all the major central banks had already agreed on roughly what that target should be, and had adopted inflation targeting (or some variant of it) as their monetary framework. If all central banks more or less target inflation in some range around 2 per cent per year, why would 'one's preferred rate' deviate, especially if one no longer had to insulate against foreign inflationary developments? Friedman's case no longer seemed relevant for the industrialized world today.

The Great Recession provided yet another important new argument against flexible exchange rates that is far from theoretical (brought forward by Cook and Devereux, 2016). The argument rests on the role that the exchange rate regime can have in anchoring long-run inflation expectations when central banks find themselves constrained by the zero lower bound (henceforth ZLB) on interest rates. If monetary authorities have a currency target, the argument goes, domestic inflation cannot deviate too much from foreign inflation. Even in response to large adverse domestic shocks, therefore, inflation expectations remain anchored. This prevents damaging deflationary dynamics. Under a floating exchange rate, instead, this external nominal anchor does not exist. Rather, once interest rates fall to the ZLB, falling inflation expectations can exacerbate the recession as they mean that real interest rates remain too high.

This argument against flexible exchange rates suggests that, precisely in a scenario that involves a very deep recession, flexible exchange rates may fail to provide macroeconomic stabilization. The 'straight-jacket' of fixed-exchange rate regimes may not be detrimental after all, given that our (advanced) economies seem to be vulnerable to the ZLB problem.[2]

There is at least one problem with this line of thought, however: it does not seem to align well with the actual experience of many countries during the crisis. To illustrate this, we produce a graph which shows the evolution of output and exchange rates vis-à-vis the euro in four Scandinavian countries during the Great Recession.

One reason for choosing the four Scandinavian countries to illustrate the case is that they have comparable income and cultural and institutional commonalities. Without downplaying relevant country-specific factors that weigh on the divergent response reported in the graph, in our view a crucial difference was made by the exchange rate arrangement. Another reason is that the Great Recession has affected the US and several non-Scandinavian countries in the euro area more directly and much more deeply than the Scandinavian economies, both in the initial phase of the financial crisis and, quite obviously, in the later years, when financial and macroeconomic conditions worsened in the euro area. Hence our four countries have been exposed to a strong and persistent deflationary environment among their closest economic partners.

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2   Admittedly, we ourselves may have played a role in starting this argument, as we had it spelled out (but also critically considered) in our paper on fiscal policy dating from 2010 (and published as Corsetti, Kuester and Müller, 2013).

Figure 1. Output and the exchange rate 2007–2012 in four Scandinavian countries
Real GDP (left) and change of exchange rate (end of quarter price euro, in local currency).
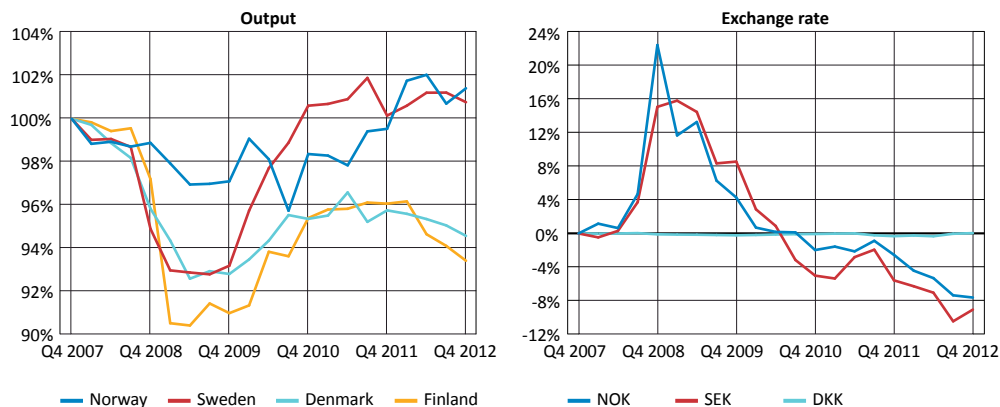
Note. The sample period is 2007Q4–2012Q4. GDP is normalized to 100 per cent in 2007Q4, and the exchange rate is expressed in percentage changes relative to 2007Q4. A positive value in the right-hand chart means a depreciation relative to 2007Q4.
Sources: OECD Economic Outlook 98 and Bundesbank

Out of the four countries in the graph, two have given up exchange rate flexibility vis-à-vis the euro: Finland is a member of the euro area; Denmark operates an independent currency, but maintains a narrow peg to the euro. The other two, Sweden and Norway, pursue inflation targeting and have flexible exchange rates.

The left panel of the figure shows a sizeable output contraction for Finland and Denmark, the countries with a fixed exchange rate to the euro, and for Sweden – but not for Norway. The contraction in Finland and Denmark is persistent. Sweden, instead, recovers fast. This is noteworthy. The fact that the recession was less persistent in countries with flexible exchange rates suggests that the monetary regime may be an important factor.

Indeed, the right panel shows that the Norwegian Krone depreciated sharply against the euro during the first year of the crisis – something you may expect in a country that does not face a constraint on its monetary policy and enjoys room to maneuver regarding policy rates. Crucially, however, flexible exchange rates also made a difference in Sweden. The Swedish Krona depreciated by almost as much as the Norwegian currency. This is all the more remarkable since Sweden in 2009–2010 was characterized precisely by the circumstances that have made some of the recent literature after Cook and Devereux (2016) lean towards *fixed* exchange rates. Namely, in Sweden, policy rates were at what was then considered the effective lower bound. Despite the limited room for a monetary easing, the Swedish Krona depreciated.[3]

With all the necessary caveats, the evidence in the graph provides support for Friedman's classic dictum in favour of flexible exchange rates. The benefits of flexible exchange rates do not necessarily seem to wither in a Great Recession scenario.[4] What proves important for explaining this, is that the Great Recession did not originate in Scandinavia.

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3   Some readers may wonder if our explanation captures the Sweden experience in its entirety. In particular, the Swedish depreciation may in part have been driven by the fact that some Swedish banks had large exposures in a few Baltic countries. This would make the evidence more consistent with our model, for the model would have argued that, from the global shock alone, the Swedish Krona should have depreciated somewhat less than the Norwegian Krone. An important piece of evidence for the mechanism in our model is the rapid recovery of Sweden after the Great Recession.
4   In addition to the issues discussed in this text, recent literature has reassessed exchange rate regimes in relation to the potentially destabilizing effects of large capital flows (see, for example, Obstfeld, Ostry and Qureshi, 2017) and/or currency wars (see, for example, Caballero, Farhi and Gourinchas, 2015). In both cases, the issues pertain more to the desirability of capital controls, macro pru and international policy cooperation than to the desirability of flexible versus fixed exchange rate regimes.

2 Friedman 1953 in a global Great Recession

In a recent paper (Corsetti, Kuester and Müller, 2017a), we provide the theory. We start from the same models and many of the same premises that have been brought to bear against flexible exchange rates. What we unveil, crucially, is the importance of where the recessionary shock originates and/or where it is stronger: in the domestic economy or abroad. The new case against flexible exchange rates (as put forward by Cook and Devereux, 2016) relies on the domestic economy being hit by a shock that is stronger at home than abroad. The main lesson from our work, instead, is that, from the vantage points of small open economies, flexible exchange rates retain important welfare benefits if the risk is a *rest-of-the-world* rather than a local recessionary shock. While the arguments are not exactly the same as the ones put forward by Friedman, the reasons clearly resonate with his view of the merits of flexible exchange rates as a cushion against foreign price drift.

To be as clear as possible, we are not questioning the validity of the results stressed in the existing literature – these and our results are all nested in the same framework. Rather, we change the way we interpret the crisis. Namely, we look at a Great Recession as a global shock that propagates asymmetrically across small open economies, rather than a shock that affects all economies symmetrically. We show new results, taking seriously the fact that the vast majority of countries in the world are exposed to large contractionary impulses from *abroad* – a risk clearly illustrated by the global crisis, and arguably still quite high today.

To develop our analysis, we rely on the most standard New-Open-Macroeconomics model – specified in such a way that we can derive tractable analytical expressions and thus inspect the transmission mechanism in a transparent fashion. We solve the model under three monetary regimes: an unconstrained float, where monetary policy can always pursue a conventional Taylor-type rule targeting the natural rate of interest (the 'Norway' case above); a float where monetary policy pursues a Taylor rule but is unable to adjust interest rates for an extended period (the 'Sweden' case); and a credible and permanent exchange-rate peg (the case of 'Denmark and Finland'). In other words, we contrast an unconstrained monetary regime to two constrained regimes. One is constrained by a currency peg, the other faces the ZLB.

The question we want to call attention to is: which exchange rate regime can ensure better macroeconomic and welfare performance vis-à-vis severe shocks? That is, vis-à-vis the possibility of a strong contractionary shock hitting the domestic economy more severely than abroad (as examined by the literature), and vis-à-vis a Great Recession that originates abroad and propagates so strongly as to send both global and domestic monetary policy to the ZLB constraint. We are interested in understanding which regime provides better 'insulation', and which regime could be best complemented by other stabilization policy, especially fiscal policy.

We find that the nature of macroeconomic risk associated with country-specific and global recessions differs. Therefore, large recessionary demand shocks that originate at home or abroad have fundamentally different policy implications.

Flexible exchange rates do provide a great deal of insulation to the domestic economy if the source of the recessionary shock is abroad. If foreign interest rates become constrained by their ZLB, foreign monetary policy cannot effectively cushion an adverse foreign demand shock. In this case, we show that flexible exchange rates are superior to fixed exchange rates, even if domestic monetary policy becomes itself constrained by the ZLB. Note that this lines up well with the figures shown above.

To appreciate the reason, it is useful to recall in detail how shocks propagate across borders. With a large persistent demand shock in the foreign economy, and if the foreign central bank cannot fully cushion the shock, foreign demand falls and the foreign price level falls as well. The demand effect of the shock, by assumption, is asymmetric – it is stronger abroad. If it can, the home central bank will stabilize domestic inflation and make sure that

the foreign shock only partially transmits to home activity. The home central bank does so by reducing nominal rates far enough so that the currency depreciates. Indeed, it makes sure that the currency depreciates sufficiently so that the home price of home-produced goods denoted in foreign currency falls by more than foreign prices (the home terms of trade depreciate). This supports demand for domestic goods and the domestic price level. Depreciation of the nominal exchange rate will continue for as long as the foreign deflationary crawl (the fall in the foreign price level) continues.

A key novel finding from our work is that some of this stabilizing effect of flexible exchange rates materializes even if the domestic central bank cannot reduce the nominal rate by as much as it would like, that is, if it reaches the ZLB. A flexible exchange rate still works to partially insulate the domestic economy from an adverse foreign demand shock.

Why? In the long run, purchasing power parity constrains the dynamic of the real exchange rate: because foreign prices decline more strongly than domestic prices in response to the shock originating abroad, either domestic prices have to continue to fall in the future (which the domestic central bank will not allow), or the nominal exchange rate has to depreciate at some point. Because the nominal interest rate is at the ZLB both in the home and the foreign economy, there cannot be an interest rate differential to sustain expectations of a depreciation over time (according to the uncovered interest parity condition).[5] A weaker future exchange rate is consistent with financial market equilibrium (absence of arbitrage) today only if the currency immediately depreciates by the full amount. When the shock hits, then, an immediate depreciation improves price competitiveness (the home terms of trade unambiguously depreciate). This stabilizes demand at home, albeit not quite as much as absent the ZLB constraint on domestic monetary policy.[6]

Thus, even if the domestic interest rate cannot be reduced due to the ZLB, the nominal exchange rate ensures that the home monetary stance is relatively more expansionary, per effect of the exchange rate on the trade in goods. Although interest rates are at the ZLB in home as well as in foreign, the home country experiences lower deflationary pressure.

The key take away point is that the home currency depreciates upfront even if the home authorities are unable to guarantee monetary stimulus via a sufficiently deep cut in policy rates[7] – the recent experience of Sweden arguably being the leading example.

Here, thus, is our reformulation of 'the classical case for floating rates in the XXI century:' on the one hand, upfront depreciation stabilizes demand, both external and domestic, for domestically produced goods;[8] on the other hand, it decouples domestic prices somewhat from any deflationary crawl, a crawl which may haunt the rest of the world in a global recession. In other words: the currency depreciation cushions the shock. As in Friedman's case for flexible exchange rates, the home country has the ability (if not, strictly speaking, the choice) to maintain its inflation closer to its target, in contrast to the rest of the world that is mired in a low-inflation recession.

Vis-à-vis such a world-wide recession, indeed, a currency peg performs quite poorly. Not only would a country give up the benefits of stabilizing current demand in such a regime, keeping the domestic economy fully exposed to the drop in international demand. But also, more importantly, a credible peg would anchor domestic prices to the foreign price level: if the rest of the world suffers a deflationary drift (as a consequence of being in a Great

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5   Recent work has shown that, during the global crisis, the uncovered interest parity (UIP) puzzle changes sign. Namely, the coefficient in the Fama regression, forecasting depreciation using the interest rate differential, turns from negative to positive, and is quite large in absolute value. Heuristically, at the ZLB, the UIP condition is violated in a different direction: positive interest differentials forecast excessive depreciation (Bussière et al., 2018).

6   The macroeconomic outlook is considerably worse if monetary policy is at the ZLB. Bodenstein et al. (2017) in particular show how the ZLB problem exacerbates the depth and persistence of adverse foreign shocks.

7   This is not the case if monetary policy abroad is not at the ZLB – that is, if the global recessionary shock can be effectively stabilized, so that there is no 'Great Recession.' In this case, if the Home economy happens to hit the ZLB, the home exchange rate appreciates.

8   This is indeed quite close to the point stressed by Friedman (1953), although his analysis ignores the ZLB and does not relate the exchange rate to the monetary stance at home relative to the one abroad.

Recession style liquidity trap), the domestic economy would be bound to import the drift. Much worse: with the nominal exchange rate fixed, the adjustment of the terms of trade depends on the relative adjustment of the price levels at home and in foreign economy only. Foreign prices decline more (since that is where the shock hits directly) than prices in home. With the nominal exchange rate fixed, the home terms of trade *appreciate*, making domestically produced goods relatively more expensive and further dampening demand for these. Fixed exchange rates also mean that even the (small) domestic economy will see the domestic price level eventually fall as much as foreign prices have fallen.

At the ZLB, expectations of low future inflation cause the real interest rate to rise endogenously at home, above the foreign level, depressing Home consumption demand further still. This compounds the negative effects of falling external demand. Last but not least, price adjustment takes time. This means that the recessionary effects linger: a country that pegs its currency gives up the benefits of stabilizing future demand as well (compare the rapid recovery of Sweden in the graphs to Denmark and Finland).

The importance of these results cannot be over-emphasized. A decade after the outburst of the global financial crisis, the world economy remains vulnerable to the risk that large global shocks once again will cause a new Great Recession. This is a challenge to policymaking in small open economies, which by their very openness are particularly vulnerable to external developments. In light of our findings, in such a world, the case for flexible exchange rates remains alive and well: per se, the risk of temporary liquidity traps that rule out efficient monetary stabilization is not a good enough reason to overturn Friedman's received wisdom.[9]

3 Exchange rates and the fiscal and monetary policy mix

In our analysis, the key lessons from the Great Recession reinforce, rather than undermine, the case for floating rates. We should add here that our results apply to those small open economies that can count on stable and efficient monetary and fiscal institutions (for example, institutions that prevent sovereign risk crises).

To frame our discussion of fiscal policy, however, it is important to consider the 'other' case in our analysis, whereby the contractionary shock has a domestic nature, that is, it hits asymmetrically the home economy without directly affecting the rest of the world. For this case, our results are in line with the literature (Cook and Devereux, 2016). If the shock does not originate in the rest of the world, but in the small open economy, inflation-averse foreign monetary authorities can keep world prices stable. The main difference with our previous analysis is, precisely, the missing response of world prices. With a large *rest-of-the-world* demand shock, prices in the rest of the world fall. In response to a *domestic* shock in a small economy, instead, rest-of-the-world prices do not move.

In this context, a peg, if credible, can provide a commitment to reflate the domestic economy toward a *stable* world price level. And a credible and *stable* nominal anchor is beneficial in a small open economy. In a liquidity trap of domestic origin, fixed exchange rates or, even better, an explicit and credible exchange rate target, may help – a point that resonates with Svensson's call for a fool-proof commitment to exchange rate depreciation (Svensson, 2003). The common message is that, absent either a currency peg or a credible commitment to depreciation (which can be seen as a crawling peg), domestic interest rates would be at the ZLB, economic activity would decline, and domestic prices would start to fall.

However, it is also fair to observe that, precisely in situations in which the ZLB problem would emerge amid flexible exchange rates in the domestic economy only (say, because of the large domestic demand shocks just discussed), there could also be a 'benign coincidence:'

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9   For a related discussion in the context of secular stagnation, see Corsetti et al. (2017).

provided that public debt is sustainable, fiscal policy can be expected to become a rather effective tool of stabilization. A strong inflationary impact of fiscal policy magnifies the size of the multiplier at the ZLB. In fact, it can be shown to exceed unity if the fiscal stimulus is well timed, namely if higher government spending comes online precisely while the ZLB binds (for example, Woodford, 2011 or Farhi and Werning, 2016). Importantly, this is so independently of the (domestic or external) origin of the shock. And indeed, in a recent empirical contribution based on long time series for the US, Ramey and Zubairy (2017) find that fiscal multipliers tend to be larger if interest rates are low. Similarly, Miyamoto, Nguyen and Sergeyev (2017) provide evidence from Japan that multipliers are indeed larger at the ZLB.

Conversely, as established in earlier work of ours (Corsetti, Kuester and Müller, 2013), fiscal policy tends to be less effective under a peg because, by anchoring long-run expectations of the price level to constant world prices, an exchange rate target limits the inflationary impact of public spending. This result can be seen as one more reason to hold that the ZLB problem does not necessarily weaken the case for flexible exchange rates in small open economies. However, details matter: Erceg and Lindé (2012) show that the fiscal multiplier at the ZLB may be smaller than one and also smaller than the multiplier under the peg if prices adjust slowly (and the fiscal stimulus is not well timed).

A stable fiscal framework, to be strengthened in good times in view of future downturn risk, is a clear prerequisite for good stabilization policies. The recourse to fiscal policy may nonetheless be limited by economic or institutional constraints. Here the literature has argued that even the emergence of sovereign and country risk in a downturn – complicating stabilization policy and, obviously, detrimental to social welfare – does not appear to undermine the benefits of floating rates relative to a currency peg (see Krugman, 2014, and previous work of ours – Corsetti, Kuester and Müller, 2016).

4   A lesson for Sweden and other relatively small open economies

To bring our analysis to bear on possible lessons that the Great Recession may have taught us concerning currency regimes, it is tempting to make qualified references to three classics.

Mundell (1961) has forcefully argued that the optimal exchange rate arrangement depends on how synchronized a country's business cycle is with those of its trading partners. What the modern literature adds to this is the emphasis that not only the type of shock that hits the domestic or foreign economy matters, but also the size and sign of the shock. With large enough contractionary shocks in part of the monetary union, the ZLB scenario considered in the current text may arise in the union as a whole, independently of the exchange rate regime. Costs and benefits of a currency area need to be re-discussed in light of this possibility.

Poole's (1970) classic paper has argued that the choice of instruments for stabilization depends on the source and transmission of shocks. As in Poole, also in our analysis the choice between a float or a peg vis-à-vis the risk of a ZLB is to be assessed in light of the implications of the exchange-rate regime on the type and propagation of large contractionary shocks. The analysis highlights that a credible exchange rate target can enhance the policymaker's ability to pursue macroeconomic stability when the risk of such large contractionary shocks is mostly of domestic origin. The main benefit of this regime consists of providing a nominal anchor. This prevents vicious feedback effects between insufficient demand and expectations of deflation. A floating rate is, instead, more efficient when there is a risk of large recessions in the rest of the world: even if the domestic policy interest rates fall to their ZLB like the rates abroad, in relative terms, the domestic monetary stance is expansionary: the currency depreciates in real terms and deflationary pressures abate. Exactly the opposite would occur if one adopts a currency peg.

Friedman (1953), the third classic reference, argued that domestic monetary autonomy insulates a country against foreign price level drift. Our paper emphasizes that the case for a flexible exchange rate applies to both directions of foreign price level drift: flexible exchange rates allow a country to steer clear of foreign inflation and foreign deflationary tendencies (a case relevant for the Great Depression and the Great Recession). Both directions remain relevant today.

In this paper, we have argued that, in a global recession, flexible exchange rates remain the best option for most countries to insulate their economy from the global slump, even if their own monetary policy becomes constrained by the zero lower bound. The experience of Sweden in the Great Recession bears this out, where the Swedish Krona depreciated in the Great Recession, providing insulation against falling foreign price levels.

Our argument is, however, not the only one standing in favour of exchange rate flexibility. Indeed, at the opposite end of the case for flexible exchange rates in the Great Recession, one can point to the experience of Switzerland. The Swiss franc *appreciated* vis-à-vis the euro, reflecting the fact that Switzerland's status as a financial 'safe haven' has led its currency to command a premium. The Swiss authorities have long resisted this appreciation, up to setting record negative rates, in part for the sake of cost-competitiveness of Swiss industries, in part to prevent an upward trending currency to feed further capital inflows. While `safe haven' considerations are arguably beyond the goals and scope of our model, the economic logic is simple. Any shock that translates into a stronger currency premium adds to pressure for appreciation, which can be resisted only by lowering policy rates further. Once rates are already negative, this is technically challenging. Most importantly, it becomes questionable in view of its implications for domestic stabilization.[10]

All things considered, past the global crisis and along the recovery from the Great Recession, the case for flexible exchange rates appears to be alive and well.

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10 With international interest rates being at the ZLB, financial market equilibrium would have required the Swiss Franc to depreciate in expectation over time (so as to remove the premium in returns). A nominal depreciation in the future only would have been commensurate with eventual domestic inflation. Instead, there was an appreciation on the spot (allowing the possibility of the currency depreciating from that higher level in the future without creating domestic inflationary pressures). Indeed, this case becomes particularly strong with the onset of the various asset purchase programs in the euro area. Their purpose was to create inflationary pressures in the euro area (so as to bring inflation closer to target in a currency area that saw weak activity). Switzerland, however, did not suffer a fiscal crisis, or particularly low activity.

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Financial frictions, financial regulation and their impact on the macroeconomy

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In the aftermath of the global financial crisis, increasing attention has been paid to the role played by financial factors in business cycle fluctuations. The crisis also led to the development of economic policies, beyond traditional microprudential regulation, that promote financial stability. Macroprudential policy is one such tool. It fosters a more resilient financial system by directly tackling systemic risk, that is the risk of a breakdown of the entire financial system with significant economic costs. Yet macroprudential policy is still in its 'infancy'. In this article, we first emphasize the importance of financial markets for our understanding of the real economy and how they have traditionally been incorporated in macroeconomic models. Then we discuss the rationale for macroprudential regulation and present a cost-benefit framework to evaluate the merits of different macroprudential instruments; the benefits include a more resilient financial system and stable economy, and the costs involve forgone lending and lower economic activity. We conclude by summarizing some of the remaining challenges in the field.

1 Introduction

> '*I have a simple explanation [for the first Modigliani-Miller proposition]. It's after the ball game, and the pizza man comes up to Yogi Berra and he says, "Yogi, how do you want me to cut this pizza, into quarters?" Yogi says, "No, cut it into eight pieces, I'm feeling hungry tonight." Now when I tell that story the usual reaction is, "And you mean to say that they gave you a [Nobel] prize for that?"*'
>
> Merton Miller

The macroeconomic discipline has come under strong criticism after the global financial crisis of 2007–2008, mostly due to the negligence of financial factors in mainstream macroeconomic models.[1] The majority of models used by policymakers and central banks around the world before the crisis did not explicitly allow for well-articulated financial markets: they often assumed complete and efficient capital markets where firms' ownership and capital structures are irrelevant, and so are financial institutions.[2]

This is the case, for example, in the widely used New Keynesian workhorse DSGE[3] model by Smets and Wouters (2007). In this stylized model, households (and firms) have full access

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1   See the special issue of the Oxford Review Economic Policy 'Rebuilding Macroeconomic Theory".
2   Under complete markets, there exists a market with a price for every asset for all possible states of the world. Agents can buy, either directly or indirectly, any asset, that is there exist contracts to insure against all possible eventualities (see Gulko, 2008). Markets are furthermore efficient if prices fully reflect all available information (Fama, 1970).
3   Dynamic Stochastic General Equilibrium – a class of macroeconomic models widely used in central banking, but also in academia to assess the effects of different policies.

to financial markets and are perfectly insured against, for example, the risk of losing their jobs. It follows that financial institutions are redundant and a central bank's main role is to adjust the price of credit (see Vines and Willis, 2018). In reality, financial markets are far from this idealized world and these market imperfections, that is financial frictions, are also important for aggregate fluctuations. As a matter of fact, the disconnect between the financial and real sides of the economy is at odds with the data. As documented in Jermann and Quadrini (2012), financial flows were highly cyclical even during the tranquil time of the Great Moderation.[4]

The empirical relevance of macro-financial linkages is not a new discovery.[5] Economic classics, such as Keynes, Wicksell or Minsky were aware of the crucial role of credit in the economy. However, subsequent macroeconomic researchers shifted their focus away from the importance of financial markets for economic developments. In the 1960s, the revolutionary 'irrelevance propositions' of Modigliani and Miller (M&M henceforth) identified the necessary conditions through which financial factors would prove to be irrelevant from a theoretical perspective. In a nutshell, in a somewhat idealized world with perfectly functioning markets and absent corporate taxes, agency problems,[6] information frictions and bankruptcy costs, M&M state that a company's capital structure is irrelevant for its market value. As a result, debt and equity are only two different ways of slicing the same pizza, that is a firm's value. Kashyap and Zingales (2010) argue that the theorem, conceived to show an extreme benchmark, has over the years been (mis)used as a proof of the unimportance of corporate finance for our understanding of the real economy.

In the 1990s, some early macroeconomic studies (Bernanke and Gertler, 1989, and Kiyotaki and Moore, 1997 and Carlstrom and Fuerst, 1997) highlighted the importance of deviations from the M&M assumptions and explicitly incorporated financial factors into general equilibrium models. But together with other studies focusing on bubbles, panics and contagion, they belonged more to the periphery of the profession rather than to its core. For a very long time, financial intermediaries were treated as 'a veil' (Gertler and Kiyotaki, 2010) in mainstream macroeconomic models;[7] the increased economic stability in the prolonged period of the Great Moderation partly gave support to the notion that changes in financial conditions did not matter for macroeconomic outcomes.

The recent crisis became a wake-up call for the profession and it provided two main lessons.

First, financial intermediation is crucial for understanding business cycle dynamics. While in normal times the financial sector helps firms and households to smooth income fluctuations, it may lead to their amplification (Brunnermeier, Eisenbach and Sannikov, 2012) in crisis times. Some economists (see for example Jordà, Schularick and Taylor, 2013) argue that financial-crisis recessions are more costly than normal recessions in terms of lost output. The importance of financial factors and institutions for our understanding of the economy is further enhanced by the recognition that they could also have an impact on economic growth (see Levine, 2005).

Second, in a world where financial institutions are highly interconnected, microprudential measures should be accompanied by macroprudential ones; only the latter can explicitly take into account the systemic role of some financial actors and the resulting feedbacks between real and financial sectors in the economy. Microprudential policies (for example capital adequacy rules in the Basel accords) have been adopted by financial regulators for decades and

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4   The Great Moderation denotes a time period, starting from the mid-1980s and interrupted by the Global Financial Crisis (2007–2008), characterized by low macroeconomic volatility experienced in many developed economies.
5   Macro-financial linkages are linkages between financial conditions and macroeconomic developments. See Appendix I of Claessens and Kose (2017) for the summary of the history of research on macro-financial linkages.
6   An agency problem describes those situations in which one party (the agent) acts on behalf on another (the principal), for example when a manager acts on behalf of shareholders. In such situations, conflicts of interests could arise if the incentives between the agent and the principal are not aligned.
7   For discussions of this, see Caballero (2010), Gertler and Kiyotaki (2010), Quadrini (2011) and Fernández-Villaverde (2012).

focus mainly on the risks of individual financial institutions. As such, they might be insufficient for maintaining financial stability. In contrast, macroprudential policy attempts to foster stronger resilience of the financial system (including, for example, banks, firms and households) and reduce systemic risk, that is the risk of a breakdown of the entire financial system triggering severe damage to the economy.[8] The explicit goals of such policies are to reduce the pro-cyclicality of credit flows and address the problem of 'too big to fail' institutions (that is banks systemically important due to their size and level of interconnectedness).[9] As a result, different macroprudential measures have both time series and cross-sectional components, that is they may affect the cyclical aspects of systemic risk and its development over time, and they may affect the distribution of risk among different market participants at a given point in time. Dynamic macroeconomic models operating in a representative agent framework – where all individuals are assumed to be identical, are well-suited for the assessment of general equilibrium effects of different policies and addressing the time dimension of systemic risk. As shown in this review, recent research has also made progress in tackling the cross-sectional dimension of systemic risk by explicitly taking into account the heterogeneity of financial actors in the economy (see Corbae and D'Erasmo, 2014 and Boissay and Collard, 2016, discussed in this review).

Many micro- and macroprudential policies aim at lowering leverage, either of the banking system or that of private borrowers. While it is very hard to establish what the appropriate level of leverage should be, it cannot be disputed that some of the existing regulations (for example limited liability and deposit insurance for banks, interest tax deductions for corporations and households) encourage borrowing and introduce a wedge between private and social costs of debt, a so-called externality.[10] A too highly leveraged economy may lead to debt overhang problems.[11] In difficult times, highly leveraged agents tend to deleverage quickly, and this likely has a significant negative impact on consumption and output. As emphasized by Turner (2016), once leverage is high, it is difficult to reduce it without adverse economic effects. During the global financial crisis of 2007–2008, many existing debt contracts were actually not repaid, but shifted around the system, from the private sector to the public sector, both in the US and in Europe. Pre-emptive actions aiming at curbing the build-up of excessive leverage are therefore crucial.

In reality, policy makers face an important trade-off between the costs of systemic risk which materialize only in crisis times, and the level of economic activity in tranquil times, which is likely to be lower under stricter regulation. The 'Greenspan doctrine' was the consensus view before the global financial crisis: preemptive financial regulation was perceived as too costly and too blunt a tool (see Jeanne and Korinek, 2017) and the appropriate policy intervention was believed to be 'ex-post', that is at the time of the crisis. The crisis significantly changed our views on this trade-off but also further stressed the need to assess the costs of financial regulations ahead of the introduction of a given measure. This can only be done if the underlying market failure – the specific source of deviation from the ideal efficient market benchmark that needs to be corrected – is well identified. Thus, the design of an appropriate policy toolkit should ideally:

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8   Although there is no consensus yet on this issue, our definition of systemic risk is in line with the one of the European Central Bank: 'Systemic risk can best be described as the risk that the provision of necessary financial products and services by the financial system will be impaired to a point where economic growth and welfare may be materially affected' (ECB, 2018). See also Braconier and Palmqvist (2017) on this issue.

9   A detailed description of micro- and macroprudential policies is provided in Freixas, Laeven and Peydró (2015).

10 In economics, an externality denotes a situation where the actions of one party impact on another party and such interaction is not taken into account by agents nor reflected in market prices. Passive smoking and the related health costs are a textbook example of negative externality. Individual excessive indebtedness and its impact on (socially) expensive financial crises are another one. As such, an externality constitutes a market failure, that is a deviation from the ideal market.

11 See Myers (1977) and Lamont (1995) for the discussion of corporate debt overhang and Mian and Sufi (2014) and Melzer (2017) for household debt overhang.

i.   Identify the source of market failure to address,

ii. Rely on an adequate cost and benefit analysis,

iii. Assess the effectiveness of different tools.

Macro models with well-articulated financial sectors are well suited to conduct policy experiments by taking into account all the above in general equilibrium set-ups.

In what follows, we first review the most recent attempts in the literature to incorporate financial frictions, that is deviations from the idealized M&M world with perfectly functioning capital markets, in otherwise standard theoretical macro models. Then we evaluate through the lens of various models both the costs, that is forgone lending and economic activity, and the benefits, that is a more resilient financial system and stable economy, of different macroprudential tools.[12]

2 Modelling financial frictions

In the models reviewed in this article, financial markets deviate from the idealized M&M world for various reasons. Sometimes it is assumed that only some assets can be traded in capital markets. In other set-ups, some sort of agency problem usually limits access to credit markets. This can happen because lenders and borrowers are asymmetrically informed (informational frictions) or if lenders cannot force borrowers to fulfil their contractual agreements (enforcement problems, see Quadrini, 2011).

An important distinction in the existing literature is whether risk is exogenous, that is not influenced by economic agents' decisions, or endogenous. Systemic risk falls into the second category and it is one of the primary reasons for regulating financial institutions. In a nutshell, under-capitalization of the financial system leads to risks not being internalized by financial market participants, which can severely amplify the subsequent economic downturn or even cause a recession. Understanding the underlying source of market failure is crucial when designing an efficient instrument or combination of tools to address it.[13] De Nicolò, Favara and Ratnovski (2012) classify these externalities into three main categories:[14]

i.   *Strategic complementarities – interactions* between banks inducing them to take excessive risk (Farhi and Tirole, 2011), that is banks might find it optimal to correlate their portfolios with each other's because they anticipate that in a crisis event they will be bailed-out by the government;

ii. *Pecuniary externalities*, that is over-indebtedness among households, corporations or banks might induce fire sales during a downturn. The resulting negative impact of falling prices on their balance sheets can amplify the slump (Lorenzoni, 2008 and Bianchi, 2011); these effects on prices are not privately internalized, thereby inducing agents to take on too much debt.

iii. Externalities related to *interconnectedness*, that is one distressed bank could jeopardize the stability of other financial institutions (Allen and Gale, 2000).

Recently, Farhi and Werning (2016) put forth a different source of externality, a demand externality, which provides a justification for macroprudential policies in environments where output is demand-driven. Financial decisions of economic agents influence the wealth distribution in the economy, which, through different marginal propensities to consume among agents, affects the aggregate demand in the presence of nominal rigidities.

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12 Although monetary policy could also impact on financial stability, in this article we leave a discussion of the interactions between monetary and macroprudential policies out. See International Monetary Fund [IMF] (2005) on this issue.

13 In reality, over-indebtedness or excessive risk taking can also be the result of behavioral factors. Although, there is a vast literature explicitly taking into account those factors, in this article we focus on studies which do not consider deviations from rationality.

14 Although De Nicolò, Favara and Ratnovski (2012) mainly focus on externalities affecting financial institutions, here we broaden their definitions also to other financial markets participants, for example borrowing households and firms.

Households usually do not take into account the impact of their financial decisions on the wealth distribution and aggregate capacity of the economy. Macroprudential policies that internalize this impact could potentially improve the welfare of the economy. As an illustration, one could imagine a sudden credit crunch in a world with borrowers and savers where monetary policy is constrained by the zero lower bound. By restricting borrowing before the crisis, a regulator could improve the spending capacity of borrowers during the crash, thereby stabilizing the economy. These stabilization benefits are not taken into account by private agents, thus justifying the regulatory intervention.

For the ease of exposition, in what follows we distinguish whether the financial friction impairs the supply or demand of credit.

2.1 Credit-demand frictions

Early attempts in the literature to incorporate deviations from the M&M irrelevance proposition into macro models focus on the demand side of credit. In those studies, macro financial linkages arise because firms and/or households are financially constrained, that is capital markets are not perfectly functioning. Specifically, limited access to credit markets creates a link between firms' and households' balance sheet conditions and the real economy. Such a link can act both as an amplification tool and as a source of business cycle fluctuations, as further explained below. In this respect, studying financial frictions helps to address two of the central issues in macroeconomics: *i)* understanding how even moderate changes in economic fundamentals can have large macroeconomic consequences *ii)* explaining the origins of business cycles.

Financial frictions can amplify the impact of economic disturbances via their impact on households' and firms' balance sheets. This is the case in the seminal work of Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1999). In the first paper, lenders cannot force borrowers to repay their debt unless it is collateralized. Hence, in their work, capital is both a factor of production and it has collateral value, and both aspects are reflected in its price. In a bust, due for example to disruptions originating in the production sector of the economy, so-called supply shocks, movements in the price of capital further impair borrowers' collateral capacity, thereby aggravating the effects of the initial shock. Therefore, the interaction between credit limits and asset prices amplifies and spreads the effects of the initial negative shock to other sectors. In Bernanke, Gertler and Gilchrist (1999), there are information asymmetries between borrowers and lenders and monitoring is costly. This agency problem creates an interest rate spread between internal and external funding proportional to borrowers' net worth. In a downturn, the market value of firms' net worth deteriorates. As a result, agency costs increase countercyclically, thereby further reducing firms' borrowing ability. This last channel triggers a contraction in investments and a further deepening of the crisis. This is the so-called 'financial accelerator'. Iacoviello (2005) builds on Kiyotaki and Moore (1997) in a model where housing has a dual role as a consumption good as well as a collateralizable asset. In that framework, housing price dips can considerably depress aggregate demand.

Furthermore, financial frictions can also be a source of business cycles rather than a mere amplification tool, as shown in Jermann and Quadrini (2012). Also in their set-up, firms could default on their debts and this limits their ability to borrow. Moreover, debt is preferred to equity because interest rate expenditures are tax deductible. Crucially, it is further assumed that firms cannot easily change their capital structure, that is the composition of debt and equity. As a result, a sudden deterioration of firms' financing conditions, a so-called negative financial shock, will force them to cut employment and depress aggregate demand. According to the estimates in Christiano Motto and Rostagno (2003), a 'liquidity shock' induced households to accumulate currency at the expenses of deposits during the Great Depression. In their set-up, financial factors are important for the real economy because a financial accelerator à la Bernanke, Gertler and Gilchrist (1999) is at work.

2.2 Credit supply frictions

More recently, banks have been explicitly incorporated into macro models in order to explore the impact of credit supply imperfections on financial intermediation and the real side on the economy. In this strand of literature, *financial intermediaries'* balance sheet conditions matter for business cycles fluctuations.

In reality, banks fulfil multiple functions. They contribute to the efficiency of the payment system, channel funds between savers and investors, provide liquidity (demand deposits) and engage in maturity transformation, loan monitoring and risk management (see Friexas, Laeven and Peydró, 2015). In the existing theoretical literature, financial intermediaries can provide one or more of the above mentioned services. However, the well-functioning of the financial system can be disrupted by the excessive risk-taking (of bankers) or by poor financial regulations.

In Gertler and Karadi (2011), banks channel funds from savers to investors and are involved in maturity transformation, that is they hold long-term assets financed by short-term deposits. A *moral hazard* [15] problem in the funding markets creates a spread between lending and deposit rates. Specifically, as bankers can choose to divert available funds, their liabilities are constrained by their equity capital. As a result, movements in financial intermediaries' balance sheets will spread to the rest of the economy and amplify business cycles. A similar transmission mechanism is at work in Gertler and Kiyotaki (2010), where different financial intermediaries interact in the interbank market and are subject to shocks that can lead to bank-runs. In both models, the demand side of credit works in a frictionless manner, that is firms' borrowing is not restrained by collateral constraints.

Moral hazard problems could be multi-layered. They can, for example, arise between depositors and banks, but also between entrepreneurs and financial intermediaries. Meh and Moran (2010) build on the double moral hazard framework of Holmstrom and Tirole (1997). In their set-up, banks can more efficiently channel resources between investors and entrepreneurs by monitoring the quality of different investment projects. At the same time, to induce banks to properly monitor and not invest in a too risky loan portfolio, investors require banks to invest their own capital, that is to have some skin in the game. It follows that bank capital positions influence the business cycle though a bank channel transmission mechanism, that is the effects of supply-side disturbances are amplified and propagate to the real side of the economy.

Borrowers' and financial intermediaries' balance sheet conditions interact with each other. In Iacoviello (2015) and Mendicino et al. (2016), both the demand and supply side of credit are impaired. In Iacoviello (2015), household and entrepreneurs' borrowing is collateralized by real estate, as in Iacoviello (2005). Banks intermediate funds between savers and borrowers and are subject to a capital adequacy constraint, that is their ability to raise funds in the deposit market is constrained by the amount of equity capital. In Mendicino et al. (2016), the banking side features two key distortions. First, banks operate under limited liability and deposits are partially insured by the government. Second, uninsured bank debt is priced according to the expected economy-wide bank failure risk, thereby creating an incentive for banks to relax their lending standards. On the demand side of credit, both households and entrepreneurs can default on their credit and the cost of external funding is tied to their balance sheet conditions, as in Bernanke, Gertler and Gilchrist (1999).

Finally, the degree of competition in the banking sector can also play a role for macroeconomic stability. In Gerali et al. (2010), banks issue collateralized loans to both households and firms, obtain funding via deposits, and accumulate capital out of retained earnings. Financial intermediaries operate in a market with imperfect competition and can adjust rates only infrequently. This market set-up creates interest spreads which depend on

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15 Moral hazard describes those situations in which a contract creates a conflict of interests between the parties involved. For example, an insurance contract could prompt the insured to take on more risk because she is protected.

the banks' capital-to-assets ratio and the degree of interest rate 'stickiness'. Households', firms' and banks' balance sheet conditions matter for how disturbances propagate in the economy. Similarly, Andres and Arce (2012), develop a framework where investors' credit capacity is tied to the value of their real estate holdings. Lending margins are optimally set by banks in a market with imperfect competition and have a significant effect on aggregate variables. Their findings show that in the long run, stronger banking competition increases output by reallocating the available collateral towards investors. At the same time, competition increases the short-run response of output, credit and housing prices to disturbances.

3   Macroprudential tools: a costs and benefits analysis

This section evaluates the economic impact of several macroprudential measures through the lens of different theoretical macroeconomic models.[16] Following the structure of section 2, we start by discussing macroprudential measures that mostly affect credit demand, although some of these measures have implications for credit supply, too. We then end this section by discussing bank capital regulation that directly affects credit supply.

Many of the reviewed papers address the problem of excessive household indebtedness that, along with low capital ratios of banks, increases the overall leverage of the system.[17] As explained in the previous sections, too high leverage can considerably increase macroeconomic volatility, thereby motivating the need for regulations. Table 1 summarizes the main quantitative findings of the discussed papers. Some papers mentioned in this section provide mainly qualitative insights and as such, they are not considered in Table 1.

Table 1. Quantitative findings of discussed papers.

Paper	Findings
LTV regulation	
Gelain, Lansing and Mendicino (2013)	Lowering LTV from 0.7 to 0.5 lowers house price volatility by 4 percent and lowers household debt volatility by 27 percent under rational expectations. Under adaptive expectations, it lowers house price volatility by 2 percent and household debt volatility by 18 percent. The volatility of consumption, output or inflation is not affected.
Rubio and Carrasco-Gallego (2014)	Increasing a static LTV ratio up to 0.55 is welfare enhancing for borrowers and savers. Above LTV of 0.55, increasing LTV further decreases the welfare of borrowers and increases the welfare of savers, leading to an overall decrease in welfare. A countercyclical LTV ratio reacting to credit growth increases the total welfare.
Mendicino and Punzi (2014)	Coupled with an interest rate rule reacting to credit growth, a countercyclical LTV rule reacting to house prices almost doubles welfare, decreasing the volatility in the economy.
Chen and Columba (2016)	Lowering LTV from 85 to 80 percent leads to a short-run reduction in consumption and output. In the long-run, debt-to-income goes down by 10 percent, output by 0.5 percent and house prices by 0.2 percent. Stricter LTV rules improve welfare, but only marginally so below the 60% limit.
Finocchiaro, Jonsson, Nilsson and Strid (2016)	A reduction of the loan-to-income ratio by 10 percent in equilibrium requires lowering LTV from 75 to 69.5 percent (by 7.22 percent). On aggregate, housing and goods consumption do not change. GDP goes down by 0.4 percent.
Alpanda and Zubairy (2017)	Stricter LTV regulation is an effective tool (second-best) in reducing the household debt-to-GDP ratio at the expense of lower output and aggregate consumption in the short run. Higher levels of LTV induce more volatility and are welfare-detrimental for patient households, while they are preferred by impatient households. The optimal regulatory LTV ratio is at around 0.66.

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16 See Guibourg and Lagerwall (2015) for a more general discussion of how macroprudential measures affect the economy.
17 See Emanuelsson, Melander and Molin (2015) for a discussion of risks linked to elevated household indebtedness and Sveriges Riksbank (2015) for a discussion of possible measures to manage financial risks in the household sector.

Grodecka (2017)	When borrowers are constrained by the LTV constraint only, lowering LTV by 5 percent from 85 percent reduces equilibrium debt to GDP by 8 percent, house prices by 2 percent and output by −0.2 percent. In the short run, the effects are stronger. Taking into account a realistic distribution of borrowers across different constraints in Sweden, where 60 percent of borrowers are constrained by LTV, lowering LTV lowers equilibrium debt to GDP by 3.09 percent, house prices by 3.17 percent and increases output by 0.09 percent in the long run.
LTI/DSTI regulation	
Gelain, Lansing and Mendicino (2013)	If lenders use an additive borrowing constraint, putting 75 percent of weight on labor income and 25 percent weight on the housing collateral value, the volatility of house prices increases by 3 percent and the volatility of household debt goes down by 44 percent under rational expectations, while it reduces the volatility of house prices by 5 percent and of household debt by 49 percent in the model with hybrid expectations. The volatility of consumption and output remain unchanged.
Finocchiaro, Jonsson, Nilsson and Strid (2016)	A reduction of the loan-to-income ratio by 10 percent in equilibrium requires lowering LTI from 251 to 226 percent (by 25 percentage points). The aggregate consumption goes down by 0.1 percent and GDP by 0.4.
Grodecka (2017)	When borrowers are constrained by the DSTI constraint only, lowering DSTI from 25 percent by 5 percent reduces equilibrium debt to GDP by 7 percent and output by −0.4 percent, without a negative effect on house prices. In the short run, negative output and house price effects are reduced compared to a similar LTV experiment. Taking into account a realistic distribution of borrowers across different constraints in Sweden, lowering DSTI lowers equilibrium debt to GDP by 3.09 percent, house prices by 0.21 percent and output by 0.07 percent in the long run.
Amortization regulation	
Chambers, Garriga and Schlagenhauf (2009b)	Mortgage products with flexible amortization schemes can increase homeownership up to 6 p.p., mostly among young and poor people. Their availability also increases average house size and residential investment.
Forlati and Lambertini (2012)	In a model with two-period mortgage loans, low early amortization leads to higher leverage, output and housing prices in equilibrium. The dynamic responses to shocks are amplified in that case.
Chen and Columba (2016)	Increasing the amortization pace from 50 to 45 years lowers output in the short and in the long run. Long-run output is lowered by 0.4 percent, house prices by 0.5 percent and debt-to-income ratio by around 10 percent. Welfare impact of stricter amortization regulation is non-linear.
Finocchiaro, Jonsson, Nilsson and Strid (2016)	A reduction of the loan-to-income ratio by 10 percent in equilibrium requires accelerating the amortization from 50 years to 44.9 years. The aggregate consumption does not change and GDP goes down by 0.3.
Svensson (2016)	In a model in which unconstrained borrowers follow their optimal future mortgage path, imposing a 2 percent amortization requirement over a 10 year horizon leads to an increase in initial and average debt from 7.6 to 20 percent, depending on the interest rate spread between the savings and mortgage rate and the refinancing possibilities of borrowers.
Hull (2017)	Stricter amortization rules have little impact on reducing debt-to-income ratios because optimizing households refinance to remain on their preferred optimization path.
Grodecka (2017)	Taking into account a realistic distribution of borrowers across different constraints in Sweden, increasing the amortization pace by 5 percent lowers debt to GDP by 4.2 percent, output by 0.09 percent and increases house prices by 0.13 percent. In the short run, house prices may fall under stricter amortization rules.
Tax deductibility of mortgage interest rates	
Gervais (2002)	Abolishing interest rate tax deductions or introducing taxation of imputed rents for home owners is welfare enhancing for all income quintiles. The abolition of tax deductibility of mortgage interest payments leads to a home ownership rate that is 4.2 percentage points lower, lower income taxes (by 2.2 percent under the assumption of constant government revenues) and almost unchanged output. If imputed rents were taxed at the same level as business capital income, the home ownership rate would be lower by 4.2 percentage points, housing capital would decline by 8.56 percent and business capital would rise by 6.64 percent. Income tax rate decreases by 14 percent.

Chambers, Garriga and Schlagenhauf (2009a)	Abolishing interest rate tax deductibility increases the home ownership rate by 0.7 p.p., leads to a reduction in income taxes (under a constant government revenue) and increases welfare by 1 percent. When imputed rents from owning are equalized with taxes on income from rental units, resources are redistributed from housing to business capital. Average and marginal tax rates are reduced, increasing the income and homeownership rate (by 3 p.p.). Welfare increases by 3.3–3.7 percent.
Cho and Francis (2011)	Removing mortgage interest deductibility decreases home ownership by 0.07 p.p. and increases welfare by 0.16 percent. Applying the income tax rate to usually untaxed imputed rents, leads to a fall in home ownership by 34.73 p.p. and welfare increases of almost 10 percent. Tax incentives have little impact on wealth inequality.
Floetotto, Kirker and Stroebel (2016)	Abolishing interest rate tax deductions lowers house prices by up to 3 percent in the short run and by 1 percent in the long run. Home ownership rate drops by 14.76 p.p. (from 72.27 percent), and 17.8 percent of agents are worse off in the new steady state. Taxing imputed rents leads to a drop in home ownership rate by 32.29 percentage points, a short-run decrease in housing prices by 11 percent and a 4 percent decrease in the long run. 52.4 percent of agents are worse-off in the new steady state. Transition welfare costs are higher than steady state welfare costs.
Chen and Columba (2016)	Lowering tax deductibility of mortgage rates decreases welfare. Lowering tax deductibility from 30 to 35 percent decreases the debt-to-income ratio in the long run by 2.2 percent. If additional government revenue is redistributed to households, the policy change can have no effect on output.
Finocchiaro, Jonsson, Nilsson and Strid (2016)	All the experiments refer to a policy change lowering debt-to-income by 10 percent. If government transfers the additional revenue to borrowers and savers in proportion of their salary, tax deductibility has to be lowered from 30 percent to 2.8 percent, leading to an increase of goods consumption by 0.2 percent and a GDP lower by 0.3 percent. If the government transfers additional revenues only to borrowers, tax relief has to be lowered to −6 percent. Aggregate consumption goes down by 0.1 percent and GDP by 0.6 percent. The additional revenue can be used to boost public consumption. In that case, the government has to lower the tax deductibility to 6.2 percent. Aggregate consumption goes down but GDP increases by 0.3 percent.
Alpanda and Zubairy (2016)	A reduction of interest rate deductibility from 100 to 70 percent lowers the steady state output by 0.22 percent and borrowers' welfare by 0.59 percent, while savers gain 0.22 percent of welfare and renters 0.33 percent. Introducing a tax on imputed rent of 7.7 percent leads to a fall in the steady state of output by 0.26 percent, welfare losses for savers (−0.17 percent) and borrowers (−0.3 percent) and welfare gains for renters (+0.33 percent).
Alpanda and Zubairy (2017)	Abolishing tax deductibility of mortgage interest rates is welfare enhancing. Lowering the tax deductibility of mortgage rates is the most effective measure in terms of the reduction of household indebtedness per unit of lost output.
Sommer and Sullivan (2017)	Eliminating interest rate deductibility increases homeownership from 65 to 70 percent and lowers house prices by 4.2 percent. Mortgage debt goes down by 31 percent. Welfare is higher by 0.757 percent. In the transition to the new steady state, 58.4 percent of agents are better-off without mortgage tax deductions.
Capital regulation	
Gertler, Kiyotak and Queralto (2012)	Introducing a subsidy (0.0061) per unit of outside equity financed with a tax on total assets, which together has a flavor of countercyclical capital requirement for outside equity, leads to increase in welfare by 0.285 percent.
Angeloni and Faia (2013)	Regulatory capital ratios lower bank risk, defined as bank run probability. Mildly countercyclical capital ratios dampen the business cycle.
Corbae and D'Erasmo (2014)	Increasing the risk-weighted capital requirement from 4 to 6 percent leads to an increase in interest rates by 50 basis points, and 9 percent decline in lending and intermediated output. Deposit insurance decreases by 59 percent due to a decrease in bank exits.

Covas and Driscoll (2014)	Introducing a liquidity requirement lowers equilibrium loan supply by 3 percent, while increasing bank holdings of safe securities by 6 percent. Output declines by 0.3 percent and consumption by 0.1. When risk-based capital requirements are increased from 6 to 12 percent, bank securities holdings increase by 9 percent. Loan supply decreases by 1 percent, output and consumption by 0.1 percent.
Clerc et al. (2015)	There is an optimal risk-based capital ratio: 10.5 percent for business loans and 5.25 percent for mortgages. High bank leverage amplifies the business cycles. The effect of countercyclical capital ratios is ambiguous: may amplify or dampen the business cycle, depending on the level of capital ratio.
Chen and Columba (2016)	Increasing risk weights on households' mortgages from 25% to 30% lowers household debt in the short run by 0.5 percent and aggregate consumption by 0.05. In the long-run, the debt level is almost unchanged. In the steady state, the DTI ratio increases by 0.5 percent, aggregate consumption falls by 2 percent and output by 2.4 percent. Increasing risk weights on mortgages is welfare improving, with diminishing marginal effect above a risk weight of 40 percent.
Begenau (2016)	There is an optimal risk-based capital ratio: 14 percent for U.S. calibration. Higher risk ratios may lead to more, not less lending, due to households' demand for liquid banks' assets and its impact on bank funding costs. Lower bank leverage reduces output volatility.
Begenau and Landvoigt (2017)	There is an optimal capital ratio: 15%. Increase in capital requirements leads to a rise in the shadow banking. The aggregate banking system becomes safer under higher values of capital ratios.
Boissay and Collard (2016)	The need for regulation arises due to an agency problem on the market of interbank loans. Introducing capital and liquidity requirements is welfare enhancing. The optimal policy mix for U.S. calibration entails a leverage ratio of 17.35%, a liquidity ratio of 12.5% and a risk-weighted capital requirement of 19.83%.
Davydiuk (2017)	Optimal Ramsey policy requires a cyclical capital ratio, mostly in the range of 4 to 6 percent. It can raise above 6 percent in periods of abnormal economic growth.

3.1 Loan-to-value regulation

Loan-to-value (LTV) regulation is a very popular macroprudential tool, widely applied in advanced and emerging economies (see Akinci and Olmstead-Rumsey, 2018). The majority of theoretical macroeconomic studies evaluating the effectiveness of loan-to-value regulation focus on the time-dimension of systemic risk and operate in an environment with limited heterogeneity. In this class of models, agents are usually classified in two representative groups: borrowers or savers, and, as such, the cross-sectional aspects of borrowing limits are often left out from the analysis. Moreover, the existing studies mostly concentrate on LTV regulation in the context of mortgage borrowing. From a microprudential perspective, LTV constraints typically stem from moral hazard problems between borrowers and lenders and are designed to secure the lenders' payoff in the case of the borrowers' default. At the same time, an LTV constraint links debt to asset prices and creates collateral externalities thereby impacting on systemic risk, something that can be addressed by macroprudential interventions.

LTV regulation can address externalities arising both on the supply side and on the demand side of credit. From the perspective of lenders, LTV limits impose quantity restrictions on their asset allocation. This mitigates externalities connected to *strategic interactions* that could induce banks to reduce their lending standards and take large risk exposures. From the perspective of borrowers, LTV constraints address two main externalities: a *demand externality* and *pecuniary externalities*. Households taking on debt do not take into account how their behavior impacts wealth distribution in the economy, the development of housing prices, general debt level, and more broadly, output. Once

a negative shock hits the economy, foreclosures tend to lead to further house price falls, generating negative feedback loops (see Frame, 2010).

Aside from the collateral function, LTV regulation can be seen as protection of homeowners financing their houses with mortgages, given that it ensures a minimum equity stake in the home. This stake acts as a cushion against negative home equity. As Mian and Sufi (2014) explain, homeowners have a junior claim on home and take the first losses when house prices start to decline, which erodes their equity. Moreover, a house price collapse may lead to debt overhang of homeowners who start to reduce their consumption to maintain the debt service, which creates a big negative demand effect on the economy since their marginal propensity to consume is usually higher than for the rest of the population. As such, imposing LTV requirements, aside from securing lenders' payoff in the case of borrowers' default, protects borrowers as well, and, correcting for the demand externality, has far-reaching macroeconomic implications, beyond the distribution of losses between the lenders and borrowers. High LTV, meaning low borrowers' equity in the house, may also lower borrowers' incentives to honor their debt obligations, that is it may increase the probability of default when house prices start to fall, which will in turn negatively affect banks. Thus by lowering the leverage of the economy, LTV limits stabilize business fluctuations. However, too strict LTV requirements may be also negative for the output[18] or even welfare-detrimental, as discussed in this section.

Most of the existing theoretical literature tackling this issue builds on Iacoviello (2005). Since stricter LTV limits reduce borrowers' leverage, a common finding in this strand of literature is that stricter LTV regulation is effective in reducing macroeconomic volatility (Gelain, Lansing and Mendicino, 2013; Rubio and Carrasco-Gallego, 2014 and Mendicino and Punzi, 2014) and household indebtedness (Chen and Columba, 2016, Finocchiaro et al., 2016, Alpanda and Zubairy, 2017 and Grodecka, 2017). These benefits come at the cost of lower output, aggregate consumption and, in some cases, borrowers' welfare (see Table 1 for the estimates).

LTV requirements can be explicitly designed to address the procyclicality of credit flows issue. Rubio and Carrasco-Gallego (2014) examine welfare implications of different static LTV levels, along with the effects of introducing a macroprudential Taylor-type rule that reacts to credit growth. They find that a countercyclical LTV rule that responds to changes in credit is welfare-enhancing. In a similar setup, Mendicino and Punzi (2014) study welfare implications of countercyclical LTV rules in a two-country model where monetary policy may respond to household indebtedness or house prices. The LTV policy maximizing social welfare depends on the assumed behavior of monetary policymakers. Largest welfare gains compared to static policies are obtained when LTV reacts countercyclically to house prices, while interest rate reacts to credit growth.

3.2 Loan-to-income/Debt-service-to-income regulation

Loan-to-income (LTI) and debt-service-to-income (DSTI) regulations impose a limit on borrowing or debt service in relation to disposable income, thereby directly targeting risky borrowers who might also raise macropudential concerns in the presence of *pecuniary* and *demand externalities*.[19] On the side of the lender, similarly to LTV regulation, these limits address the *strategic interaction externality*, preventing lenders from lowering their credit standards. Notably, DSTI limits, by directly linking interest rate expenses to debt, enhance the transmission mechanism from interest rates into credit growth, house prices and aggregate demand. LTI and DSTI limits can coexist and they complement both LTV caps and capital

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18 Here and in what follows, we refer to 'output costs' in terms of GDP levels; the papers reviewed in this article are silent on the potential effects of different policies on growth rates.

19 See Alfelt, Lagerwall and Ölcer (2015) for the analysis of LTI as a policy measure, with the focus on Sweden.

adequacy requirements. Some of the reviewed papers specifically address the interactions between different regulations (see Greenwald, 2016 and Grodecka, 2017).

Lowering LTI and DSTI limits reduces household indebtedness (Finocchiaro, et al. 2016, Grodecka, 2017) and lowers the volatility of house prices and credit in the economy (Gelain, Lansing and Mendicino, 2013). This may however come at the cost of lower GDP.

While the literature considering LTV requirements for borrowing households is fairly extensive, theoretical models incorporating LTI or DSTI constraints are much rarer, despite their important role in the lending process in many countries (see Akinci and Olmstead-Rumsey, 2018). Some of the macroeconomic papers consider constraints applied to borrowers in separate models, without studying their coexistence and interaction. An example is Finocchiaro et al. (2016) who study the effects of macroprudential policies separately in a model where borrowers are subject to LTI constraints and in a model where borrowers are subject to LTV constraints. They find that stricter LTI limits are effective in lowering debt to GDP at the cost of lower output and consumption.

More research is needed on the interaction of different borrowing constraints that are applied to borrowers by lenders.[20] An early example of considering LTV and LTI limits in one general equilibrium model is the paper by Gelain, Lansing and Mendicino (2013) who study the impact of borrowing constraints on the volatility observed in the economy.[21] In one of their experiments, they augment their typical LTV borrowing constraint with a loan-to-income part, concluding that such a rule is effective in decreasing the volatility of debt in the economy. Two recent papers more explicitly account for the coexistence of different borrowing constraints (Greenwald, 2016, Grodecka, 2017), augmenting a typical Iacoviello (2005) style collateral constraint with a payment-to-income/debt-service-to-income constraint.[22] They conclude that the effectiveness of loan-to-value regulation as a macroprudential tool in such a framework is lowered, because not all borrowers in the economy are always bound by this constraint. DSTI limits seem to have a bigger impact on the economy in this setup.

3.3 Amortization regulation

Amortization rules specify the repayment of debt principal in the case of a long-term debt contract. As such, they directly affect the speed of deleveraging. The amortization pace impacts the evolution of the loan-to-value of a given contract, and hence, it can handle situations where households overborrow in the presence of, for example, *pecuniary* or *demand externalities* or behavioral factors. Amortization regulation can also introduce limitations for lending, influencing banks' assets and their composition, correcting therefore for externalities arising due to *strategic interactions*.

Traditional mortgage amortization schemes require a gradual repayment of the principle over time and these annuity mortgages are the most common form of amortization arrangements worldwide (for an international comparison of mortgage terms see the report by Lea, 2010). However, some countries allow for more flexible schemes under which amortization payments vary over time and may be frontloaded or backloaded. In the U.S., before the crisis of 2007–2008, some loan contracts even allowed negative amortization; in such contracts, the monthly debt service did not cover interest payments, causing the

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20 Models in the overlapping-generations framework often take into account a coexistence of two borrowing limits. However, their interaction is rarely a focus of the analysis. Moreover, some of them operate in a partial equilibrium context, excluding the analysis of general equilibrium effects.

21 The additive borrowing constraint in Gelain, Lansing and Mendicino (2013), putting 75 percent of weight on labour income and 25 percent weight on the housing collateral value, turns out to have no impact on the volatility of consumption or output. The decrease in the volatility of household debt is driven by the fact that including the income in the borrowing constraint induces countercyclicality of the loan-to-value ratio and stabilizes the debt.

22 While Greenwald (2016) focuses on a constraint-switching effect due to which borrowers switch between being bound by a DSTI or LTV constraint, Grodecka (2017) studies the interaction of two constraints in a model with occasionally binding constraints, including situations when borrowers are constrained by both LTV and DSTI regulation at the same time, or by neither of them.

principal to increase. In Sweden, but also for example Denmark, U.K. or Australia, interest-only mortgage contracts have also been/are popular, in which, for a certain period, only the interest on loans is paid. These amortization schemes, in practice, backload the principal payment, which means that borrowers' home equity is not increasing over time. This may reduce the incentives of the borrower to honor his debt obligation, as discussed in the LTV section. Chambers, Garriga and Schlagenhauf (2009b) show that flexible amortization schemes enable better matching of the life-cycle profiles of borrowers, potentially increasing the pool of borrowers and thus homeownership, mostly among young and poor people.[23]

While LTV rules mostly apply at the origination of the loan, traditional amortization schemes ensure that, over the duration of the loan contract, the LTV of existing homeowners goes down. Thus, similarly to stricter LTV or LTI ratios, stricter amortization rules reduce the leverage of the system and, accordingly, business cycle fluctuations (Forlati and Lambertini, 2012; Chen and Columba, 2016, Finocchiaro et al., 2016 and Grodecka, 2017). At the same time, they may not coincide with some borrowers' optimal repayment path, which can induce the borrowers to try to circumvent the forced amortization (Svensson, 2016 and Hull, 2017).[24] The cost of stricter amortization rules may also include lower output (Chen and Columba, 2016; Finocchiaro et al., 2016 and Grodecka, 2017). Besides their influence on the average LTV in the economy, amortization rules also have a direct impact on the bindingness of DSTI constraints, as stricter amortization rules increase the periodical debt service, which may be to a disadvantage for certain types of households.

3.4 Housing-related tax policy measures

Housing-related tax policy measures usually aim at promoting homeownership. However, as a by-product, through the preferential tax treatment of home owners, they also incentivize household leverage and hence interact with other macroprudential tools that aim at addressing overborrowing. Among all the measures considered in this article, the conclusions of research on tax-related measures are the most disparate. Existing studies usually focus on the impact of these policies on home ownership rates and welfare. In what follows, we focus on the research that tackles the issue of mortgage interest rate tax deductibility and the taxation of imputed rents. In most countries, there is no tax deduction on mortgage interest payments and imputed rents are not taxed (see OECD, 2017 and Andrews, Caldera and Johansson, 2011). However, mortgage interest tax deductions are relatively more popular than taxing imputed rents and some countries allow for the full deduction of interest payments from taxable income.

How would the abolition of interest rate deductibility impact on home ownership and welfare? According to Gervais (2002), Cho and Francis (2011) and Floetotto, Kirker and Stroebel (2016), operating in an overlapping generations framework (OLG),[25] such a policy would reduce the homeownership rate, but increase welfare in the economy. Tax deductions lower the revenue of the government which could be spent on lowering for example labor taxes in the economy. Thus, it is not obvious which effects the abolition of tax deductions would have. Infinite horizon models mostly focus on the cost side of stricter tax policies: Chen and Columba (2016) and Finocchiaro et al. (2016) show that the steady state impact of abolishing interest rate deductions depends on how the government decides to spend the additional tax revenue. Chen and Columba (2016) conclude that lowering mortgage interest

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23   However, this flexibility does not have obvious implications for the volatility of borrowers' consumption, whose effect depends on the level of inflation in economy.

24   Svensson (2016) shows that unconstrained households can react to an amortization requirement by increasing, not decreasing their debt: they will initially borrow more than planned, invest the superfluous amount in a savings account and use the withdrawals from this account to satisfy the regulation. On a related note, Hull (2017) shows that introducing stricter amortization requirements in a setup where borrowers have access to consumer loans lowers the aggregate debt-to-income ratio only slightly. This is due to the fact that, even if an amortization path is suggested by the regulation, people can still refinance and use the obtained funds to nullify previous periods' amortization in order to follow their optimal amortization path.

25   In overlapping generation models, agents in different phases of their life, that is young and old, interact with each other.

rate tax deductibility reduces welfare, Alpanda and Zubairy (2016) and Alpanda and Zubairy (2017) confirm this conclusion, but only for the borrowers in the economy. Another set of studies, finds opposite effects of house-related tax incentives on the home ownership rate in OLG set-ups. Chambers (2009a) find that eliminating the interest rate tax deduction leads to a small, but positive effect on the home ownership rate.[26] The welfare effects from abolishing tax deductibility in Chambers, Garriga and Schlagenhauf (2009a) are positive. Sommer and Sullivan (2017) second these results.

The impact of introducing taxation on imputed rents[27] is mostly qualitatively similar to the effects of lower interest tax deductibility. Gervais (2002), and Cho and Francis (2011) conclude that introducing taxation of imputed rents has stronger negative effects on home ownership rates than abolishing interest rate tax deductibility. Floetotto, Kirker and Stroebel (2016) confirm the results for home ownership, but in contrast to the other studies, find that introducing a tax on imputed rents turns out to be welfare detrimental. Chambers, Garriga and Schlagenhauf (2009a) conclude that introducing imputed rents taxation can increase the home ownership rate and is welfare improving. Alpanda and Zubairy (2016) show that it is mostly renters that benefit from taxing imputed rents, while homeowners suffer from this policy.

Apart from home ownership and welfare, housing-related taxation also influences business decisions of firms. If home ownership is promoted, more resources are allocated to the construction sector. Gervais (2002) and Chambers, Garriga and Schlagenhauf (2009a) find that when these tax incentives are lowered, resources are redistributed from housing to business capital.

Through their impact on household leverage, housing-related taxes can also impact the debt level in the economy. Lower levels of interest rate tax deductibility are effective in reducing household debt (Chen and Columba, 2016, Finocchiaro, et al., 2016, Alpanda and Zubairy, 2017). Lower household leverage may come at a cost of lower output in the economy, but this mostly depends on how the government spends the additional revenue, as discussed in the earlier part of this subsection.

To sum-up, the conclusions from the literature on housing-related tax policy measures vary greatly and depend to a large extent on the assumptions regarding households' heterogeneity, OLG versus representative agents' frameworks, and different aspects of the rental market.

3.5 Capital regulation

Capital regulation directly affects the supply of credit in the economy and it is widely used worldwide (see Kara, 2016). Most of the macroeconomic models studying capital regulation focus on the time-dimension of systemic risk and the procyclicality of bank lending. Banks are highly leveraged, hence both changes on the asset side of their balance sheets (loan defaults, falling prices of collateral) and on the liability side (rollover problems, bank runs by depositors) can easily lead to a disruption in bank activities and bank distress or even bankruptcies. The procyclicality of financial flows is heightened in the presence of externalities defined in section 2. When banks have correlated portfolios (due to *strategic interactions*), they will likely want to liquidate their portfolios at the same time, creating the fire sales problem and downward pricing spirals (*pecuniary externalities*). Due to the *interconnectedness* of banks, problems in one institution can spread to others, amplifying the initial crisis. In this case, microprudential regulation complements macroprudential

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26 This is due to the fact that declining demand for mortgages and owner-occupied housing after the abolition results in an increase of the demand for rental units, which raises their price. Moreover, under the assumption of constant government revenue, income taxes in the model will be lowered, which all together has a slight positive impact on the home ownership rate.
27 Imputed rent refers to the implied income that a homeowner makes because he does not have to pay rent to a landlord compared to a renter that has to pay rental costs. In some countries, the imputed rent, as a rent that the homeowner pays to himself, is taxed.

regulation and helps to mitigate systemic risk (see Freixas, Laeven and Peydró, 2015). If each individual banking institution is less leveraged due to individually imposed capital requirements, it is likely that less macroprudential regulation will be needed.

Capital requirements, often considered from today's perspective as macroprudential tools, were first designed for microprudential purposes, since they ensure that bank shareholders put 'skin in the game', lowering the incentives for risk taking on the side of the bankers and increasing public confidence in the banking business. This helps to obtain funds that can be channeled to the productive sector in the economy, which in turn fosters growth (Meh and Moran, 2010). In an event of bank distress, bank capital acts as a buffer and prevents problems in one financial institution from spreading to the rest of the system. In the absence of capital regulation, bank leverage can be above the socially optimal level due to existing frictions, such as preferential tax treatment of debt, deposit insurance or the corporate structure of banks that implies limited liability of shareholders, which all lead to a high leverage of the banking sector. An appropriate capital regulation has to find a compromise between its benefits, that is reducing banks' failure risk, lowering the costs of recessions by mitigating capital crunch and fostering optimal allocation of credit, and its costs, that is curbing economic activity.[28]

Which are the channels through which capital regulation can contribute to financial stability and what are the costs? The existing macroeconomic literature provides many insights into this. Capital requirements can improve banks' solvency prospects, making bank runs and liquidity problems less likely. High leverage and maturity mismatch lie at the heart of the modern banking business, which makes banks vulnerable to rollover risk.[29] The greater the leverage of the bank, the greater this risk (Angeloni and Faia, 2013). Thus, capital regulation can reduce the probability of a bank run (Angeloni and Faia, 2013 and Gertler and Kiyotaki, 2015).[30] However, this increase in financial stability comes at a cost, that is capital requirements can lower bank intermediation, and thus output and consumption in the economy (Corbae and D'Erasmo, 2014 and Chen and Columba, 2016). This is often the result of increased bank funding costs (if equity is more expensive than debt due, for example, to tax reasons). The resulting surge in lending spreads curbs lending (Almenberg et al., 2017).[31] Given the trade-off between higher financial stability and lower credit intermediation, some researchers conclude that the social welfare gains are a hump-shaped function of capital requirements (Clerc et al., 2015; Chen and Columba, 2016; Begenau, 2016 and Boissay and Collard, 2016). That is, above a certain level of capital regulation, the costs induced by reduced credit intermediation are higher than the benefits from making the banking sector more resilient to failures.

Despite their benefits, fixed capital (and liquidity) requirements can lead to excessive credit contraction in crisis times, because highly leveraged banks reduce their lending to meet regulatory limits. Massive deleveraging can lead to collateral fire sales that drive asset prices down and put further strain on banks' balance sheets. Fixed capital requirements can thus increase the cyclicality of bank lending. In such a situation, countercyclical tools may be welfare-enhancing, as they may contribute to the stabilization of the aggregate output. This is confirmed by Gertler, Kiyotaki and Queralto (2012), Angeloni and Faia (2013) and Davydiuk (2017). Clerc et al. (2015) show instead that countercyclical capital ratios add stability to the economy at high levels of capital requirements but, at low levels of capital requirements, they amplify the business cycles.

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28 See Freixas, Laeven and Peydró (2015) and Almenberg et al. (2017).

29 Rollover risk is the risk associated with the refinancing of debt. In the case of banks, this risk refers to a situation in which banks need to renew their maturing funding, but they cannot do so due to for example market freeze.

30 Liquidity requirements (Covas and Driscoll, 2014) and deposit insurance (Diamond and Dybvig, 1983) are other tools to reduce problems linked to maturity mismatch and reduce the occurrence of bank runs.

31 In a model in which households have a preference for holding safe and liquid assets provided by the banks, Begenau (2016) shows that bank funding costs do not have to go up under higher capital requirements.

As discussed in the introduction, macroeconomic models are well-suited to study the overall benefits and costs of banking regulation due to their general equilibrium focus that takes into account feedbacks between different sectors of the economy. However, most of these models are built as 'closed systems', and cannot predict the consequences of capital regulation on financial institutions outside the radar of the regulatory authorities, the so-called 'shadow banking' sector. Specifically, high capital requirements could contribute to the development of a shadow banking sector whose riskiness exceeds the riskiness of a low-regulated banking sector, contributing to financial instability. However, this does not necessarily need to happen. Begenau and Landvoigt (2017) show that raising capital ratios from the status quo indeed increases the size of the shadow banking sector, which expands its operations by scaling up, but not by increasing its leverage. Hence, their study concludes that despite the rise in the shadow banking activity, the aggregate banking system becomes safer.[32] More macroeconomic research on these possible 'unintended' consequences of banking regulation is needed, as well as on the interaction of different regulations.[33] Countercyclical capital buffers try to reduce the tension between micro and macro regulation, that is to maintain the risk sensitivity of the requirement for different financial institutions and, at the same time, mitigate the cyclicality of the regulation. Models with many heterogeneous banks are particularly well suited to tackle this issue (see Corbae D'Erasmo, 2014, Boissay and Collard, 2016 and Grodecka, 2016).

4 Conclusions

The multifold aim of this article was to i) increase our understanding of the financial sector and its importance for the real economy, ii) review the most recent attempts in the literature to incorporate financial frictions in otherwise standard macro models and iii) evaluate both the costs (forgone lending and economic activity) and the benefits (a more resilient financial system) of macroprudential regulation. Systemic risk, the primary target of macroprudential policy, may arise from different sources of market failures. We have argued that identifying the exact source of market failure is key to designing the appropriate instrument to address it.

While traditional microprudential regulation has a long tradition in economic policy, macroprudential policy is still in its infancy (Galati and Moessner (2017). This poses a series of challenges that remain to be addressed by the existing economic literature.

Importantly, different policy measures coexist and interact with each other. Boissay and Collard (2016), Greenwald (2016) and Grodecka (2017) attempt to specifically take this interaction into account in a macroeconomic framework. Furthermore, too restrictive measures could create incentives for economic agents to circumvent regulation, thereby creating unintended side-effects of regulation. The development of alternative financing channels, such as the shadow banking system (see Begenau and Landvoigt, 2017) or a surge in unsecured credit in response to too strict LTV or LTI requirements exemplifies this problem. Finally, a comprehensive account of the benefits of financial regulation should explicitly consider the interaction between policy and the occurrences of financial crisis. In most of the existing literature, which operates in a linear framework, financial crises are the results of big exogenous 'financial shocks'. Some researchers (Mendoza, 2016) argue that, as a result, linear set-ups are ill-suited to capture the transition from regular times to times of financial distress and, therefore, the benefits of effective financial regulation. Furthermore, linear set-ups cannot handle the impact of risk on portfolio decisions of market participants

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32 This happens because, contrary to the commercial banking sector, there is no deposit insurance in the shadow banking sector and shadow banks incorporate this 'bank run' probability while choosing their leverage. Moreover, higher capital requirements lower the funding costs of banks, which makes them more profitable.

33 The finance literature has studied the interactions between different forms of banking regulation, see for example Kashyap, Tsomocos and Vardoulakis (2014), Walther (2016) or Mankart, Michaelides and Pagratis (2017), but these aspects of regulation have not been covered extensively by the macroeconomic literature.

(Covas and Driscoll, 2014; Begenau and Landvoigt, 2017 and Laséen, Pescatori and Turunen, 2017 are notable exceptions). Nevertheless, non-linearities bear clear computational costs that need to be taken into account when evaluating the potential use of such models in policy analysis.

The decade after the unfolding of the worst financial crisis after the Great Depression has brought about a golden age in macro-finance research. While tremendous progress has been made, the road ahead is still full of challenges and opportunities in the direction of i) deepening our understanding of macro financial linkages and ii) building the right policy toolkit for financial regulators.

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