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Cross-border spillover effects of macroprudential policies: a conceptual framework

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Abstract

Due to the international dimension of the financial sector within the EU and beyond, domestically oriented macroprudential policies have the potential to create material cross-border spillover effects. This occasional paper provides a detailed overview of the academic and empirical literature on cross-border effects of macroprudential policies. It also summarises a stocktaking exercise, conducted by a task force of the ESCB's Financial Stability Committee (FSC), on existing national approaches within the EU for assessing and monitoring such cross-border spillover effects. The paper accompanies an FSC report presenting a framework to be used by macroprudential authorities when assessing cross-border spillover effects induced by enacted or planned policy measures.

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Executive summary

Macroprudential measures implemented by national authorities may have cross-border repercussions. Due to the international dimension of the financial sector within the European Union (EU) and beyond, domestically oriented macroprudential policies have the potential to create material cross-border spillover effects. Ideally, such cross-border spillover effects – which could be both positive and negative – should be factored in when assessing and calibrating planned macroprudential measures. Hence, ensuring the effectiveness and consistency of macroprudential policy in the EU requires that policymakers give due consideration to the cross-border effects of macroprudential policy measures adopted by national authorities and take into account other countries' macroprudential settings when adopting their own macroprudential policies, or when warranted, that they adopt suitable reciprocating macroprudential policy measures.

Against this background, the Financial Stability Committee (FSC) of the European System of Central Banks (ESCB) has established a "best practice" framework for assessing (negative) cross-border spillover effects of macroprudential policies. The FSC framework provides a harmonised approach to monitoring and assessing cross-border spillover potential related to the adoption of macroprudential measures. The intention is that the FSC framework can serve as a starting point when assessing cross-border spillover effects of planned policy measures. The framework is described in more detail in the accompanying FSC report.[1]

The aim of this occasional paper is to provide some of the analytical underpinnings of the FSC cross-border spillover framework. In order to design the framework, the FSC established a dedicated task force[2] to conceptualise relevant transmission channels, take stock of existing approaches and propose operational ways forward. The task force was set up in ESCB composition, meaning that representatives of non-euro area EU Member States were also included. Given the strong synergies with work by the European Systemic Risk Board (ESRB), the task force maintained a close interaction with relevant ESRB structures. This paper, in combination with the accompanying FSC report, reflects the outcome of the work of the task force. While the FSC report provides a detailed description of the recommended operational best practice framework, this occasional paper instead provides a detailed overview of the relevant academic literature on cross-border effects of macroprudential policies. It also summarises a stocktaking exercise conducted by the task force on existing national approaches within the EU for assessing and monitoring such cross-border spillover effects.

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1 See ECB (2020), "Financial Stability Committee – Framework to assess cross-border spillovers of macroprudential policies", April.

2 Task Force on Cross-border Spillover Effects of Macroprudential Measures (TFSE) under the FSC's Macroprudential Policy Group (MPPG).

The existing literature analysing macroprudential cross-border spillovers concerns the transmission of policies focusing primarily on banks' lending activities. While the analytical approaches differ considerably, the key takeaway is that cross-border spillover effects transmitted via the bank lending channel can be meaningful. The nature, direction and magnitude of the spillover effects will vary both across modelling approaches and across model specifications. Spillovers via non-bank lending channels are also likely to be material in view of the increasing role of non-bank financial intermediation and market-based finance. However, empirical evidence on such channels is still relatively scarce.

Most of the relevant national authorities in the EU have a framework to assess and monitor cross-border spillovers from macroprudential policies in place. As a rule, these frameworks are based on a set of indicators relying heavily on the guidance provided in the ESRB Handbook[3]. In addition to this, several authorities incorporate results obtained from empirical models into the assessment.

The majority of authorities see merit in extending the existing guidance for the assessment of cross-border spillovers. The stocktaking exercise indicated that enhancements to the current operational guidance should address a number of essential gaps, as follows: (i) the lack of guidance on suitable models; (ii) the absence of explanation regarding the indicators (including indicative data sources for each indicator); (iii) the difficulties in gathering data to compute some of the indicators; and (iv) the difficulties in mapping the indicators to the channels and the direction of cross-border effects. In particular, with respect to the most useful additional practical guidance, authorities underscored: (i) the build-up of a common set of indicators and possible thresholds to assess the materiality of spillovers; and (ii) the development of structural models (empirical or theoretical) to conduct ex ante assessments and the design of a comprehensive framework including both indicators and models that could represent guidance on best practices. The accompanying FSC report presents an operational framework which aims to address and improve on those elements.

[3] ESRB (2018), "The ESRB handbook on operationalising macroprudential policy in the banking sector", January.

1 Introduction and motivation

Financial activities often transcend national borders. The international dimension of many bank and capital market-related transactions and organisational structures by extension implies that policy interventions targeting areas of the domestic financial system can easily propagate across borders.

Macroprudential policy measures typically target financial stability risks in national jurisdictions. Even within the EU with its common market and highly integrated financial markets and banking sectors, macroprudential policies tend to focus largely on financial stability risks and activities within the confines of national borders.

Macroprudential measures implemented by national authorities may have cross-border repercussions. Due to the international dimension of the financial sector within the EU and beyond, domestically oriented macroprudential policies have the potential to create material cross-border spillover effects. Ideally, such cross-border spillover effects – which could both be positive and negative – should be factored in when assessing and calibrating planned macroprudential measures. Hence, ensuring the effectiveness and consistency of macroprudential policy in the EU requires that policymakers give due consideration to the cross-border effects of macroprudential policy measures adopted by national authorities and take into account other countries' macroprudential settings when adopting their own macroprudential policies, or when warranted, that they adopt suitable reciprocating macroprudential policy measures.

Moreover, the depth of (structural) macro-financial linkages between countries may strengthen or weaken the cross-border effects of macroprudential policies. The total impact of policies will hinge on the intensity of cross-border economic activity. It is therefore important to identify and understand the underlying spillovers across economies in the real and financial sectors in order to pin down the full general equilibrium impact of these policies.

Against this background, the ESCB Financial Stability Committee has established a best practice framework for assessing (negative) cross-border spillover effects of macroprudential policies. The FSC framework provides a harmonised approach to monitoring and assessing cross-border spillover potential related to the adoption of macroprudential measures. The intention is that the FSC framework can serve as a starting point when assessing cross-border spillover effects of planned policy measures. The framework is described in more detail in the accompanying FSC report.[4]

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[4] See ECB (2020), "Financial Stability Committee – Framework to assess cross-border spillovers of macroprudential policies", April.

established a dedicated task force[5] to conceptualise relevant transmission channels, take stock of existing approaches and propose operational ways forward. The task force was set up in ESCB composition, meaning that representatives of non-euro area EU Member States were also included. Given the strong synergies with work by the ESRB, the task force maintained a close interaction with relevant ESRB structures. This paper, in combination with the accompanying FSC report, reflects the outcome of the work of the task force. While the FSC report provides a detailed description of the recommended operational best practice framework, this occasional paper instead provides a detailed overview of the relevant academic literature on the cross-border effects of macroprudential policies. It also summarises a stocktaking exercise conducted by the task force on existing national approaches within the EU for assessing and monitoring such cross-border spillover effects.

The paper is structured as follows. Chapter 2 provides an overview of the literature distinguishing between bank lending channels, bank non-lending channels and non-bank financial transmission channels. It also distinguishes between theoretical and more empirical approaches. Chapter 3 presents the stocktake of prevailing national approaches to assessing cross-border spillover effects. Chapter 4 summarises and provides the contours of the analytical framework, which is described in more detail in the accompanying FSC report.

[5] Task Force on Cross-border Spillover Effects of Macroprudential Measures (TFSE) under the FSC's Macroprudential Policy Group (MPPG).

2 Concepts and literature review

This chapter reviews the existing theoretical and empirical literature on the cross-border transmission of macroprudential policies. The intention is to set out concepts and mechanisms that can assist the reader in thinking about this issue. For cases where there is already an established literature, highlighting these concepts and mechanisms will be straightforward. However, for channels where this aspect has only indirectly or partially been explored, the intention is to use what literature is available to qualitatively describe the transmissions and their importance.

The chapter is structured in the following manner. Section 2.1 reviews the literature on the bank lending channel. Section 2.1.1 is dedicated to theoretical multi-country (or open economy) structural models involving one (or more) macroprudential instruments, as well as more simulation-based contagion frameworks and stress-test-based frameworks. Section 2.1.2 looks at the empirical literature distinguishing between studies using aggregate macroeconomic datasets and studies using micro bank-level data. Section 2.2 reviews the literature on other activities of banks including the possible spillovers arising from banks' involvement in equity, bond and derivatives markets. Section 2.3 reviews the role of non-bank channels in cross-border spillovers of macroprudential measures. In particular, the section examines the role of the so-called "shadow banks" as substitutes for traditional bank credit, as well as their pivotal role in the transmission of non-credit activities, focusing on capital markets.

2.1 Bank lending channel

The main focus of the existing literature analysing macroprudential cross-border spillovers concerns the transmission of policies through channels related to banks' lending activities. Against this background, this section summarises the literature where cross-border spillover effects are generated via the impact of macroprudential measures on bank lending. The section is divided according to different analytical approaches ranging from structural and theoretical models, through simulation-based models (such as stress-test and contagion models), to various empirical specifications.

While the analytical approaches differ considerably, the key takeaway is that cross-border spillover effects transmitted via the bank lending channel can be meaningful. The nature, direction and magnitude of the spillover effects will vary both across modelling approaches and across model specifications.

2.1.1 Structural and simulation-based models

Structural and stylised models are useful tools for outlining and simulating the potential for cross-border spillover effects and their transmission channels

within a consistent (often general equilibrium) modelling framework. This differs from empirical approaches, which are often more partial equilibrium in nature and less rigorous from a theoretical standpoint. At the same time, the theoretical and structural models described in Section 2.1.1.1 are typically more stylised and rudimentary in nature and less well suited for capturing features related to financial agents' heterogeneous behaviour. The stress-testing and contagion models described in Sections 2.1.1.2 and 2.1.1.3, on the one hand, allow for capturing heterogeneous agents but, on the other hand, are typically characterised by partial equilibrium features. The common feature of the three model approaches described in this section is that they can be useful for conducting simulation exercises to see how the financial sector (and the broader economy) would respond to the activation of specific macroprudential measures. If well calibrated, these types of tools may be highly valuable for ex ante assessments of macroprudential policies. While the empirical approaches outlined in Section 2.1.2 are arguably more suitable for ex post assessments, these can also provide policymakers with ballpark estimates against which to (ex ante) assess planned policy measures (see also the FSC report accompanying this occasional paper). That being said, the more theoretical approaches described in this section and the empirical approaches described in the subsequent section should be employed in a complementary fashion.[6]

2.1.1.1 Structural models

The theoretical literature on the international spillover effects of macroprudential policies is still relatively scarce. While the last decade has seen a multitude of studies aiming to better understand the domestic transmission of macroprudential policies, there are relatively few theoretical studies on the cross-border spillover effects of such policies.[7] This section focuses on theoretical, or structural, models which share two common features: a multi-country set-up and the presence of a policy instrument with macroprudential interpretation. Both elements are necessary but often not sufficient to offer a non-trivial description of the transmission of macroprudential policies. Structural models of cross-border transmission of macroprudential policies can be classified into three categories: (i) industrial economics models of international banks; (ii) stylised finite horizon models; and (iii) infinite horizon dynamic stochastic general equilibrium (DSGE) models.

Industrial economics models

Industrial economics models provide a rationale for outward spillovers of macroprudential policies. Dalen and Olsen (2003) investigate the transmission of prudential policies from the viewpoint of a bank with foreign subsidiaries or branches. Bank activities are controlled by two supervisors: a domestic supervisor overseeing banks' domestic activities (and the activities of foreign branches) and a foreign

[6] In particular, the design and calibration of structural models should be informed by stylised, empirical facts. Likewise, empirical model specifications should be informed by theoretical underpinnings embedded in the structural and stylised models.

[7] As described in Section 2.1.2, the number of empirical studies on the topic has expanded more rapidly.

supervisor overseeing the activities of foreign subsidiaries. Both supervisors have two policies at their disposal: a floor on the investment of the risk-free asset and a bank insurance premium. In the model, outward spillovers arise from changes in the floor on risk-free assets. All else being equal, a tightening of the instrument in a jurisdiction will lower the profitability of local activities. This would trigger portfolio re-optimisation and affect bank activities in another country. The insurance premium allows the supervisors to expropriate profits of banks authorised in their jurisdictions and introduces additional regulatory arbitrage spillovers.

A number of papers focus explicitly on the failure of national micro-prudential supervisors to internalise cross-border externalities.[8] Carletti, Dell'Arricia and Marquez (2016) assess the architecture of bank supervision through the lens of organisation theory (Aghion and Tirole, 1997). They find that if the national and the centralised prudential authorities do not share the same objectives, the information flow between the two layers may be impeded and could give rise to excessive leniency of supervision. In the same vein, Repullo (2018) presents a theoretical model whereby the optimal level of prudential centralisation hinges on the relative costs between the national and centralised supervisors of collecting information relevant for taking prudential decisions.

The move to more centralised supervision could have implications for how multinational banks organise their foreign activities. Calzolari, Colliard and Loranth (2017) show that the move to a more supranational supervisory structure (such as the Single Supervisory Mechanism) could induce changes to multinational banks' organisational structures, potentially giving rise to a higher reliance on foreign branches than on foreign subsidiaries – a feature which, as will be argued below, could have strong implications for the nature of potential cross-border spillover effects of macroprudential policies.[9]

The degree to which cross-border spillover effects should be addressed via supranational coordination and action should be assessed bearing in mind the degree of banking sector heterogeneity. Beck and Wagner (2016), as well as Colliard (2019), argue that the benefits of coordinating prudential supervision beyond national borders stem from the fact that national supervisors do not necessarily internalise cross-border externalities. But the costs of moving towards more international harmonisation and coordination are related to cross-country differences in bank business models and bank failure costs, and to the incentives (and the ability) of local banks to hide information from the supranational prudential authority.

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8 See also Ampudia et al. (2019).

9 Calzolari et al. (2017) argue that there are two externalities that the supranational supervisor would address: (i) a monitoring externality whereby the supranational supervisor would gather information that the home supervisor would not have access to which could lead to tougher supervision of subsidiaries, thus incentivising banks to move to a branch structure; and (ii) an intervention externality whereby the supranational supervisor would take a more holistic approach to interventions which could lead to more lenient treatment of foreign subsidiaries (than when the national host supervisor was in full control). It is not clear a priori which externality would dominate.

Stylised finite horizon models

The stylised finite horizon models emphasise the time dimension of decisions of both financial intermediaries and supervisors, and the non-linear nature of macro-financial risks. In a standard stylised finite horizon model, agents take decisions on policies and asset allocation in the first period, ahead of the realisation of the macro-financial risk. In the next period(s), the risk occasionally materialises and the earlier decisions have an impact on the severity of the crisis (and individual losses). Such a multi-country set-up is used by Bengui (2014) and Kara (2016) who emphasise liquidity risks, and Jeanne (2014) who emphasises default risk of many borrowers. Korinek (2014) presents a general stylised two-country model set-up where he considers controls on capital inflows and current account policies aimed at foreign exchange (FX) stabilisation.

Macroprudential actions are transmitted via international financial markets and may give rise to cross-border spillover effects. There is no banking sector in these models; the investment decisions are taken by individuals. National macroprudential policies (and other shocks) transmit across jurisdictions via international financial markets. In Bengui (2014), supervisors establish the share of liquid assets in investors' portfolios taking into account the welfare of domestic (or global) agents. A regulation-induced decrease in liquidity risk-taking in a country increases the global supply of liquidity during a future crisis and lowers the spot market interest rates. This encourages agents in another country to take on more risk, due to the access to cheaper funding in the event of a crisis. In Kara (2016), a regulation-induced decrease in holdings of risky high-return investments dampens the global demand for liquid assets during a future crisis. Similar to Bengui (2016), liquid assets are more readily available to agents in another country, which encourages them to take on more risk to begin with. In all three models, we may observe only outward spillovers of macroprudential policies and national supervisors have full control over all domestic exposures. Jeanne (2014) considers Pigouvian taxes aimed at reducing excessive leverage. In Korinek (2014), both domestic macroprudential policies and prudential capital controls have international spillovers through their impact on capital flows. In his model, the transmission of these policies happens only via the trade channel. A macroprudential policy affects domestic savers and borrowers (or a bank) and is, in turn, passed through to the domestic economy, including exports and imports. Changes in the trade account are matched one-to-one by an increase or reduction of a country's external borrowing needs and hence its current account.

Infinite horizon DSGE models

DSGE models offer a fully dynamic setting where the effectiveness of macroprudential policies may be tested in the presence of different real, nominal and financial frictions, and structural shocks. Accounting for various frictions makes these models less stylised than finite horizon models, and better able to fit the data. Furthermore, the fully dynamic design of the models allows the studying of time-invariant, rule-based and optimal (based on welfare maximisation)

macroprudential policies. These types of models may therefore be particularly relevant for conducting ex ante macroprudential policy assessments.

Several multi-country DSGE models incorporate a rudimentary and often exclusively domestically focused banking sector. Rubio (2014), Rubio and Carrasco-Gallego (2016), Mendicino and Punzi (2014) and Brzoza-Brzezina et al. (2015) develop two-country DSGE models to study the effectiveness of (predominantly rule-based) loan-to-value (LTV) policies, while Quint and Rabanal (2014) and Palek and Schwanbeck (2015) analyse the effects of a stylised instrument that results in an increase in borrowing costs in the economy. However, a banking sector in these models is either missing or its role is limited. Rubio (2014), Rubio and Carrasco-Gallego (2016), Brzoza-Brzezina et al. (2015) and Quint and Rabanal (2014) assume the presence of a continuum of financial intermediaries (perfectly competitive or acting in monopolistic competition), which accept deposits from savers and provide loans to borrowers. Banks are only domestically active. Therefore, a banking sector specified along these lines will only indirectly affect the international transmission of policies. In these models, international propagation of macroprudential policies happens via the trade channel and international financial markets.

At the other extreme, Dedola, Karadi and Lombardo (2013) explore the cross-border transmission of shocks in a (somewhat unrealistic) setting of full financial integration.[10] They consider a two-country DSGE model with fully integrated markets for banks' assets (e.g. loans to firms) and liabilities (e.g. short-term deposits). In the model, credit spreads become highly correlated across countries. A shock that brings about a tightening of the balance sheet constraint in one country (e.g. due to higher risk weights on lending) also generates endogenously a tightening of the balance sheet constraint in the other country, resulting in a global contraction of credit. However, as in Korinek (2014), in these models one can observe only outward spillovers of macroprudential policies.

Darracq Pariès, Kok and Rancoita (2019) present another two-country DSGE model with a banking sector and cross-border lending which is suited to studying outward lending channels to a foreign country. This model considers a monetary union with two countries which are interconnected via trade and bank lending channels.[11] The individual economies are modelled following Darracq Pariès, Kok and Rodriguez Palenzuela (2011), implying that each economy consists of three agents (households, firms and banks) and two sectors producing residential and non-residential goods, respectively.[12] In the model, the two countries are interconnected via trade and banking sector linkages. On the trade side, residential goods are treated as durable goods and are non-tradable, while non-residential goods

[10] In their model, financial intermediaries raise short-term funds domestically and abroad, and allocate them to domestic and foreign assets, subject to time-varying endogenous balance sheet constraints.

[11] The current version of the model is calibrated for the five largest euro area countries, but will soon be estimated for all euro area countries.

[12] Banks are affected by three layers of financial frictions, which have important implications for the propagation of shocks in the economy. First, banks face risk-sensitive capital requirements as well as adjustment costs related to their capital structure. Second, banks have some degree of market power in the retail market which generates imperfect pass-through of market rates to bank deposit and lending rates. Third, due to banks' imperfect information about their borrowers and hence monitoring costs on their credit contracts, firms and impatient households face external financing premia which depend on their leverage.

can be traded across countries. As regards cross-border credit linkages, it is assumed that households and firms can borrow abroad (as well as at home).[13] The model allows for conducting a variety of macroprudential policy simulations including total capital requirements and buffers, sectoral capital requirements and LTV caps. The outward spillovers to other countries depend on direct transmission channels like the financial and trade openness of the country, but also on the interaction with the monetary policy response, which is allowed to react endogenously in the model. Cross-border spillover effects are found to be non-negligible, while the size and direction depend both on the country and on the macroprudential measure applied. Overall, cross-country spillovers are largest for broad-based capital measures and depend on the amount of domestic deleveraging (which directly affects cross-country lending) and also on the size of the country (which affects both the exports of the foreign country and the reaction of monetary policy within the monetary union).

Vitek (2017) proposes a multi-country (40 economies) DSGE model with a more complex structure of financial intermediation including both banks and capital markets and diverse spillover transmission channels. In this so-called Global Macrofinancial Model (GFM), banks transform household deposits and money market funds into risky (subject to occasional default) mortgage-based loans to domestic households, and risky collateralised loans to domestic and foreign enterprises. The macroprudential policy shocks under consideration are capital requirement shocks as well as mortgage and corporate LTV limit shocks. Macro-financial spillovers are transmitted via trade, exchange rate, financial, and commodity price linkages. In particular, international financial linkages encompass cross-border bank lending, non-financial private sector borrowing, portfolio debt and equity exposures, and contagion effects. Commodity price linkages matter only when activating countries are large enough to significantly alter world energy and non-energy commodity prices. The model is able to capture both outward and inward spillovers, which depending on the activating country and the transmission channel can be sizeable. The latter are related to the activity of foreign banks in the domestic market, more specifically their provision of credit to local enterprises.

In a similar vein, Darracq Pariès, Jacquinot and Papadopoulou (2016) present a multi-country model with financial frictions including sovereign risk, corporate default and bank default. Darracq Pariès et al. (2016) calibrate a large multi-country model covering three regions: the four largest euro area countries, the rest of the euro area, and the rest of the world. The model can be used to provide a monetary policy perspective on the impact from (macro- and micro)prudential and regulatory measures. It allows for assessing the long-term costs and benefits of capital regulation, while accounting for cross-border spillover effects. As in the two previous studies mentioned above, cross-border spillover effects from measures taken in one country can be meaningful but will depend on the specific situation (scenario).

[13] A related DSGE model by Poutineau and Vermandel (2015) with interbank and corporate cross-border lending contains similar dimensions, but does not consider any macroprudential instrument.

2.1.1.2 Contagion models

Another channel of transmission of macroprudential policy across borders, next to direct cross-border lending, is likely to be via intra-financial sector linkages.[14] This channel is likely to gain in importance with an increasing complexity and interconnectedness of the financial system. Financial contagion can be interpreted as the transmission of shocks between financial market participants resulting from a shock initially limited to a relatively small number of institutions (Allen and Gale, 2000; de Bandt and Hartmann, 2000; Upper, 2007). Allen and Gale (2000) introduce a concept of financial fragility showing that interlinkages "work well as long as there is enough liquidity in the system", but can transmit problems if there is an excess demand for liquidity. Although the financial links have a positive impact on risk diversification and risk sharing through flexibility and monitoring (Rochet and Tirole, 1996), Allen and Gale (2000) note a generally high propensity of financial systems to be affected by shocks and observe a non-monotone relationship between the density of network connections and how broadly contagion is spread throughout the network.

Financial contagion can take many forms of transmission. For instance, it can be transmitted via direct channels, such as via bilateral exposures (see e.g. Eisenberg and Noe, 2001), via protection selling and buying (e.g. Heise and Kühn, 2012; Hałaj, 2013; D'Errico et al., 2017), via common exposures due to overlapping portfolios (Caccioli et al., 2012; Hałaj et al., 2015; Montagna and Kok, 2016; Roncoroni et al., 2019) or via other indirect channels such as through information contagion, correlation and behavioural commonalities (see Kodres and Pritzker, 2002; Acharya and Yarulmazer, 2008; Acharya et al., 2012). Furthermore, financial contagion may engulf the financial system at large, but can also affect sub-systems of interbank networks (Elsinger et al., 2006; Degryse and Nguyen, 2007) or the payment system (Bech and Garratt, 2006). Ideally, fully capturing potential financial contagion within the financial system requires a "holistic" approach, for example, using multi-layered network analysis, accounting for interactions and spillovers between different network segments (see e.g. Montagna and Kok, 2016). This would help capture the fact that financial institutions are often linked to each other in a wide range of networks and that shocks occurring in one network segment could therefore easily spill over to other segments, leading to more widespread contagion effects than would be identified when analysing the different network segments in isolation. Moreover, the events triggering financial contagion can be multi-faceted, ranging from solvency and liquidity shocks to payment system disruptions.

Most contagion studies do not focus on the cross-border dimension and tend to concentrate on within-market contagion (i.e. focusing on the national perimeter). There are a few exceptions to this general trend, however. Minoiu and Reyes (2011) explore the properties of the global banking network using cross-border bank lending data for 184 countries over the period 1978-2009. They document a relatively unstable global banking network, with structural breaks in network indicators identifying several waves of capital flows. Gabrieli et al. (2015) likewise explore a cross-country dataset (using true bilateral exposure data) to explore cross-border

[14] Gabrieli and Georg (2014) illustrate the importance of the interbank lending channel in a European context.

interbank contagion effects in the European banking sector. Their results show the critical impact of the underlying network structure on the propagation of losses. Raddant and Kenett (2016) show how network analysis can facilitate the monitoring of movements by stocks in the global financial system over time. The paper analyses nearly 4,000 stocks in 15 countries. It concludes that stock returns tend to move together within regions – but not across them – in times of stability, but move in global sync in times of crisis.

However, there are only a few studies that inherently embed macroprudential policy parameters which would allow for assessing contagion-related cross-border spillover effects. A few ECB studies[15] and some studies by the US-based Office of Financial Research (OFR) are among the exceptions. Hałaj and Kok (2015) use an agent-based network formation model of the euro area banking sector where banks are subject to capital and liquidity constraints, as well as large exposure limits, to explore the implications for contagion risk (including cross-border spillovers) embedded in the system when changing the regulatory parameters. Hałaj et al. (2015) and Roncoroni et al. (2018) expand this framework to include bank-firm relationships and the potential amplifying contagion and cross-border spillover effects of having overlapping corporate portfolio structures using a sample of large euro area banks with cross-border linkages. Among the OFR studies, Bookstaber et al. (2014) provide a general risk management framework showing how policies can be useful in steering the contagion risk in the system. While general in nature, this agent-based model (and other OFR studies) does not, however, emphasise the cross-border dimension. Another recent study by Cont and Schaaning (2017) highlights the importance of endogenous financial stability risk via fire sales that defies national borders, and points to the potential for various types of macroprudential policies to mitigate such risks. Covi et al. (2019) present a highly granular contagion model for the euro area banking sector and beyond, which embeds different capital and liquidity regulatory constraints (including macroprudential buffers).

Despite recent advances, using contagion models for measuring and assessing cross-border spillover effects from macroprudential policies is still in its infancy. While promising in principle, whether or not these types of analytical tools can be employed for policy analysis in real time crucially hinges on having access to sufficiently granular, high-quality data. Often it is necessary to rely on simulations, which limits the practical policy use of analytical contagion tools/models. More recently, an increasing number of new datasets potentially allows for more precise measurement and construction of contagion models. These include supervisory data (e.g. large exposure reporting), payment transaction data for overnight interbank lending (TARGET2), snapshots of interbank networks (e.g. ad hoc EBA/ESRB data collection exercises), ECB securities holdings statistics (covering banks' and other financial institutions' holdings of securities by ISIN code), data on derivative transactions (i.e. EMIR data), and – with the implementation of the AnaCredit project – also credit register data. Finally, various sources of market prices are often used.

[15] See also Halaj, Kok and Montagna (2013), "Gauging the effectiveness of cross-sectional macroprudential tools through the lens of interbank networks", *Financial Stability Review*, ECB, November.

2.1.1.3 Stress-test applications

Stress-testing frameworks are founded on well-established links between institutions' solvency and liquidity positions, as well as their portfolio, funding and income structures. They are typically characterised by a satellite model structure linking developments in key macro-financial developments through their impact on various bank risk drivers in the institutions' P&L account and balance sheet.[16] Some of the more advanced frameworks embed feedback and contagion mechanisms reflecting the fact that shocks to individual (or groups of) banks may give rise to effects that go well beyond the impact on individual banks.[17] In a nutshell, this structure allows for deriving the impact from e.g. shocks to banks' capital and liquidity positions (e.g. reflecting a macroprudential action) on banks' balance sheets and P&L accounts, and further down the line – via feedback mechanisms – on the broader economy.

One of the advantages of stress-testing models for assessing cross-border spillovers of macroprudential policy measures relates to the high degree of data granularity that typically characterises such frameworks. In other words, standard top-down stress-testing tools usually rely on highly granular information on banks' portfolio structure and income sources. In general, stress-testing tools require very detailed and large datasets. Typically, stress-testing tools make extensive use of supervisory data (COREP/FINREP) or even special data collections purely for stress-test purposes. The detailed information about e.g. the geographical distribution of exposures implies that the impact of a domestic macroprudential measure can easily be mapped to a bank's foreign exposures, and thereby be used to gauge potential outward spillover effects of the measure. The translation of "shocks" to bank capital into, say, their foreign exposures could either rely on simplistic assumptions on how the loan and securities portfolios are likely to be affected (e.g. a proportional change in loan supply across portfolios, an assumed or estimated pecking order) or more sophisticated optimising mechanisms whereby banks decide on relative changes to their exposures based on risk-return considerations (see e.g. Halaj, 2013).

The broader macro implications for the foreign country that would be induced by such portfolio reshuffling would, in turn, require some macro feedback effects. For instance, the ECB macroprudential stress-testing framework, STAMP€, (Dees, Henry and Martin (eds.), 2017) takes into account the two-way interaction between banks and the real economy, as well as the related macro feedback effects generated by banks' balance sheet adjustments, also in a cross-border dimension. To this end, two models are used: a Global Vector Autoregression (GVAR) model (Gross et al., 2016) and a DSGE model (Darracq Pariès et al., 2011) calibrated for individual countries. In addition, cross-border spillovers related to trade and exchange rate channels can also be tracked using the Stress Test Elasticities (STEs) platform (a

[16] For a few representative overview publications on stress-testing frameworks, see e.g. Boss et al. (2006), Dent et al. (2016), Elsinger et al. (2009), Schmieder et al. (2011), Schmieder et al. (2012), Burrows et al. (2012), Gauthier et al. (2014), Henry and Kok (2013), Hirtle and Lehnert (2014), Kitamura et al. (2014), Kapinos and Mitnik (2015), Dees et al. (2017), Daniels et al. (2017) and Budnik et al. (2019).

[17] See e.g. Burrows et al. (2012), Henry and Kok (2013), Gauthier et al. (2014), Dees et al. (2017) and Budnik et al. (2019).

reduced-form model based on the forecasting models of national central banks in the EU).

Overall, top-down stress-testing tools have advantages in the context of assessing cross-border spillover effects of macroprudential measures, as they rely on very granular exposure breakdowns and can be linked to various satellite models in a flexible way, also with a view to simulating macro feedback effects (on the foreign country). Their disadvantage for the purpose of cross-border spillover assessments, on the other hand, is related to their partial equilibrium nature and to the fact that it is challenging to combine micro-level calculations with the macro level in a consistent manner. Apart from the potential use of stress-testing tools for assessing cross-border effects of policy measures, to our knowledge there is currently only limited evidence of such effects derived from these types of analytical tools. One reason might be that most authorities that employ stress-testing tools tend to focus on the impact on the domestic economy and their banking sector. The ECB's multi-country framework may therefore be an exception in this regard.

2.1.2 Empirical evidence

In comparison to the structural and simulation-based models where (as described above) the availability of relevant analytical tools is relatively scarce, empirical studies on cross-border spillover effects are more plentiful. In the following, the most relevant existing empirical studies are reviewed. The discussion is divided into empirical studies based on aggregate, macroeconomic data (Section 2.1.2.1) and empirical studies based on bank-level micro data (Section 2.1.2.2). As data availability for capturing cross-border effects is crucial for the empirical specification and output, both sections will first discuss data and model specification issues and second provide the key findings of the most relevant studies.

Overall, the main findings of the empirical literature are that cross-border spillover effects do matter. Although the evidence is somewhat mixed, in general it suggests that both inward and outward spillovers can be meaningful. This notwithstanding, the magnitude and direction of the effects are found to depend on the specific circumstances. With regard to inward spillovers, there is relatively solid evidence of the presence of leakages of domestic macroprudential measures, in particular via foreign branches not captured by domestic policy activation. Outward spillover effects are also found to be present in most studies, although the effects (on lending) vary across instruments, bank balance sheet characteristics and the nature of banks' relationship abroad (e.g. whether the entity is a core part of the business or more like an ancillary business line).

2.1.2.1 Empirical evidence based on aggregate (macroeconomic) data

Data and empirical specification

The availability of data is the key constraint in empirical specifications of aggregate data-based studies on cross-border spillovers. Only a few macro-level datasets are available for the analysis of bank lending channels. All of them have certain limitations, as described below.

Most of the studies falling under this category use as a dependent variable the change in international banking exposures across countries. This is a proxy for the financial flow from the source economy (s) to recipient economies (r), where either the source or the recipient country may be the domestic country activating a measure. Outward spillovers can therefore be measured by observing financial flows from the banking sector of a domestic country (d) to all sectors in foreign countries (f), and inward spillovers by tracking financial flows from a foreign country (f) to the domestic economy (d), where a measure was activated. This terminology, which is used in most of the empirical literature, differs somewhat from the one used in the ESRB Handbook and described in the introduction. However, these terminologies are not mutually exclusive and Box 1 describes how they correspond.

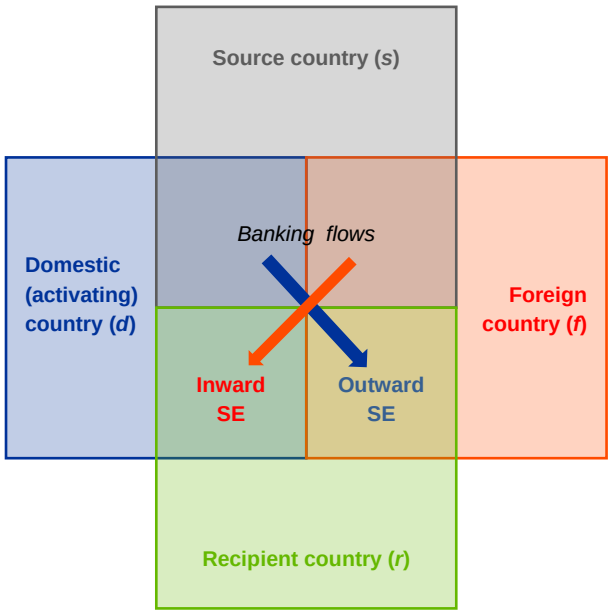
Box 1
Terminology of cross-border spillover effects

While the terminology adopted by the FSC to a large extent follows the one put forward in the ESRB Handbook, some mapping is needed to the terms used in the empirical literature which is reviewed in Chapter 1 of this report. This particularly applies to how the “inward” and “outward” transmission channels are mapped to “source” and “recipient” countries – terms often used in the literature – and how these in turn correspond to domestic (and policy-“activating”) countries and foreign countries, respectively.

In the empirical literature, spillovers are often tracked via changes in international banking flows. A financial flow is described as originating in a source country (s) and reaching a recipient economy (r). Depending on the identification strategy, either (s) or (r) may be an economy that activates a prudential measure (d), or alternatively, a foreign economy (f). Figure A outlines their relationship. Inward spillovers can be measured in terms of financial flows from a foreign source country (f, s) to a recipient economy (d, r) which activates a policy. Outward spillovers can, in turn, be measured as a change in the financial flows from the banking sector of a domestic source country (d, s), which activates a policy, to foreign recipient countries (f, r).

Figure A

Mapping of cross-border spillover channels



To measure financial flows, the studies generally draw on aggregate data from the international banking statistics of the Bank for International Settlements (BIS). Beirne and Friedrich (2017) and Kang et al. (2017) use BIS locational banking statistics (LBS), which provide quarterly information on the assets and liabilities of the banking sectors located in 44 reporting counties vis-à-vis non-residents. In contrast, some other papers employ BIS consolidated banking statistics (CBS), either on immediate borrowers (Houston et al., 2012; Bremus and Fratzscher, 2015; Avdjiev et al., 2017 and 2019) or on an ultimate risk basis (Reinhardt and Sowerbutts, 2015).[18] The BIS CBS provide quarterly data since 2000 on international outstanding claims and liabilities of banks headquartered in 31 reporting countries vis-à-vis the resident sector of more than 200 counterparty countries.[19,20] With regard to the holder, CBS provide information on foreign financial positions of banks' head offices on a global consolidated basis, i.e. including both cross-border claims and the exposures of own foreign affiliates in host countries (both in foreign and local currency), and excluding inter-office positions (BIS, 2009). With regard to the type of asset, foreign financial claims include mainly interbank deposits, loans to banks and non-banks, and holdings of debt and equity securities.

[18] While the BIS CBS are based on the nationality of the reporting banks' headquarters, the BIS LBS are based on the residency of reporting banks. LBS are therefore consistent with balance of payments data. A loan granted to the UK resident sector by a UK branch of a US-headquartered bank is accounted for under the CBS, but not under the LBS. CBS have been generally preferred for empirical studies since LBS did not disclose until recently the breakdown of the residency of counterparties by the nationality of the reporting institutions. Importantly, CBS data include the local lending of foreign-based affiliates of domestic-owned banks.

[19] For a number of reporting countries, data are available from 1983 on a semi-annual basis.

[20] Along with data on an *immediate* borrower basis, the BIS CBS encompass data on an ultimate risk basis. The latter are based on the residency of the counterparty ultimately responsible for the repayment of an obligation, and take into account risk transfer positions via derivatives and off-balance-sheet items. However, CBS on an *ultimate* risk basis are only available since March 2005 for 26 reporting countries (BIS, 2009).

A few studies (e.g. Beirne and Friedrich, 2017) use balance of payments data on cross-border non-bank inflows from the International Financial Statistics (IFS) of the International Monetary Fund (IMF) to complete the information on bank claims from the BIS. While benefiting from a longer time span than the BIS dataset, the IMF IFS dataset has an important shortcoming, namely it provides data on cross-border bank flows to (from) each recipient (source) country, without disaggregating by counterparty country.

BIS banking statistics are more suitable for empirical studies since they provide the cross-country breakdown of counterparty residency for each reporting member. Therefore, the dependent variable can be specified as the foreign bank inflows to each recipient country r from each source country s, which potentially yields over 30*200 bilateral international relations. Using this bilateral dimension, the equation of pair-wise banking flows is often specified as a gravity model (see below). To the extent that macroprudential regulation targets domestically authorised banks, BIS statistics can be used to estimate potential outward spillovers.

However, BIS data have some shortcomings related to their high level of aggregation. First, they remain aggregate, so that it is not possible to disentangle supply effects from demand effects by using heterogeneity in the reaction to macroprudential measures across banks. Second, although BIS statistics disclose pair-wise exposures among countries, on a bilateral basis they do not provide the split between branches' and subsidiaries' local exposures (they only provide the split between cross-border claims in foreign currency and local claims by foreign affiliates in local currency). As a consequence, the type of potential inward spillovers (either via the adjustment of foreign creditors' risk profile or via regulatory arbitrage/leakages) is hard to identify. These deficiencies also apply to the IFS data.

To address these shortcomings, some studies complement BIS statistics with more disaggregated information. Rather than using more granular data to better identify credit supply shifts, they seek to explore the extent to which foreign bank flows are due to foreign affiliates. In this vein, Reinhardt and Sowerbutts (2015) use information on the share of subsidiaries in the total of foreign affiliates drawn from Fiechter et al. (2011) and from some national supervisory data. Houston et al. (2012), on the other hand, gather bank-level data from BankScope. The latter dataset is also used by Avdjiev et al. (2017) to compute bank balance sheet characteristics as control variables.

The ECB balance sheet item (BSI) statistics are another potentially useful data source. The BSI statistics provide comprehensive information at a monthly frequency on cross-border (and domestic) claims and liabilities of monetary financial institutions resident in euro area countries (and EU Member States for some series) from 1997 onwards, broken down by instrument, counterparty sector and country (the latter only on a quarterly basis). The BSI statistics are residency-based and hence not consolidated. This implies that business from affiliates of banks from country A operating in country B is included in the domestic loan volumes for country B, and not as cross-border banking flows. In turn, business from foreign affiliates of banks headquartered in B and operating in A is not included in the credit aggregates of country B. Although BSI statistics provide a comprehensive breakdown by

counterparty sector and country, the latter is only available from late 2014 onwards. This may explain why this dataset has not been used in empirical (time-series) studies dealing with cross-border spillovers from macroprudential policies. One exception, however, is Gross et al. (2016) who employ the BSI data in a cross-section GVAR setting to explore cross-border spillover effects of shocks to bank capital.

The main explanatory variable is a measure of the activated macroprudential policies. Box 2 provides an overview of the approaches taken so far (in principle applying to both the macro- and micro-level studies).

Box 2
Measurement of macroprudential policies

The vast majority of the empirical studies on the impact of macroprudential policies exploring a cross-country dimension employ one of three large databases on bank regulation: (i) the Bank Regulation and Supervision Database introduced by Barth, Caprio and Levine (2008) and implemented by the World Bank; (ii) the BIS database of information on macroprudential measures related to the housing market (introduced by Borio and Shim, 2007, and extended by Shim et al., 2013); and (iii) the IMF database of macroprudential policies introduced by Lim et al. (2011).

The dataset of Barth, Caprio and Levine (2008) encompasses a range of indices measuring bank regulation and supervision in over 100 countries. The dataset has been updated four times. The first wave covers the years 1998-2000, the second 2003, and the last two 2007 and 2013. The scope of the database is very broad, e.g. it includes diverse restrictions on banks' activities, the strength and independence of bank supervisors, and the transparency and quality of external audit – in essence microprudential restrictions. Among the measures closer to the macroprudential realm, Barth et al. (2008) consider the capital regulatory index (reflecting the extent to which capital regulation takes into account diverse latent and materialised risks). The dataset also allows the tracking of the implementation of Basel II capital regulations.

The database of Borio and Shim (2007) used and extended by Shim et al. (2013) and Kuttner and Shim (2013) includes detailed information on policies targeting housing sector imbalances in over 50 (mostly developed) economies. The database includes information on the use of instruments such as risk weights, provisioning rules, borrower-based measures and sectoral exposure limits.

The IMF database of Lim et al. (2011) found its most recent continuation in the Prudential Instrument Database developed for the needs of the International Banking Research Network (IBRN) and described by Cerutti et al. (2016). The latest updates of the database stem from the regular (bi-annual) IMF survey on Global Macroprudential Policy Instruments (GMPI). At the current juncture, the Cerutti et al. (2016) database contains quarterly information spanning from 2000 to 2014 for 64 countries on instruments such as general capital requirements, sector-specific capital requirements (split into real estate credit, consumer credit, and other), interbank exposure limits, concentration limits, LTV ratio limits, and reserve requirements (in local and in foreign currency). Other studies merge information from the above databases, often marginally extending their coverage. This is the case for Kang et al. (2017).

A comprehensive dataset of macroprudential policies (MaPPED) has been developed and described by Budnik and Kleibl (2018). It covers the implementation of macroprudential policies

across all EU countries from 1995 onwards, and extends the scope of the IMF database along various dimensions. First, it contains a richer set of instrument types such as distinct CRD IV capital buffers or liquidity requirements. It also improves the quality and comparability of information across countries for overlapping instruments. Second, it keeps track of both implementation and announcement dates, improving the identification of the effects of each policy. Third, it groups policy instruments into those affecting domestic exposures and those affecting foreign exposures of banks, which may be relevant for the purpose of assessing spillover effects of macroprudential policies.

In addition to the availability of the data on the timing of macroprudential policies, another challenge is measuring the "intensity" or "magnitude" of the actions. Because of the great heterogeneity of policies across countries, authors commonly focus on tightening or easing episodes of macroprudential instruments falling under broader instrument categories, without distinguishing between the size of the policy measures[21] (i.e. whether for instance a countercyclical capital buffer (CCyB) requirement is tightened by, say, 50 or 100 basis points). Studies differ in the aggregation of policy instruments when building policy indicator variables. However, if not otherwise mentioned, most studies measure macroprudential policies with a set of discrete variables that take a value of 1 for quarters and countries when a tightening of a macroprudential measure has taken place, -1 for quarters and countries when a loosening of a macroprudential measure has taken place, and 0 otherwise. The second type of index is constructed as the sum of all changes in that policy instrument recorded prior to and during the quarter of interest. These indices thus proxy the overall change in the tightness of an instrument at a given point in time.

The usual empirical specifications in most studies can be summarised by the following equation:

$$Bank\ flow_{r,s,t} = \alpha + \beta Regulation_{r(s),t-n} + \varphi Controls_{r(s),t-n} + \phi Interactions_{r(s),t-n} + \delta_{r(s)} + \theta_t + \varepsilon_{r,s,t}$$

Particularly when data allow for a quarterly frequency, explanatory variables may enter the equation with lags of (n) periods, to take into account the delay in the response of bank flows to policy variables. $Bank\ flow_{r,s,t}$ stands for the bank flow to country r from country s at time t. Regulation is generally a vector of indices representing prudential policy actions in source economies, but at times also the prudential policy stance for recipient countries. Controls is a vector of variables controlling for features of country r that may also include features of country s, or the gap between the two, which captures some sort of "distance" derived from gravity-type models. Generally these are time-varying variables aimed at taking into account the demand for and supply of credit in r and s, the relative position of the domestic financial and business cycles, and banking sector characteristics (e.g. size, liquidity and capitalisation). In some cases, these variables capture more structural features, and are usually measured at low frequency (e.g. financial development, capital flow mobility, institutional quality, banking sector concentration or efficiency, presence of affiliates from s in r), or are even time-invariant controls (e.g. geographical proximity, common language). The latter may also be introduced as country fixed effects, $\boldsymbol{\delta}_{r(s)}$.

[21] A more elaborate approach to measuring the intensity of macroprudential instruments has been proposed by Vandenbusche et al. (2015), while assessing the impact of housing market-related measures on house prices.

Some specifications also take into account global push factors in international bank flows, such as monetary policies in core economies or global risk aversion. They do so by either including these factors as control variables, or "packaging" them as time fixed effects, θ_t. Finally, some specifications include an Interactions vector encompassing the product of each Regulation index and some of the control variables. Empirical studies that do so seek to pin down whether some factors in recipient and/or source countries (e.g. bank balance sheet characteristics, presence of affiliates, banking efficiency, capital account openness, or belonging to the euro area) attenuate or enhance the average effect of prudential policies.

Key findings

The empirical studies surveyed here are sorted according to the type of macroprudential measure evaluated in the study. The extent to which inward and outward spillovers are captured in a study is highlighted. While usual databases on macroprudential instruments reflect both policy tightening and easing, in what follows we generally refer to the tightening of measures.

One strand of literature examines the efficacy of broad indices of macroprudential measures. This literature identifies: (a) inward spillovers from an aggregate index of macroprudential policy; and (b) outward spillovers from broad indices of capital flow management measures (CFMs)[22] and from jurisdictions with more stringent capital regulation.

Studies focusing on the efficacy of broad indices of macroprudential measures tend to find some evidence of inward spillovers. Cerutti et al. (2017) build a comprehensive cross-country database on prudential instruments and use an aggregate index to estimate the potential spillovers. A macroprudential policy tightening is found to entail a rise in the share of non-financial sector liabilities vis-à-vis foreign banks, suggesting the existence of some type of inward spillovers.

Focusing on CFMs of a macroprudential nature, Beirne and Friedrich (2017) find some evidence of geographical reallocation amounting to outward spillovers. A tightening of CFMs by a domestic country entails increasing bank inflows to the banking sector of other economies in the same region. Still, the latter effect is statistically significant only for recipient advanced economies, and only when it arises from well-regulated and efficient (i.e. low cost-to-income ratio) banking sectors in activating countries.[23]

Studies that explicitly focus on spillovers but still use broad measures of banking regulation suggest that international bank funds tend to flow out from countries with more stringent capital regulation to more lenient jurisdictions.

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22 This refers to financial sector controls and foreign currency-related measures. Both are considered CFMs insofar as they are macroprudential measures potentially affecting capital flows to/from residents.

23 Another strand of literature, more focused on capital controls, finds a different type of outward spillovers. When domestic authorities tighten residency-based CFMs, part of the capital from the rest of the world that used to flow to the domestic country (e.g. Brazil) is diverted to neighbouring countries (e.g. in Latin America); see, for example, Lambert et al. (2011) and Forbes et al. (2016).

The effects of regulation in both the domestic and the foreign country are analysed, so that both negative inward and positive outward cross-border spillover effects are found. Using a variety of estimation techniques and correcting for potential endogeneity bias, Houston et al. (2012) find evidence of this search for friendlier regulation, or regulatory arbitrage. The latter occurs not only via a rise in cross-border banking flows, but also through a higher presence of foreign affiliates in more lenient jurisdictions. Their findings, however, are confined to the pre-crisis period. Besides, the study remains silent about the potential role of monetary policy gaps across countries. Bremus and Fratzscher (2015) also find evidence of banking flows to less capital-stringent jurisdictions when comparing the average growth of cross-border claims between the pre-crisis and the post-crisis periods. However, this effect might also be explained by expansionary monetary policies in domestic countries in the post-crisis period. Moreover, the euro area banking sectors actually reduced outward cross-border claims when facing relatively stricter domestic capital regulations.[24]

Another strand of literature that focuses on more targeted macroprudential measures finds evidence of both inward and outward spillover effects, although the effects depend on the specific instrument. The main findings of these studies are that: (a) inward spillovers (leakages) arise from macroprudential instruments targeting national lenders; (b) outward spillovers (cross-border credit reallocation) arise from instruments targeting borrowers; and (c) there is mixed evidence on cross-border spillovers related to changes in reserve requirements and capital-based instruments.

Inward spillovers tend to arise from measures targeting domestically authorised lenders on a consolidated basis. The above finding of cross-border spillover effects due to a search for friendlier capital regulation no longer holds when studies use more targeted macroprudential policy measures. Using a more granular macroprudential database and controlling for the relative role of foreign affiliates, Reinhardt and Sowerbutts (2015) find that when a country (d, r) tightens measures that apply to lenders under national jurisdiction, such as capital instruments, the non-financial sector increases borrowing (f, s) from foreign banks.[25] The effect is enhanced if foreign affiliates located in (d) consist mainly of branches of banks headquartered in (f), rather than subsidiaries. This form of inward spillover may be associated with regulatory leakages, as foreign financial institutions benefiting from a competitive advantage step in to take over the activities left by regulated domestic banks.

By contrast, macroprudential instruments that target the borrower side (i.e. lending standards such as limits on LTV and debt-to-income (DTI) ratios) may entail outward spillovers. Specifically, Hills et al. (2017) find that a tightening of lending standards (i.e. borrower-based measures) in domestic economies (d, s) results in an outward cross-border credit reallocation, which increases bank flows to foreign countries (f, r). The same type of outward spillover is found for a tightening of

[24] This latter effect could, however, also be due to the general pressure to deleverage non-core assets facing euro area banks during the sovereign debt crisis.

[25] The authors find similar evidence after a tightening of reserve requirements. However, the positive effect on inward banking flows is much less consistent than that of capital instruments.

reserve requirements. While capital instruments are applied on the basis of the globally consolidated banking group's nationality, lending standards and reserve requirements constrain the resident sectors in the domestic country (d). For these residency-based instruments, international banks from (d) may have incentives to raise funding and lend abroad, in order to keep their desired risk profile. In a similar vein, Kang et al. (2017) find that outward banking flows from credit reallocation can arise when the country (d) tightens measures targeting the borrower (e.g. LTV, DTI and loan-to-income (LTI) limits). Besides, they show that cross-border spillovers appear to be particularly sizeable for European countries.

In some cases, empirical evidence does not provide clear-cut results on the aforementioned pattern, particularly for reserve requirements and LTV limits. Consistent with the fact that reserve requirements are usually implemented on a residency basis, they are sometimes found to entail outward spillovers (e.g. Reinhardt and Sowerbutts, 2015). In turn, other studies find a rise in bank inflows into countries tightening local reserve requirements, both when including them in a broader index (Kang et al., 2017) and as a separate instrument (Avdjiev et al., 2017). The latter also find that bank inflows appear spurred by tighter LTV limits in the destination country, particularly from well-capitalised and liquid banking sectors in the source countries.[26] The unconsolidated level of application of both measures makes it difficult to explain the evidence on inward leakages. Avdjiev et al. (2017) argue that, since reserve requirements and LTV limits are often imposed to contain a potential credit boom, foreign banks would have some incentives to enter the activating country's market during the upward phase of the cycle. Yet this interpretation remains counter-intuitive, as a tightening of these instruments (particularly the LTV limit) would generally "tax" any type of lending to residents.

Capital-based measures targeting domestic lenders can also give rise to outward spillovers via credit reallocation and macro feedback effects. Gross et al. (2016) develop a Mixed-Cross-Section Global Vector Autoregressive (MCS-GVAR) model for 28 EU economies and a sample of individual banking groups to study the propagation of bank capital shocks to the economy. The model can be used to establish ranges of impact estimates for capital-related macroprudential policy measures, including countercyclical capital buffers, systemic risk buffers and global systemically important bank (G-SIB) buffers, also with a view to assessing the cross-country spillover effects of such policy measures. They demonstrate that outward cross-border spillover effects can be of meaningful magnitudes, and that they can occur both via direct cross-border lending activities and via macro feedback effects.

[26] On a gross flow basis, the authors also find some outward spillover effects from both local reserve requirements and LTV limits, but these results are neither robust to the specification nor do they hold in subsample estimates.

2.1.2.2 Empirical evidence based on bank-level (micro) data

Data and empirical specifications

Measuring the effects of macroprudential measures on bank loan supply is far from simple as there are many confounding factors, such as variation in bank lending due to changes in loan demand. These are likely to vary across banks and countries, and over the cycle, all of which cannot be accounted for using macro data only. The use of micro data helps in addressing these factors.

The main dependent variable in micro data-based studies is generally specified as bank lending since this is the key transmission channel running from banks to the real economy. Using changes in loans as the dependent variable also has the advantage that loan data are relatively comparable across banks and countries (Buch and Goldberg, 2017). However, this type of bank-level data is usually collected by the national authorities acting in their capacity as bank supervisor and cannot be publicly shared. The granularity of data used ranges from the bank to sector level. Using growth in lending to different sectors as the dependent variable allows bank credit demand to be disentangled from bank credit supply (Aiyar, Calomiris and Wieladek, 2014a and 2014b).

In terms of explanatory variables reflecting changes in macroprudential policies, several studies looked at changes in bank capital requirements. Many of these studies are based on United Kingdom (UK) data, which contain information on capital requirements at the bank level and thus allow for conducting a unique "policy experiment" (Aiyar, Calomiris and Wieladek, 2014a and 2014b; Aiyar et al., 2014). During the 1990s and 2000s, the UK's Financial Services Authority varied individual banks' minimum risk-based capital requirements for all UK-owned banks and resident foreign subsidiaries. The change in the minimum capital requirement is expressed as a percentage of risk-weighted assets. To explicitly analyse leakages, Aiyar, Calomiris and Wieladek (2014a) regress branch lending growth on lending of a reference group of regulated banks instrumented by the change in capital requirements that occurred for that reference group. The alternative approach of Danisewicz et al. (2017) and the IBRN studies consists in using a set of indicator variables as described in Box 1.

When seeking to measure the effects on bank loan supply from changes in macroprudential measures, it is important to recognise and control for bank characteristics, loan demand, as well as country characteristics. Aiyar, Calomiris and Wieladek (2014a and 2014b) use the employment growth rate at quarterly frequency for each of the economic sectors analysed to control for bank credit demand. Depending on the framework, the specifications are estimated using different sets of fixed effects: bank-specific fixed effects that should capture heterogeneity in lending growth arising from relatively long-run, time-invariant bank characteristics, and country-specific fixed effects that should capture time-invariant country traits.

Time-varying country traits are controlled for by including macroeconomic variables such as GDP growth and inflation. Time-varying bank-specific

characteristics, such as Tier 1 capital, the ratio of risk-weighted assets to total assets, indicator variables that capture whether the bank is a subsidiary of a foreign bank, or whether the bank has assets that exceed a certain threshold, and changes in the ratio of write-offs to risk-weighted assets (to control for changes in loan quality) are included using data from BankScope and regulatory databases (Aiyar, Calomiris and Wieladek, 2014a and 2014b; Aiyar et al., 2014; Buch and Goldberg, 2017).

Key findings

While empirical evidence relying on aggregate data tends to find that lending declines when regulations tighten, evidence from using micro data shows a more mixed pattern of responses to macroprudential policy actions. This difference might be due to a better identification in the latter, since the use of micro data helps in solving the identification problem which beleaguers studies based on aggregate data. However, before the IBRN initiative there was little evidence on cross-border spillover effects based on micro data from a broad range of countries, mainly because of the lack of cross-country data.[27] Several studies looked at prudential policy leakages from the perspective of one specific country, especially the UK.

The main issue explored by this literature is the extent to which cross-border activities affect the macroprudential policy effectiveness within a country's borders (i.e. inward spillovers). Indeed, efforts by domestic regulators to influence the aggregate supply of credit may be thwarted to some degree by "leakages", as other foreign credit suppliers substitute for the variation induced in the supply of credit by regulated banks. Credit substitution could occur through foreign banks operating domestic branches that are not subject to capital regulation by the domestic supervisor, or through bond and stock markets (inward spillover). Aiyar, Calomiris and Wieladek (2014a) focus on the leakages that arise when an instrument covers UK banks, but it is not applied to the branches of foreign banks operating in the domestic market. They conclude that leakages weaken policy effectiveness in the domestic market. Aiyar, Calomiris and Wieladek (2014b) show that foreign-regulated branches are an important source of credit substitution. Leakage by foreign-regulated branches can occur either as a result of competition between branches and regulated banks that are parts of separate banking groups, or because a foreign banking group shifts loans from its UK-regulated subsidiary to its affiliated branch, which is not subject to UK capital regulation. Their results suggest that the presence of both channels is important, but the responsiveness of affiliated branches is substantially stronger (roughly twice as strong). By contrast, they do not find any evidence of leakages through capital markets. This evidence has important policy implications: (i) significant leakages result from interbank competition, in addition to loan transfers between affiliated entities of the same banking groups, forcing foreign banks to consolidate their operations in each country into either a foreign branch or a foreign subsidiary;

[27] The IBRN brings together central bank researchers from around the world to analyse issues pertaining to global banks. One of the topics explored is the changing scale, type and location of banking activity stemming from shifts in micro- and macroprudential regulatory policy.

and (ii) international cooperation will be necessary to prevent regulatory arbitrage between domestically regulated banks and foreign branches.

There is evidence of outward spillovers via foreign branches and subsidiaries. The response of foreign branches to regulatory changes is also explored by Danisewicz et al. (2017) but from a different perspective. They compare the response of foreign banks' branches versus subsidiaries in the UK to changes in macroprudential regulations in foreign banks' home countries. By focusing on branches and subsidiaries of the same banking group, they are able to control for all the factors affecting parent banks' decisions. They document that following a tightening of capital regulation, branches of multinational banks reduce interbank lending growth by around 6 percentage points more relative to subsidiaries of the same banking group. This could depend on the higher degree of control which parent banks hold over branches than subsidiaries. By contrast, lending to non-banks does not exhibit such differences. Moreover, a tightening in measures other than capital requirements such as lending standards or reserve requirements at home does not have any differential effects. Outward spillovers are also analysed, among others, by Aiyar et al. (2014). They exploit exogenous changes in the capital ratios of UK banks to investigate whether these regulatory shocks are transmitted abroad. They find a negative and statistically significant effect of changes to banks' capital requirements on cross-border lending: a 100 basis point increase in the requirement is associated with a reduction in the growth rate of cross-border credit of 5.5 percentage points.[28] They also document that the negative cross-border credit supply response is significantly lower in "core countries" (identified using the relative magnitude of the lending relationship) than in others. Furthermore, banks tend to cut back cross-border credit to other banks (including foreign affiliates) more than credit to firms and households.

Cross-border spillovers may also occur via banks' risk-taking behaviour. Pioneering in reporting a cross-country perspective on cross-border spillover effects of bank regulation is the paper by Ongena, Popov and Udell (2013), which explores lending across 16 different European countries. They show that tighter restrictions on bank activities in home countries lead cross-border banks to extend loans to opaque corporate clients in host-country markets. Home-country regulation that reduces the scope of bank activities in domestic markets results in higher risk-taking abroad, implied by relatively more lending to informationally opaque firms. Since informational opacity is associated with higher ex ante risk, this result suggests an increase in risk-taking.

More insights about inward and outward spillovers of prudential policy from a cross-country perspective have been gained thanks to the IBRN. The IBRN's multi-study initiative provides specific country and cross-country evidence using detailed banking micro data, which makes it possible to account for heterogeneity at

[28] They use capital requirements expressed in basis points, rather than dummies. An increase in the capital requirement from 11% to 11.5% of risk-weighted assets (RWA) is measured as a 50 basis point increase, rather than as a 4.5% increase; in other words, an increase from 11% to 11.5% is treated the same as an increase from 2% to 2.5%. In fact, policymakers are typically interested in the credit supply impact of raising or lowering capital requirements by a certain number of basis points and the minimum capital requirements are quite tightly distributed within a range from about 8% to 15% of RWA.

the bank level. The studies exploit variation in prudential instruments across countries, bank balance sheet characteristics, and the location of foreign affiliates. Identification using heterogeneity and a consistent methodology across the countries involved in the project is greatly aided by the degree of granularity of the data used. In particular, the effects of five different prudential instruments are tested in 15 countries (general capital requirements, sector-specific capital buffers, LTV ratio limits, both foreign and local reserve requirements, interbank exposure limits and counterparty concentration limits), and there are two cross-country studies.[29] It should be noted that while the definition of outward spillovers used in the context of the IBRN initiative is the same as the one proposed in this report, the definition of inward spillovers is not.[30]

Based on the meta-analysis of the 15 country-specific and two cross-country studies, the IBRN research obtains three main findings summarised in Buch and Goldberg (2017): (i) prudential instruments spill over internationally via the lending channel, but there is heterogeneity in the size and direction of transmission;[31] (ii) the magnitudes of spillovers are not large on average, but the pattern of results highlights the potential for larger and more consequential spillovers as the use of macroprudential instruments increases; (iii) the effects of prudential instruments on lending vary depending on individual bank characteristics such as balance sheet size and composition, business models, or internal liquidity management via banks' internal capital markets. For example, foreign affiliates with higher illiquid asset shares and with stronger reliance on deposit funding tend to respond more to LTV ratio limits and sector-specific capital buffer changes in the parent location.[32] Overall, this finding suggests that a tightening of prudential regulations could induce a reallocation of market shares away from weaker banks towards banks with stronger balance sheets. The majority of the national studies within the IBRN reveal that the two prudential measures that have the most significant impact on international bank lending are limits on LTV ratios and reserve requirements.[33] Furthermore, the analysis conducted in the context of the IBRN suggests that outward spillovers are more likely to be observed towards countries where foreign banks have a high market share and with fewer banks, highlighting the importance of market concentration for the cross-border transmission mechanism of prudential actions.

The evidence for the euro area suggests that the direction and magnitude of spillovers depend on the type of policy instrument. Using a similar methodology as in the context of the IBRN, Franch, Nocciola and Żochowski (2017) analyse the cross-border propagation of prudential regulation in the euro area (see also Nocciola and Żochowski, 2016). Using a unique confidential database on balance sheet items

29 See Buch and Goldberg (2016) for a review of all the contributions to the IBRN.

30 Inward spillovers, as defined in this report, are closer to the concept studied by Aiyar, Calomiris and Wieladek (2014a and 2014b).

31 As reported by Buch and Goldberg (2017), almost all prudential instruments have been associated with both positive and negative spillovers.

32 In particular, banks' size, core deposit ratios, capital ratios and illiquid asset ratios appear to be important features of the transmission of outward spillovers through foreign affiliates of domestic parent banks (Avdjiev et al., 2016).

33 A tightening of lending standards (i.e. borrower-based measures) is found to entail cross-border credit reallocation, which increases bank flows towards foreign countries. Specifically, Hills et al. (2017), analysing data from the UK, find that when a foreign authority takes a lending standards action, UK-resident affiliates owned in that jurisdiction expand private non-financial corporation and household lending in the UK.

of euro area financial institutions, they estimate panel models for 248 banks from 16 euro area countries. They find evidence of outward spillover effects in the sense that domestic banks reduce lending after the tightening of capital requirements in other countries, while they increase lending when LTV limits or reserve requirements are tightened abroad. They also find that foreign affiliates increase lending following the tightening of sector-specific capital buffers in the countries where their parent banks are headquartered. Their findings suggest that instruments directed at specific borrowers/sectors, such as LTV limits or sector-specific capital buffers, or acting locally, such as reserve requirements, are prone to positive cross-border spillovers, while the tightening of tools which act at the consolidated level, such as capital requirements, has negative spillovers, i.e. it leads to a decrease in lending also abroad.

2.2 Other bank activities: cross-border spillovers related to equity, bond and derivatives markets

Most existing macroprudential tools explicitly or implicitly target banks' lending policies. However, policies affecting the lending behaviour of banks may also trigger adjustments to the overall balance sheet and, for instance, capital market-related non-lending activities could be influenced in the process as banks re-optimise their risk-return characteristics following the "policy shock". As most of these latter activities (e.g. securities and derivative transactions) tend to be international in nature, cross-border spillover effects of macroprudential measures may arise through these channels.

This notwithstanding, there are very few studies that explore this macroprudential policy dimension. Overall, the assessment of the TFSE is that cross-border spillovers via such bank non-lending channels can be non-negligible, but may be difficult to capture with existing tools. This calls for further work on developing indicators and analytical tools that can capture these transmission channels for use in future macroprudential impact assessments of cross-border spillover effects.

Although macroprudential measures are typically aimed at bank lending, they may also extend to other activities, by altering the international demand for assets. While equities and bonds constitute a substantial part of banks' total assets, macroprudential policies typically do not explicitly target these instruments.[34] At the same time, banks' holdings of equities and bonds form part of the risk exposure amount (REA) – either in the banking book or in the trading book – and therefore will be at least indirectly affected by changes in e.g. sectoral risk weights and overall capital requirements. Any reshuffling of the securities portfolio triggered by a macroprudential action might give rise to price effects on those instruments, thereby potentially generating spillovers to other domestic and non-domestic holders of these and of correlated instruments. As an example, it has been argued that macroprudential policies in core advanced economies can trigger capital flows

[34] In principle, liquidity requirements (such as the net stable funding ratio and the liquidity coverage ratio), if used for macroprudential purposes, would have a more direct bearing on banks' securities portfolios.

following the reallocation of portfolios, potentially entailing spillover effects on third countries, particularly emerging market economies (EMEs) (see Turner, 2016). This could lead to the appreciation of EMEs' currencies and an increase in the volatility of bond yields in these economies (Claessens, 2016).

While the majority of contemporary macroprudential policies do not explicitly target derivative activities[35], they may affect cross-border activity in derivatives by altering banks' incentives.[36,37] For instance, stricter capital requirements may lead banks to extend their activity in derivatives in order to "release" assets or raise market funding so that they can increase their lending. Another way in which macroprudential regulation can spill over via derivative activities is if banks have an urgent need for liquidity to satisfy liquidity floors or caps, or if there is a need to hedge against large FX exposures. Nevertheless, most of the regulatory changes affecting derivative transactions since the global financial crisis have focused on microprudential aspects.[38] An important part of those initiatives has also centred on the mutual recognition of cross-border activity and the harmonisation of rules across jurisdictions.[39] This will help smoothen cross-border transactions between the largest derivatives markets, which in turn may amplify potential cross-border spillovers of derivatives market activities.

The literature on the impact of macroprudential policies on bond, equity and derivatives markets is scarce and does not distinguish between effects on domestic and foreign markets, usually focusing on the impact on (international) asset prices. In general, for domestic macroprudential policies to have an impact on foreign equity, bond and derivatives markets, two necessary conditions have to be met. First, banks should have an incentive to sell derivative contracts or the underlying assets in response to a change in domestic macroprudential policies; second, their holdings of those types of instruments will have to be large enough to generate an effect on prices in the event of a sell-off.

Cross-border spillover effects on foreign asset markets can be split into direct and indirect channels. Indirect channels may involve the bank lending channel described earlier, or trade and exchange rate channels. For instance, in response to a domestic policy change local banks might deleverage their loans to foreign non-financial corporations. This will increase the cost of funding for these non-financial

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35 Exceptions are rules restricting (temporary) short-selling of certain instruments, or restrictions on the quantity or composition of certain derivatives in the investment/loan portfolios.

36 A derivative is a financial contract that derives its value from an underlying asset. The buyer agrees to purchase the asset on a specific date at a specific price. The contract's seller does not have to own the underlying asset. He/she can fulfil the contract by giving the buyer enough money to buy the asset at the prevailing price. He/she can also give the buyer another derivative contract that offsets the value of the first. This makes derivatives much easier to trade than the asset itself.

37 There were proposals to implement margin and haircut requirements to achieve macroprudential outcomes and target collective action problems and externalities caused by microprudential collateral requirements and margin and haircut practices (ESRB, 2016). Nevertheless, at the time of writing, those policies had not been implemented.

38 Such as the standardisation of over-the-counter contracts, the trading of derivatives via central counterparties, collateral requirements, margin and haircut practices, etc.; see e.g. the CFTC regulation and cross-border rules for the US, and ESMA's EMIR rules for the EU.

39 In the EU, the European Commission and ESMA have worked on the implementation of MiFID II, which regulates the activity on derivatives markets across the Union. As recently as February 2016, the EU and the US reached an agreement on derivatives regulation and microprudential supervision.

corporations and thereby have an impact on the price of their equities and debt – ultimately affecting the foreign financial market. A more detailed description of indirect and direct channels by instrument is provided below.

Equity markets

Direct cross-border spillovers to foreign equity markets are transmitted via price effects. In particular, equity prices of foreign banks might be affected by the activation of macroprudential policies in a domestic jurisdiction. A foreign bank active in the domestic market might need either to raise capital or to restructure at the consolidated level in order to comply with the policy change. In both cases, we could observe an effect on the equity price of the consolidated entity. A domestic bank might entirely or partially sell its foreign equity positions in its trading portfolio. Equity markets are global markets and all large euro area banks have some holdings of foreign equities (especially via stock indices). If a domestic bank decides to offload a substantial part of its foreign equity holdings, it might result in a non-negligible effect on the price of the latter.[40]

Bond markets

Macroprudential policies can result in cross-border spillover effects via foreign bond markets in similar ways to equity markets. The price of bonds may be altered by capital and liquidity macroprudential policy requirements (ESRB, 2016a) and capital flow management measures (CFMs) of a macroprudential nature (Claessens, 2016). The cross-border spillover effects can materialise in the form of a persistent bond yield deviation from fundamentals, changes in price volatility and bid-ask spreads, and risk-taking along with changes in the valuation of assets. These spillovers can either be negative (as a result of an underpricing of risk or a mispricing of bonds) or positive (due to higher resilience and the correct pricing of risks).

Banks in a domestic jurisdiction that activate a measure might sell entirely or in part their foreign bond positions, thereby affecting their prices. In contrast to their equity holdings, banks hold a relatively large share of corporate and sovereign bonds. The likelihood that a sell-off of these securities by banks in the activating country might trigger a price effect is therefore (in principle) high.

Derivatives markets

The main channel via which macroprudential policies might have spillover effects on foreign derivatives markets is the deleveraging of derivatives from the trading book. Derivatives might be used for hedging activities or for trading purposes. While in theory the two are separable, in practice they are much harder to

[40] However, euro area banks' equity portfolio represents a small share of the trading portfolio and euro area banks' equity holdings account for a small share of the equity market. Therefore, it is generally unlikely that this channel could play a significant role in the transmission of cross-border spillover effects.

delineate, as the same bank can use derivatives to cover a credit/interest rate/currency exposure and, at the same time, take advantage of arbitrage opportunities and sell them off for a margin and remove them from its books. In addition, by hedging against the risks from a credit line and removing it from the books, a bank would release credit from its assets side (from a regulatory and risk management perspective), which would allow it to extend new credit by the same amount as was hedged. Thus, estimating the total impact of cross-border trading and regulation on derivatives is far from straightforward as it is not easy to disentangle these two purposes. Furthermore, there are challenges in precisely defining the cross-border dimension of derivative transactions (see Box 3 for a discussion).

Regulation can smoothen this cross-border process, or at times hinder it. Some recent papers (Cenedese et al., 2017; Du et al., 2017) have shown that bank regulation has prevented banks and market-makers from exploiting arbitrage opportunities in the (currency) derivatives markets, and closing the covered interest parity (CIP) gap. This can have consequences for the volume and price of derivative trades beyond the national market, with material impacts on banks' books further down the line.

Box 3
Defining cross-border activity in the derivatives market

Defining cross-border activity in the derivatives market is not straightforward as the market is global and the majority of actors engaging in derivatives trading are multinational in their activities. There are derivative contracts on virtually all types of assets, but in Europe interest rate derivatives dominate (with 75% of total over-the-counter market activity), followed by currency derivatives (14%), and commodities. In terms of size, listed derivatives in Europe are three times smaller than those in the US. While many types of actors engage in this market, banks dominate both on the issuance and buy side, in particular in Europe. The literature has proposed a variety of criteria to pin down cross-border activity in the derivatives market.

The first uses currency as the separating criterion, whereby trades in currencies other than the domestic one define cross-border transactions. While intuitive, there are multiple problems with this definition because of, for example, the dominance of the United States (US) dollar in global derivatives trading, the usage of the euro across borders in the euro area, and the currency unit problem in hedging using currency derivatives.

The second criterion is the location of the trade exchange. The problem here is that not all cross-border contracts are settled abroad, or that multi-party contracts can have multiple settlement locations.

The third focuses on the nationality of the counterparty. Here the difficulty is to determine nationality when counterparties are global. For instance, if the contract is with a UK subsidiary of a US-headquartered bank, it is not clear whether the ultimate counterparty is the UK or US national.

Another frequently used criterion, in particular for the US, is whether the counterparty is resident or not. Looking at the shortcomings of the previous criterion, the key idea behind this is that what defines a cross-border transaction is not the nationality of the counterparty, but whether the counterparty is permanently resident in that country or not. The main shortcoming of this criterion is

that it is a home country-centred approach as the determining factor is whether the counterparty (permanently) engages in your market, or not. It therefore fails to acknowledge broader aspects of cross-border derivative activity.

The final criterion, capturing the shortcomings of the previous criteria, is based on the legal aspect of the issuer/buyer, namely whether the derivative was issued (or bought) by a headquartered legal residence entity, or an international sub-entity. The main challenge when using this criterion is the level of detail and the granularity of data needed in order to process this filter.

Some empirical findings

The empirical literature on cross-border spillover effects of macroprudential policies on equity, bond and derivatives markets is virtually inexistent. The closest related literature focuses on the effects of capital regulation on banks' equity and bond prices, but without distinguishing between domestic and foreign markets.

Bank stock prices tend to decline following capital increases. Cornett and Tehranian (1994) examine differences in stock price reactions following voluntary capital injections by commercial banks and involuntary capital injections required to meet regulatory capital requirements. The authors find that stock price declines associated with voluntary common stock issues are significantly greater than those associated with involuntary common stock injections, consistent with Ross (1977). Empirical tests also confirm that for both voluntary and involuntary stock issuances, the abnormal stock price reaction is negatively related to the relative size of the offering and positively related to managerial ownership prior to the security issue, although these relationships are stronger for voluntary issues. Elyasiani et al. (2013) examine investors' reactions (in terms of equity price returns) to announcements of large capital infusions by US financial institutions from 2000 to 2009. These infusions include private market infusions (seasoned equity offerings – SEOs) as well as injections of government capital under the Troubled Asset Relief Program (TARP). Investors reacted negatively to the news of private market SEOs by financial institutions, both in the immediate term (e.g. the two days surrounding the announcement) and over the subsequent year, but positively to TARP injections.

Capital issuance tends to have more negative stock price effects for banks than non-banks. Li et al. (2016) study the differences in the announcement effects of SEOs of commercial banks and non-banks, and explore the influence of bank regulation and the financial crisis on such differences. The authors find that abnormal stock returns upon SEO announcements for US commercial banks are significantly higher than those of non-banks, consistent with the hypothesis that bank regulations reduce the likelihood that bank SEOs signal overpriced equity. The propensity score matching-based difference-in-difference analysis indicates that the differences in stock returns between banks and non-banks decreased during the 2007-09 financial crisis period and increased after the passage of the Dodd-Frank Act in 2010.

The above-mentioned studies by Turner (2016) and Claessens (2016) suggest that macroprudential policies can create cross-border spillover effects via the bond markets. However, it is difficult to empirically disentangle the direct impact of macroprudential policies from other common (push or global) factors, such as macroeconomic policies in advanced economies, global investor risk aversion, etc. In particular, cross-border spillover effects from macroprudential policies may be indirectly enhanced by spillovers from monetary policy (Rawdanowicz et al., 2014; Claessens, 2016) and exchange rate movements (Hofmann et al., 2017), respectively.

2.3 Non-bank channels

Macroprudential policy measures targeting the banking sector may also impact the economy via non-bank channels. This could occur through migration of bank activities to less regulated non-bank financial institutions ("shadow banking"[41]), resulting in leakages that may render the policy measures less effective. For instance, the banking sector has the possibility to use techniques to circumvent regulation by transferring exposures to entities, such as securitisation or special-purpose vehicles.

This section reviews existing studies that have analysed such bank/non-bank substitution effects initiated by macroprudential policy actions. While most of the studies do not explicitly consider cross-border spillover effects, the fact that shadow banking entities and their operations are typically international in nature implies by extension that any unintended spillover effects are likely to also have cross-border implications.

All in all, the topic of cross-border spillover effects of macroprudential policies involving bank/non-bank interactions is still at a nascent stage. There is, however, some evidence that macroprudential measures targeting the banking sector can have meaningful spillover effects on the non-bank financial sector.

Theoretical literature and empirical evidence

The rapid growth of non-bank financial institutions and their close interconnectedness with traditional banks is well documented (see e.g. Claessens et al., 2012; Pozsar et al., 2013). Malatesta et al. (2016) find that the euro area shadow banking system has grown in importance and became more interconnected with the traditional banking system after the global financial crisis. Errico et al. (2014)[42] show that European banks are large holders of US other financial corporations' debt securities. Pozsar and Singh (2011) focus on the rise of asset managers as a major source of funding for banks through the reuse of pledged

[41] The terms "non-bank financial institutions" and "shadow banking" are used interchangeably in what follows.

[42] The authors describe the shadow banking system in the US using a new Global Flow of Funds (GFF) conceptual framework developed by the IMF's Statistics Department.

collateral.[43] Consequently, the activities of non-banks can pose a risk to macro-financial stability.

A recent strand of literature analyses interactions between traditional and "shadow" banks. Gornicka (2016) considers traditional banks' incentives to gain off-balance-sheet exposure by extending implicit guarantees to shadow banks. Hanson et al. (2015) present a framework where shadow and traditional banks have access to a common pool of liquidity. They show that traditional banks have a comparative advantage in holding illiquid assets with low fundamental risk when they are protected by deposit insurance guarantees. In a similar environment, Luck and Schempp (2016) find that shadow banking grows excessively large from a social viewpoint due to pecuniary externalities similar to fire-sale externalities. Fire sales caused by the liquidation of shadow banks play a key role in spreading financial instability to traditional banks. Shleifer and Vishny (2011) provide an extensive review of the literature on fire sales, while Krishnamurthy (2010), Merrill et al. (2012) and Mitchell and Pulvino (2012) provide empirical evidence for fire sales during the financial crisis. Diamond and Rajan (2005) show that (shadow) bank failures cause contagion by aggravating liquidity shortages in the rest of the financial sector. Ari et al. (2017) derive an equilibrium where ex ante identical banks endogenously cluster into traditional and shadow banking strategies. Commitment is costly and traditional banks pay a lump-sum cost to commit to a safe portfolio strategy. The commitment costs reflect any costly action undertaken by banks to resolve asymmetric information issues with their depositors, such as issuing detailed balance sheet reports, eschewing opaque intermediation processes like securitisation, or issuing costly equity with voting. Gennaioli et al. (2013) emphasise the ability of shadow banks to generate safe assets through securitisation. They show that shadow banks become excessively exposed to systemic risk when low probability tail events are neglected by investors. In a similar vein, Moreira and Savov (2017) focus on liquidity transformation whereby shadow banks create money-like assets that become illiquid in times of high uncertainty.

In a model with banks and shadow banks, Goodhart et al. (2012, 2013) explore the transmission of five regulatory tools to mitigate defaults, credit crunches and fire sales. These five regulatory tools include limits on LTV ratios, capital requirements for banks, liquidity coverage ratios for banks, dynamic loan loss provisioning for banks, and margin requirements on repurchase agreements. They affect financial stability through different channels, e.g. by limiting credit for real estate mortgages during the boom, reducing incentives for regulatory arbitrage, or transferring intermediation to and from the shadow banking system. In both exercises, the model suggests that a combination of instruments including margin requirements directly affecting shadow banks would be an optimal policy option.

[43] Consequently, the activities of non-banks can contribute to a build-up of macro-financial risks, along with those of traditional banks. Acharya et al. (2013) document the collapse in the market for asset-backed commercial paper at the onset of the crisis, while Gorton and Metrick (2012) and Krishnamurthy et al. (2014) show a similar contraction in repo markets. Together, these two markets account for the vast majority of funding for shadow banks. Covitz et al. (2013) find that the drying-up of funding for shadow banks was associated with a rise in macro-financial risks such as uncertainty about sub-prime mortgage values. In their framework, early withdrawals are triggered by a negative revision of expected asset pay-offs.

In all these studies, regulatory constraints restrict intermediation by traditional banks and create opportunities for unregulated shadow banks. Fève and Pierrard (2017) use a small-scale DSGE model to show how shadow banking and macroprudential policies interact as they consider the effects of asymmetric regulation. They estimate the model only with US data and find that the imposition of asymmetric regulation on banks causes a leak towards the shadow banking sector, which in turn undermines the expected stabilising effects of macroprudential policies. Dempsey (2017) highlights the trade-off between a safer banking sector through the imposition of higher capital requirements and potentially channelling lending into the non-bank sector. The model suggests that overall welfare is actually maximised by safer banks, even if the aggregate default risk is higher. Harris et al. (2014), Plantin (2015) and Ordoñez (2017) highlight the role of regulatory arbitrage as a primary cause of shadow banking.

In a recent empirical study, Cizel et al. (2016) show that the imposition of macroprudential policy measures on the banking sector tends to lead to a substitution away from bank lending to non-bank lending. The authors measure the substitution of credit between banks and non-banks with the difference between the quarterly change in bank credit and the quarterly change in non-bank credit, scaled by total credit.[44] Overall, they show that the imposition of macroprudential policy measures results in a 2 percentage point (pp) increase in the provision of credit by non-bank financial institutions after the first year of macroprudential tool imposition, and the effect is even stronger in market-based economies (3 pp). Two years after the adoption of macroprudential policy measures, bank credit is reduced by 3.2 pp in advanced economies, while in emerging economies the slowdown is even more severe and close to 10 pp.

Further studies provide empirical evidence of the potential for substitution between bank finance and market-based finance. Baumann et al. (2005) highlight the substitution between market finance and bank corporate lending for UK firms and find clear statistical evidence that loan growth rises (falls) when corporate bond spreads increase (drop). Correa et al. (2015) find that a tightening of monetary policy in activating countries leads banks to rebalance their portfolios, as they limit domestic credit and substitute towards foreign non-bank borrowers from advanced economies.[45] Forster et al. (2011) analyse cross-border financial flows and highlight that the international transmission mechanism may operate differently through the banking and shadow banking sectors, particularly in periods of rising global risk aversion and counterparty risk.

Box 4 provides details about potentially useful data sources for measuring and monitoring the cross-border spillover potential via non-bank financial channels.

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44 Regarding measures of bank and non-bank credit, the authors use the BIS database on private non-financial sector credit (Dembiermont et al., 2013). The authors also use the World Bank's Financial Development Database (Cihak et al., 2012), which covers 80-100 countries for the period 1980-2012. This dataset provides information on the size of the balance sheets of banks and of various types of non-bank financial institutions.

45 Correa et al. (2015) use as the main data source the locational banking statistics compiled by the BIS.

Box 4

Data sources for gauging cross-border spillovers via non-bank financial channels and data gaps

In order to assess cross-border spillover effects via non-bank financial channels, a few data sources are worth highlighting.

The BIS database on private non-financial sector credit (as used by Cizel et al., 2016) can be useful. This database contains information on private credit data (loans, debt securities) for 40 economies (mostly advanced) over the last 40 years on a quarterly basis. In addition, the BIS's locational banking statistics (LBS) are a useful complementary source (see also Correa et al., 2015). This dataset is confidential and is only available to the central banks of the reporting countries. The LBS contain data on the aggregate cross-border claims and liabilities of banks located in 45 reporting countries on a quarterly basis since 1977, with a breakdown by currency, instrument (loans and debt securities) and type of counterparty (bank or non-bank).

Data on cross-border financial flows from other sources can also be assessed. The Financial Stability Board (FSB) has created a system-wide monitoring framework to assess global trends and risks in the global shadow banking system. The data series contains a broad measure and a narrow one. The main findings are presented in the annual FSB Global Shadow Banking Monitoring Report, published since 2011. The FSB's methodological framework is largely endorsed by the ESRB, which has an EU-level focus. However, the ESRB's framework uses an entity-based approach and an activity-based approach to shed light on the risks stemming from the legal form of financial institutions or their activities, respectively. The Organisation for Economic Co-operation and Development provides a data series for institutional investors (investment funds, insurance companies and pension funds), reflecting the level and structure of their financial assets. Data are presented at country level and include outstanding amounts of financial assets such as deposits, securities, loans and shares. The ECB's financial accounts statistics provide flow-of-funds data between different sectors of the economy broken down by instrument, sector and various other categories. Some country dimensions are also available.

3 Stocktake of existing analytical frameworks in use across the EU

This chapter focuses on current practices at institutions involved in the implementation of macroprudential policy. For this purpose, the FSC Task Force conducted a stocktake of analytical approaches employed by the relevant authorities in the EU, i.e. national central banks, national supervisory authorities and the ECB, in order to assess potential cross-border spillovers from macroprudential policy instruments. Although this chapter takes the ESRB guidance as a starting point to analyse the frameworks that relevant authorities have in place, it does not aim to assess compliance with the ESRB guidance.

The stocktake relies on information from multiple sources. As a starting point, the information provided by Member States' relevant authorities in reply to the ESRB follow-up questionnaire on compliance with Recommendation ESRB/2015/2 was analysed.[46] This analysis provided valuable insights into national analytical approaches, but the level of detail varied across countries. To ensure a comprehensive and up-to-date stocktake, the information was complemented by responses to a more granular questionnaire designed particularly for the purpose of describing in further detail the national frameworks in place. To avoid information duplication, the responses to the Recommendation ESRB/2015/2 questionnaire, notifications on the activation of macroprudential measures and limited public information were taken into account in designing the questionnaire. The information collected via the tailored questionnaire was instrumental for identifying best practices and providing recommendations for further development later in this report.[47]

The chapter is structured as follows. Section 3.1 recalls the main elements of the existing guidance on the analytical framework to assess cross-border effects. Section 3.2 reviews the frameworks currently used by relevant authorities for monitoring and assessing cross-border spillovers from macroprudential policies: Section 3.2.1 highlights the main features, Section 3.2.2 examines the use of model-based approaches, and Section 3.2.3 looks at indicator-based approaches, describing the indicators, the associated spillover channels and the underlying data sources and challenges. Finally, Section 3.3 discusses the plans by relevant authorities to improve the existing frameworks or to develop new frameworks, highlights perceived gaps in the current guidance that should be addressed in the future, and summarises the key findings.

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46 The first reporting on the implementation of Recommendation ESRB/2015/2 was due by 30 June 2017 (reports have to be sent to the ESRB every two years). The TFSE work stream responsible for the stocktake was granted access to this information via a General Board written procedure (GB/WP/2017/030 "Request to access the follow-up templates of Recommendation ESRB/2015/2 by MPPG TFSE") after signing declarations of confidentiality.

47 Sixteen responses from EU national authorities were received; these responses provide the main basis for the stocktake described in this chapter.

3.1 Basis for analytical frameworks for monitoring and assessing cross-border spillovers

The ESRB guidance has been a natural starting point for national authorities in developing their approaches to assessing cross-border effects of macroprudential policy measures. This guidance is provided in Recommendation ESRB/2015/2 on the assessment of cross-border effects (sub-recommendation A) and voluntary reciprocity for macroprudential policy measures (sub-recommendations B-D), and in the ESRB Handbook (Chapter 11). The recommendation has been adopted to ensure the effectiveness and consistency of macroprudential policy within a highly integrated European financial system. To this end, policymakers need to account for the cross-border spillover effects of policies and deploy suitable instruments to address them. A necessary first step is the systematic assessment of the direction, sign and size of potential cross-border effects. In a second step, a coordinated policy response in the form of (voluntary) reciprocity of national measures might be needed. The recommendation also seeks to ensure a consistent implementation of these steps throughout the EU, e.g. with regard to the channels assessed as well as the methods and data used. The ESRB Handbook provides guidance on establishing a monitoring framework for cross-border effects and a policy framework for coordinating reciprocity actions.

It is recommended that relevant authorities assess the inward and outward cross-border spillover effects from activating macroprudential measures ahead of their adoption and regularly monitor their impact. The ESRB Handbook identifies five economic and financial channels for potential spillovers:
(a) cross-border risk adjustments; (b) network formation and potential for contagion; (c) regulatory arbitrage; (d) altering credit conditions through the relative cost of lending; and (e) trade effects. The relative importance of these channels is instrument specific. Table 3.1 presents the evaluation carried out by the ESRB on channel relevance by instrument.

Table 3.1

Relative importance of the main transmission channels of macroprudential instruments

Degree of importance of the spillover channels:			Cross-border risk adjustment				Network and contagion		Regulatory arbitrage			Lending
Potentially strong transmission			Adjustments of cross-border credit exposures	Cross-border loan origination inward spillover	Adjustments of cross-border securitisation activity	Access to cross-border capital markets	Adjustments of cross-border liquidity / funding lines	Adjustments of asset prices	Capital regulatory arbitrage	Liquidity regulatory arbitrage	Shadow banking activity	Altering relative cross-border cost of lending
Potentially medium-strong transmission												
Potentially weak-medium transmission												
Transmission channel considered to be weak or absent												
		Level of consolidation										
Capital instruments	G-SII / O-SII buffer	consolidated										
	Systemic risk buffer / O-SII buffer	consolidated										
		sub-consolidated / solo (exposure-based)										
	Countercyclical buffer	consolidated										
	Leverage ratio	consolidated										
Sectoral choice	Sector-specific capital buffers, large exposure restrictions	exposure-based										
	Risk weights / Loss-given-defaults	exposure-based										
	LTV, LTI/DTI, DSTI (on new loans)	exposure-based										
Liquidity positions	Liquidity coverage ratio, liquidity charges	consolidated										
	Net stable funding ratio	consolidated										
	Loan-to-deposit	consolidated										
		solo										

Source: ESRB Handbook (Table 11.2).
Note: The ranking presented in the table is mainly based on expert judgement.

Based on the implications stemming from the evaluation displayed in Table 3.1, the ESRB recommends that, as a minimum, national authorities should assess the spillover channels operating via (i) cross-border risk adjustment and (ii) regulatory arbitrage. The ESRB Handbook presents a list of indicators that could be used to measure these spillovers (Tables 1a and 1b in Chapter 1 of the Handbook as well as Table B.1 in Appendix B of this report complement these indicators).[48]

Results from the IBRN initiative can be considered as an additional source of guidance for some authorities. This initiative was a one-off empirical exercise that aimed to assess the cross-border spillovers of prudential policy; its methodology and

[48] The spillovers from activating macroprudential measures can be positive and/or negative. This depends on the stage of the financial cycle in the activating country and the degree of synchronisation with financial cycles of other countries, as well as the endogenous response of other policies (e.g. monetary policy). Generally, the recommendation to assess cross-border effects covers both bank and non-bank macroprudential policy measures, but is not related to whether relevant authorities deem reciprocity measures necessary or not.

main findings are documented in Buch and Goldberg (2017) and described in more detail in Section 2.1.2 of this report. A number of EU countries participated in this project and gained more insights into certain aspects of the transmission of cross-border effects, for instance, what the main transmission channels are, how significant the cross-border spillovers can be, which measures are most likely to cause cross-border effects, and how foreign lending by domestic banks adjusts to changes in prudential policy. However, so far these empirical studies have not been further developed in order to be applicable for regular monitoring.

3.2 Frameworks currently used for monitoring and assessing cross-border spillovers: outcome of the TFSE questionnaire

3.2.1 General overview

Most of the relevant national authorities in the EU have in place a framework to assess and monitor cross-border spillovers from macroprudential policies. As a rule, these frameworks are based on a set of indicators relying heavily on the guidance provided in the ESRB Handbook. In addition to this, several authorities incorporate results obtained from empirical models into the assessment. Besides the guidelines provided by the ESRB, a few authorities have used additional inputs to inform their assessment, such as findings from the IBRN project or complementary datasets not mentioned in the ESRB guidelines. Even though analysis of cross-border effects is usually published in analytical material accompanying announcements of macroprudential measures and public notifications, the descriptions of frameworks are usually not disclosed to the public, partly due to the fact that many authorities view their current frameworks as still being under development. Further plans by authorities mostly constitute enhancing the current frameworks, although concrete objectives and timelines are rarely defined.

The cross-border risk adjustment and regulatory arbitrage channels are assessed as most important by the majority of respondents. This is in line with the assessment provided in the ESRB guidance. A few authorities mentioned network formation and contagion as well as altering the effects on credit conditions as important channels, while none of them mentioned the trade channel as significant.

However, there are also countries which have not mentioned standardised methods to assess cross-border spillover effects. The reasons are twofold. For some countries, spillover analysis is a new concept and they are still working on developing a first framework. The situation is further explained by limited use of macroprudential measures or by the design of applied measures which does not call for an extensive cross-border assessment. Sometimes such countries mention that the findings of the FSC and its recommendations will be incorporated in their strategy. The second sub-group of countries which have no standard framework to assess cross-border spillover effects are small economies, which have limited cross-border

exposures or a majority of domestically owned financial institutions. As a result, it is argued, there is limited risk of inward or outward spillover effects from macroprudential policies.

3.2.2 Model-based approaches

Only a few authorities regularly use models to assess potential cross-border spillovers from macroprudential policy. The frameworks of these authorities do not rely on models alone, but comprise a model and a set of indicators.

One authority mentioned the use of a model-based approach for the ex ante assessment of the impact of domestically implemented capital buffers on domestic and foreign markets. The approach combines an empirical analysis based on aggregate macroeconomic variables and institution-specific data with a structural (stylised finite horizon) model. For this purpose, the quarterly forecasting model of the central bank was extended to include interest rates of loans (corporate, mortgage and consumer loans). The assessment comprises the following steps: a tightening of capital requirements leads to an additional demand for capital by banks, increasing the cost of capital. Assuming that banks will fully transfer this increase in the cost of capital to borrowers, this will ultimately have an impact on GDP. Similarly, to estimate cross-border spillover effects the interest rate differential for third countries is used. Finally, for ex post assessment, a set of core indicators is monitored.

Another authority bases its ex ante and ex post assessment of macroprudential measures, in part, on estimates provided by empirical studies. This approach combines aggregate information/indicators on bank exposures with estimates based on studies using bank-level data to assess cross-border spillovers from macroprudential policies implemented domestically (see Section 2.1.2 for an overview of such approaches).

The ECB has developed both VAR-type models and DSGE models calibrated for individual countries and incorporating cross-border trade and financial channels. The models enable the assessment of potential cross-border effects from both capital and borrower-based measures (see Section 2.1.1 for an overview of such approaches). In addition, the ECB has established multi-country stress-testing tools and network-based contagion models that encompass cross-border interlinkages and can hence measure the cross-border spillover effects of various macroprudential measures.

3.2.3 Indicator-based approaches

There is significant variation among national frameworks in terms of the indicators covered, but most authorities use a subset of the indicators suggested by the ESRB. Most of the countries have opted for measuring potential cross-border spillovers with a subset of the indicators suggested by the ESRB. Others have implemented all indicators suggested in Chapter 11 of the ESRB Handbook. A

few authorities have developed additional indicators, on top of those included in Chapter 11 of the ESRB Handbook. Many indicators are calculated both at the individual bank level as well as the banking system level. The indicators are updated on a regular basis (quarterly or annually), or with an activation or review of a macroprudential instrument.

The indicators are monitored separately and the implications drawn are based on expert judgement. No particular thresholds are in use, although a few countries reported attempts to implement visualisation tools, such as heat maps or chart dashboards, to inform the judgement, and plan to use tentative thresholds at some point.

The FSC stocktaking questionnaire provided useful insights into indicator-based approaches currently in place at national authorities. In what follows, a summary of the insights gained from the questionnaire responses is provided. First, indicators are divided into those corresponding to inward or outward spillovers. Second, for each type of spillover, indicators are further categorised into those pertaining to, respectively, the bank lending, other bank or non-bank channels. Finally, indicators in each sub-group are analysed within the framework described in Table 11.3 of the ESRB Handbook, where four main impact channels are described: cross-border risk adjustment, network and contagion, regulatory arbitrage, and monetary policy (i.e. altering the effects on credit conditions). Tables B.1 and B.2 in Appendix B provide an overview of commonly used indicators and their data sources, respectively. Table B1 also clarifies which of the indicators used in national frameworks are similar to the ones recommended by the ESRB or to the ones derived from a review of the recent literature in Chapter 3.

3.2.3.1 Inward spillovers

When analysing inward spillovers, it is worth considering the effects of domestic policy on the domestic economy related to the actions of entities headquartered in foreign economies. Authorities use a range of indicators to measure inward spillovers of macroprudential policy. Most indicators seek to measure the effects of cross-border risk adjustment or regulatory arbitrage. The former may be caused by a cross-border rebalancing of exposures or activities in response to macroprudential policy in the activating country. The latter refers to financial institutions exploiting cross-country differences in regulatory frameworks to circumvent macroprudential requirements. Some indicators are also used to measure changing network formation and potential for contagion. This spillover channel is especially relevant in cross-border networks among financial institutions.

Bank lending channel

Most of the indicators used to assess the bank lending channel focus on the cross-border risk adjustment or regulatory arbitrage channels and compare changes in the share of foreign activity (e.g. loans or securities holdings) in

total activity (indicator numbers 1, 3 and 16 in Table B.1 in Appendix B).[49] The specificities may vary somewhat, for instance by focusing only on branches in the numerator, or by including not only loans, but also securities. The measure can also be fine-tuned to correspond with the actual exposures covered by the macroprudential measure taken, for instance by focusing only on mortgage loans. The specification determines to what extent all types of foreign credit are covered, i.e. credit issued through branches or subsidiaries or direct cross-border lending. One authority is developing several additional indicators, such as a Herfindahl index (indicator number 20 in Table B.1 in Appendix B) to measure Member States' contribution to the market concentration in a specific sector in the activating Member State. The individual contribution to the index can be used as an additional proxy for the importance of another Member State for the specific sector in the activating Member State: the higher the contribution of Member State A to the Herfindahl index in Member State B, the higher the potential for cross-border risk adjustment and contagion effects between the two Member States.

Other bank channels

Almost all applied indicators relating to other bank channels originate from the ESRB Handbook. Some of them monitor the changes in the share of all or specific assets of foreign institutions compared with the total assets of all institutions (indicator numbers 22, 25 and 27 in Table B.1 in Appendix B). Specific types of assets included in the indicators are securities of sovereigns and non-financial corporations, as well as securitised assets. These indicators can be used to detect potential cross-border risk adjustments. One authority added another proxy for measuring inward spillovers that could be used to supplement the exposure-based indicators, namely the change of the number of affiliates (branches and subsidiaries) of foreign banking groups in the domestic market (indicator number 23 in Table B.1 in Appendix B) within a period of time close to the activation of a macroprudential measure. If branches are not subject to activity-based macroprudential measures, this might be interpreted as a potential sign of regulatory arbitrage and requires further analysis of the reasons and the time of announcement of the establishment of the branch. Another group of indicators measure whether changes take place in capital or liquidity levels in a group (indicator numbers 28, 29, 31 and 32 in Table B.1 in Appendix B), in order to detect potential regulatory arbitrage. Some indicators also measure whether capital levels of foreign banks are affected differently than those of domestic banks (indicator number 30 in Table B.1 in Appendix B). Some authorities also measure whether changes in asset prices or interbank securities holdings (indicator numbers 34 and 35 in Table B.1 in Appendix B) could point to cross-border spillovers through networks or contagion.

Non-bank channel

Several Member States are developing additional indicators to assess non-bank channels. They measure inward spillovers involving other financial

[49] A detailed list of indicators used in national frameworks is provided in Table B.1 in Appendix B.

institutions, namely an increase in the credit supplied by domestic and/or foreign (depending on the availability of data) non-bank financial institutions, or an increase in assets held by non-bank financial institutions (indicator numbers 42 to 45 in Table B.1 in Appendix B). This may signal waterbed effects or portfolio rebalancing.

3.2.3.2 Outward spillovers

When analysing outward spillovers, it is worth considering two related effects: first, the effects of foreign policy on the domestic economy and, second, the effects of domestic policy on the foreign economy.

(i) Effects of foreign policy on the domestic economy

Most indicators in this category are used to measure cross-border risk adjustment, while some are also used to measure regulatory arbitrage, changing network formation and potential for contagion. The majority are sourced from or modified based on the ESRB Handbook. Both the bank lending channel and other bank-related channels are assessed in detail. There is no evidence on the spillover assessment for the non-bank channel.

Bank lending channel

Cross-border risk adjustment is widely analysed by authorities by monitoring cross-border loans granted to domestic clients by foreign financial institutions (indicator numbers 1 and 3 in Table B.1 in Appendix B). Most authorities distinguish the legal status of the lender: direct lending from abroad, foreign branch or foreign subsidiary. Authorities use different relative measures for foreign lending, the most popular ones being in relation to all domestic loans, domestic loans to a sub-sector (e.g. non-financial corporations, households) and total domestic banking sector assets. Alternatively, total lending from abroad is used as a relative measure.

Some countries also use institution-specific indicators instead of aggregated indicators for banks or banking groups with cross-border activities (indicator numbers 4 and 18 in Table B.1 in Appendix B). Most of the institution-specific indicators originate from the ESRB Handbook and are modified according to the specifics of the institution and macroprudential measure analysed. One authority measures institution-specific cross-border activity of a domestic institution in relation to excess capital of the domestic banking group to approximate the risk-bearing capacity with regard to the identified systemic risk in the activating Member State.

To assess regulatory arbitrage, authorities monitor the activity of unregulated branches or direct cross-border exposure relative to the activity of regulated banks, pre- and post-regulation. Such analysis is done both at the level of the whole financial system and the level of each banking group.

Other bank channels

Indicators in this category are a mix between those originating from the ESRB Handbook and those coming from other sources. Indicators originating from the ESRB Handbook are mostly related to foreign securities holdings (indicator number 25 in Table B.1 in Appendix B) of financial institutions. In some cases, securities are separated by their origin. Indicators are used in absolute terms and in relation to financial system assets. One authority also monitors the share of domestic sovereign securities held by foreign investors in total domestic sovereign securities (indicator number 25 in Table B.1 in Appendix B). In addition to spillovers that might arise from securities holdings, one authority monitors institution-specific relevant (measure-related) cross-border funding of the domestic institution from other Member States in relation to total funding of the domestic banking group (indicator number 37 in Table B.1 in Appendix B).

The structure of the banking system is considered when looking at other bank channels. According to the ESRB Handbook, intragroup capital and liquidity management (indicator numbers 28 to 32 in Table B.1 in Appendix B), and securitisation activity (indicator numbers 25 and 27 in Table B.1 in Appendix B) is analysed. Several authorities use indicators that measure the market share of foreign branches because they might directly be impacted by macroprudential policies in the home countries of their parent banks. The market share of foreign subsidiaries and the number of foreign affiliates (branches and subsidiaries) of domestic banking groups located in activating Member States are also monitored (indicator number 22 in Table B.1 in Appendix B).

(ii) Effects of domestic policy on the foreign economy

Indicators across all channels highlighted in the ESRB Handbook are used to assess spillovers from domestic macroprudential measures to foreign economies. The usage and the variety of indicators are different across countries. The bank lending channel is covered most extensively (generally based on the ESRB Handbook), while a combination of ESRB suggested and other indicators is used to monitor the other bank channels. Practically all indicators in this group seek to measure the cross-border risk adjustment transmission channel.

Bank lending channel

Cross-border risk adjustment via the bank lending channel is widely analysed, using indicators based on the ESRB Handbook. In general, respondents find this type of analysis very informative as it helps to map the cross-border exposures and gives a good broad picture of the possible spillover effects.

Almost all countries use some indicator that captures cross-border exposures, the most widespread being direct cross-border credit/loan exposure relative to assets or loans by domestic institutions (indicator numbers 2 and 8 in Table B.1

in Appendix B). Some countries also use exposures in absolute terms, but this is less widespread compared with relative indicators. Several countries use modified indicators in addition to those suggested in the ESRB Handbook: loans in foreign currency instead of cross-border loans and total credit of the borrowing country instead of domestic institutions are used (indicator numbers 7 and 13 in Table B.1 in Appendix B). One country scales the indicator by a foreign country's GDP to assess how much lending abroad would be impacted by a rise in capital requirements and what the potential (welfare) implications for foreign economies would be (indicator number 14 in Table B.1 in Appendix B). In terms of sectors, countries tend to distinguish different segments of cross-border loans, e.g. private non-financial sector, non-financial corporates or households. One country divides the share of household loans into mortgages and consumer credit and that of non-financial corporate loans into loans to SMEs and commercial real estate loans (indicator number 8 in Table B.1 in Appendix B). Moreover, exposures to foreign central banks, foreign governments and foreign credit institutions are distinguished. One country distinguishes loans with immovable property collateral (commercial real estate and mortgages) from total cross-border loans (indicator number 12 in Table B.1 in Appendix B). Respondents indicate that the modifications of the indicator depend on the macroprudential measure that is analysed.

In addition to more straightforward indicators, one country monitors the effect on capital holdings of foreign banks' lending to the domestic economy in nominal terms from the increase in the countercyclical capital buffer (CCyB) (indicator number 21 in Table B.1 in Appendix B):

$$\text{Effect on capital} = X\% * RW * \frac{PNF\ exp.\text{to domestic country}}{PNF\ exp.\text{to all countries}} * \text{total } exp.\text{ to all countries},$$

where X% is the increase in the domestic CCyB rate, RW is the average risk weights, PNF is private non-financial sector, and exp. is foreign banks' exposure.

This indicator gives a rough first idea of the effects of a tightening of domestic capital regulations when reciprocity arrangements are in place. As a result of the increase in capital requirements, foreign banks' lending to the domestic economy will need to raise capital and this might affect their lending to the domestic economy (i.e. in a country which activated the measure) as well as to other economies.

There is limited analysis of the network and contagion aspect of the bank lending channel. For this purpose, the share of liabilities from cross-border sources is mostly used.

Some countries also monitor the potential for regulatory arbitrage. The three indicators that are used are the distribution of capital ratios at the solo level across jurisdictions, the own funds contribution to total home country own funds, and the distribution of liquid assets over total assets at the solo level across jurisdictions (indicator numbers 28, 30, 31 and 32 in Table B.1 in Appendix B).

Other bank channels

Similarly to the bank lending channel, cross-border risk adjustment is most extensively covered through the usage of indicators from the ESRB Handbook. To capture banks' cross-border activities, securities holdings by domestic and foreign banks are analysed. Spillover effects are assessed separately depending on the origin of the securities (credit institutions, government, financial corporations, non-financial corporations, etc.). Securities are measured in relation to total assets, as suggested by the ESRB, or in relation to GDP of the foreign country (indicator numbers 25 and 26 in Table B.1 in Appendix B). In addition to securities, also cross-border bank equity exposures in relation to total home country own funds are used in the assessment (indicator number 40 in Table B.1 in Appendix B). The analysis of network and contagion and regulatory arbitrage is not widely used for the other bank channel. Indicators that relate to intragroup capital and liquidity management are used. One country also uses the information about the share of liabilities from cross-border sources (indicator number 33 in Table B.1 in Appendix B).

Most of the indicators beyond those in the ESRB Handbook are designed to capture the structural features of the banking systems. They also reflect their dependence on cross-border operations and possible spillovers in a broader sense, not just through the lending channel.

Non-bank channel

There is limited experience in assessing outward spillovers for the non-bank channel. Some countries indicate that there is work in progress in this field on both creating new indicators and trying to augment the indicators for the bank channels so that they also include information about non-banks. Indicators that are currently used for the non-bank channel are foreign assets or relevant exposures held by domestic non-bank financial intermediaries by country scaled to GDP or the size of the relevant market in the foreign country.

3.2.3.3 Data sources of the indicators

Most national authorities use the common European supervisory reporting framework (COREP and FINREP) in order to assess the potential of cross-border effects. The main benefit of these data is that information is institution-specific and comparable across countries. Reporting restrictions coming along with FINREP and COREP, conditional on the structure of the national banking system, seem to be of minor importance.[50] Also, data from MFI statistics and financial accounts statistics are, at least to some extent, comparable across countries

[50] In COREP (common reporting) and FINREP (financial reporting), banking groups have to report cross-border exposure only if their total cross-border exposure exceeds 10% of total exposure (although national supervisors may set a lower threshold for banks established in their jurisdiction). Banks with a material focus on the domestic market are not obliged to report their cross-border exposure. Furthermore, less significant institutions have to report in FINREP only from the third quarter of 2017 onwards. Due to the restrictions in both data sources, cross-border spillover effects on other Member States might be underestimated.

(depending on national transpositions). In addition, data from MFI statistics might be institution specific as well. Cross-border data drawn from publicly available cross-country datasets, such as those of the BIS or the ECB, are also comparable across countries.[51] However, due to specific consolidation levels and sample compositions in the case of aggregated data, problems of delimitation have to be considered when these data sources are combined with others. Further data sources indicated by national authorities such as financial reports of financial institutions and, in particular, national confidential supervisory data are to a large extent country specific.[52] Thus, these datasets might contain useful information for some Member States, but not for others. A cross-country comparison of these data must be treated with caution.

One of the most common challenges with regard to the operationalisation of national frameworks is the difficulty in gathering data to compute indicators. Table B.2 (in Appendix B) lists different indicator categories by their main spillover channel and describes the data sources (column three) used to assess these indicators as indicated in responses to our survey. Also, additional spillover channels for which the indicator category is relevant (column two) and comments on the data source (column four) are mentioned. It is important to state that the table only includes the data sources reported by national authorities within our survey and provides no assessment of whether and how the data sources contain information relevant for the assessment of cross-border effects. Furthermore, it cannot be ruled out that there might be overlaps between different answer categories regarding the data sources. A reason for this might be a different understanding of the belonging of a specific (national) data source to the answer categories provided by our survey, e.g. one and the same indicator might be attributed by some Member States to MFI statistics and by other Member States to the category national confidential supervisory data.

3.3 Further plans by national authorities and areas for additional guidance

Going forward, a significant number of authorities plan to further develop their frameworks to assess cross-border spillovers. Nine countries are planning to leverage on the existing framework and two countries plan to develop a new framework. In terms of timeline, there is limited information regarding specific deadlines to have a final version of the improved framework. Mostly, the timeline is not defined and the work will depend on available resources. The authorities that did not indicate a plan to develop a framework mainly cited an insufficient number of enacted macroprudential policy measures as the main reason.

[51] BIS consolidated banking statistics are based on the nationality of the reporting banks' headquarters. BIS locational banking statistics are based on the residency of reporting banks. Data from the ECB MFI statistics are residency based.

[52] Reporting requirements might be subject to materiality thresholds. One authority uses a national database that allows a distinction to be made between activities of domestic branches and domestic subsidiaries located in other countries.

Some authorities are exclusively focused on improving only an indicator-based framework. Those authorities plan to enhance the existing frameworks along the following lines: (i) map the indicators more clearly to the transmission channels and the direction of potential cross-border spillovers, with the possibility of extending the number of channels in the current framework; (ii) improve the set of indicators already in place; and (iii) use expert judgement and historical distributions to define alert thresholds, summing all the information in a heat map.

Other authorities reported that further development of the framework will depend on the conclusions of the FSC or on the activation of future macroprudential measures. Finally, in one case, the improvement of the existing framework will be based on the development of a structural macro-financial model to assess global spillovers.

The majority of authorities see merit in extending the existing guidance for the assessment of cross-border spillovers. Responses to the questionnaire indicated that enhancements to the current operational guidance should address a number of essential gaps, as follows: (i) the lack of guidance on suitable models; (ii) the absence of explanation regarding the indicators (including indicative data sources for each indicator); (iii) the difficulties in gathering data to compute some of the indicators; and (iv) the difficulties in mapping the indicators to the channels and the direction of cross-border effects. In particular, with respect to the most useful additional practical guidance that may come from the work of the FSC, authorities underscored: (i) the build-up of a common set of indicators and possible thresholds to assess the materiality of the spillovers; and (ii) the development of structural models (empirical or theoretical) to conduct ex ante assessments and the design of a comprehensive framework including both indicators and models that could represent guidance on best practices.

In general, developing methodologies for assessing cross-border spillovers remains very much work in progress. Our stocktake highlights the prevailing practices and individual authorities' efforts to adjust the existing guidance to their needs or develop alternative approaches. However, the limited experience with the use of these frameworks makes it difficult to critically assess their usefulness or distil best practice approaches, and there appears to be a need for more guidance regarding both indicator and model-based approaches.

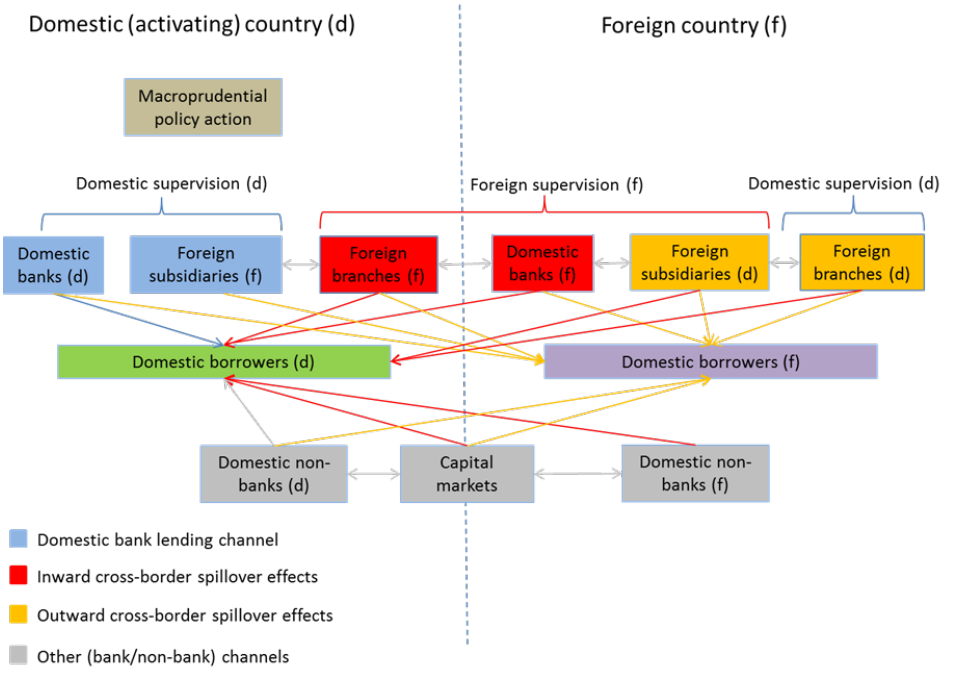
4 Summary: the contours of an analytical framework

This paper has presented an overview of existing studies on cross-border spillovers of macroprudential policies, as well as a stocktake of national approaches within the EU to assess such spillover effects. The analysis suggests a number of transmission channels through which macroprudential policies enacted at the level of national jurisdictions may entail cross-border effects. Hence, against the background of the theoretical and empirical evidence, as well as authorities' practical experiences provided in this paper, the Financial Stability Committee set out to develop an operational analytical framework that macroprudential authorities within the EU are recommended to use as a starting point when assessing and evaluating cross-border spillover effects of macroprudential measures. The recommended framework is described in more detail in the accompanying FSC report. A high-level overview of the contours of the framework is provided below.

Cross-border spillover effects can be channelled through (i) an "inward" transmission channel and (ii) an "outward" transmission channel. Inward and outward cross-border spillover effects refer to the direction in which domestic macroprudential policies interact with foreign economies and institutions. Figure 4.1 provides a highly stylised picture of the different transmission channels and the main types of institutions involved.

Figure 4.1

Stylised overview of transmission channels of macroprudential policy cross-border spillovers



Source: FSC.

Inward transmission of cross-border spillover effects refers to the effects of domestic macroprudential policies on the domestic economy (d) related to the actions of entities headquartered in foreign economies (f). The inward transmission of domestic macroprudential policy describes how domestic regulation affects foreign affiliates (bank branches or subsidiaries) located in the domestic country, e.g. through "leakages" or "waterbed" effects whereby activities migrate to entities not covered by the macroprudential measure. It also describes how domestic regulation affects the direct cross-border activity of foreign institutions in the domestic market. Thus, inward transmission of cross-border spillovers may occasionally reflect the circumvention of the targeted national macroprudential measure and may render it less effective.

Outward transmission of cross-border spillover effects refers to the effects of domestic policies (d) on other, foreign (f), economies and also, from the opposite perspective, the effect of foreign policies (f) on the domestic economy (d). The outward transmission of domestic macroprudential policy is related, but not restricted, to international activities of domestic banking groups. Unintended outward effects of a policy may be channelled via subsidiaries and branches of domestic banking groups operating in a foreign country or direct cross-border lending, or more indirectly via the impact on real activity and involving international trade channels.

While focusing on bank lending transmission channels, the FSC framework should also consider other potential activity channels and institutions. In addition to traditional bank lending channels, the FSC also considers it to be important

that authorities keep an eye on the cross-border transmission of macroprudential measures through bank non-lending channels, as well as through non-bank lending and market financing channels. A comprehensive analysis of cross-border spillovers should thus include both an institutional perspective and a market or activity-based analysis.

The FSC framework provides the analytical underpinnings for the assessment of cross-border spillover effects, also including operational guidance to authorities. Finally, also taking into account the feedback from the stocktake of national approaches, the FSC framework aims to provide authorities with "best practice" operational guidance on which analytical tools (e.g. indicators, empirical benchmarks) to use to assess cross-border spillover effects in specific situations (e.g. inward/outward spillovers, types of instruments, bank lending or non-bank channels, etc.). The accompanying FSC report lays out this practical guidance in more detail.

References

Acemoglu, D., Ozdaglar, A. and Tahbaz-Salehi, A. (2013), "Systemic Risk and Stability in Financial Networks", NBER Working Paper No 18727.

Acharya, V. and Yorulmazer, T. (2008), "Information Contagion and Bank Herding", *Journal of Money, Credit and Banking*, Vol. 40(1), pp. 215-231.

Acharya, V., Gromb, D. and Yorulmazer, T. (2012), "Imperfect Competition in the Interbank Market for Liquidity as a Rationale for Central Banking", *American Economic Journal: Macroeconomics*, Vol. 4(2), pp. 184-217.

Acharya, V., Schnabl, P. and Suarez, G. (2013), "Securitization without risk transfer", *Journal of Financial Economics*, Vol. 107(3), pp. 515-536.

Adrian, T. and Ashcraft, A. B. (2012), "Shadow Banking: A Review of the Literature", *The New Palgrave Dictionary of Economics*, Palgrave Macmillan.

Aiyar, S., Calomiris, C. W., Hooley, J., Korniyenko, Y. and Wieladek, T. (2014), "The International Transmission of Bank Capital Requirements: Evidence from the UK", *Journal of Financial Economics*, Vol. 113(3), pp. 368-382.

Aiyar, S., Calomiris, C. W. and Wieladek, T. (2014a), "Does macro-prudential regulation leak? Evidence from a UK policy experiment", *Journal of Money, Credit and Banking*, Vol. 46, pp. 181-214.

Aiyar, S., Calomiris, C. W. and Wieladek, T. (2014b), "Identifying channels of credit substitution when bank capital requirements are varied", *Economic Policy*, Vol. 29(77).

Akinci, O. and Olmstead-Rumsey, J. (2018), "How effective are macroprudential policies? An empirical investigation", *Journal of Financial Intermediation*, Vol. 33(C), pp. 33-57.

Allen, F. and Gale, D. (1994), "Limited market participation and volatility of asset prices", *The American Economic Review*, Vol. 84(4), pp. 933-955.

Allen, F. and Gale, D. (2000), "Financial contagion", *Journal of Political Economy*, Vol. 108(1), pp. 1-33.

Allen, F. and Gale, D. (2005), "From cash-in-the-market pricing to financial fragility", *Journal of the European Economic Association*, Vol. 3(2-3), pp. 535-546.

Amini, H., Cont, R. and Minca, A. (2010), "Resilience to Contagion in Financial Networks", Working Paper.

Ampudia, M., Beck, T., Beyer, A., Colliard, J. E., Leonello, A., Maddaloni, A. and Marques-Ibanez, D. (2019), "The architecture of supervision", *Working Paper Series*, No 2287, ECB (Discussion Paper).

Ari, A., Darracq, M., Kok, C. and Żochowski, D. (2016), “When shadows grow longer: shadow banking with endogenous entry”, *Working Paper Series*, No 1943, ECB.

Ari, A., Darracq, M., Kok, C. and Żochowski, D. (2017), “Shadow Banking and Market Discipline on Traditional Banks”, IMF Working Paper No 17/285.

Auer, S., Ganarin, M. and Towbin, P. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Switzerland”, *International Journal of Central Banking*, Vol. 13(2), pp. 65-93.

Avdjiev, S., Koch, C., McGuire, P. and von Peter, G. (2017), “International Prudential Policy Spillovers: A Global Perspective”, *International Journal of Central Banking*, Vol. 13(2), pp. 5-33.

Avdjiev, S., Hardy, B., McGuire, P. and von Peter, G. (2019), “Home sweet Host: Prudential and monetary policy spillovers through global banks”, mimeo.

Banerjee, R. N. and Mio, H. (2018), “The impact of liquidity regulation on banks”, *Journal of Financial Intermediation*, Vol. 35, pp. 30-34.

Bank for International Settlements (2009), “Guide to the international financial statistics”.

Barth, J. R., Caprio, G. and Levine, R. (2004), “Bank regulation and supervision: What works best?”, *Journal of Financial Intermediation*, Vol. 13, pp. 205-248.

Barth, J. R., Caprio, G. and Levine, R. (2008), “Bank regulations are changing: for better or worse?”, *Comparative Economic Studies*, Vol. 50(4), pp. 537-563.

Başkaya, Y. S., Binici, M. and Kenç, T. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Turkey”, *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Baumann, U., Hoggarth, G. and Pain, D. (2005), “The substitution of bank for non-bank corporate finance: evidence for the United Kingdom”, Bank of England Working Paper No 274.

Bech, M. L. and Garratt, R. G. (2006), “Illiquidity in the Interbank Payment System Following Wide-Scale Disruptions”, *Journal of Money, Credit and Banking*, Vol. 44(5), pp. 903-929.

Beck, T., Todorov, R. and Wagner, W. (2013): “Supervising cross-border banks: theory, evidence and policy”, *Economic Policy*, Vol. 28(73).

Beck, T. and Wagner, W. (2016), “Supranational supervision: How much and for whom?”, *International Journal of Central Banking*, Vol. 12(2), pp. 221-268.

Behn, M., Gross, M. and Peltonen, T. (2016), “Assessing the costs and benefits of capital-based macroprudential policy”, *Working Paper Series*, No 1935, ECB.

Beirne, J. and Friedrich, C. (2017), “Macroprudential policies, capital flows, and the structure of the banking sector”, *Journal of International Money and Finance*, Vol. 75, pp. 47-68.

Bengui, J. (2013), “Macro-prudential policy coordination”, manuscript, University of Montreal.

Berrospide, J. M., Correa, R., Goldberg, L. S. and Niepmann, F. (2016), “International Banking and Cross-Border Effects of Regulation: Lessons from the United States”, NBER Working Paper No 22645.

BlackRock (2017), “Macroprudential Policies and Asset Management”, February.

Bonfim, D. and Costa, S. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Portugal”, *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Bookstaber, R., Paddrik, M. and Tivnan, B. (2014), “An agent-based model for financial vulnerability”, OFR Paper No 14-05.

Borio, C. and Shim, I. (2007), “What can (macro-)prudential policy do to support monetary policy?”, BIS Working Paper No 242.

Boss, M., Krenn, G., Puhr, C. and Summer, M. (2006), “Systemic Risk Monitor: A model for systemic risk analysis and stress testing of banking systems”, *Financial Stability Report*, Oesterreichische Nationalbank.

Bremus, F. and Fratzscher, M. (2015), “Drivers of structural change in cross-border banking since the global financial crisis”, *Journal of International Money and Finance*, Vol. 52, pp. 32-59.

Brzoza-Brzezina, M., Kolasa, M. and Makarski, K. (2015), “Macroprudential policy and imbalances in the euro area”, *Journal of International Money and Finance*, Vol. 51, pp. 137-154.

Buch, C. and Goldberg, L. (2017), “Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network”, *International Journal of Central Banking*, Vol. 13(S1).

Budnik, K. and Kleibl, J. (2018), “Macroprudential regulation in the European Union in 1995-2014: introducing a new data set on policy actions of a macroprudential nature”, *Working Paper Series*, No 2123, ECB.

Burrows, O., Learmonth, D. and McKeown, J. (2012), “RAMSI: a top-down stress-testing model”, Bank of England Financial Stability Paper No 17.

Bussière, M., Schmidt, J. and Vinas, F. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from France”, *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Caccavaio, M., Carpinelli, L. and Marinelli, G. (2017), "International Banking and Cross-Border Effects of Regulation: Lessons from Italy", *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Caccioli, F., Shrestha, M., Moore, C. and Farmer, J. D. (2012), "Stability analysis of financial contagion due to overlapping portfolios", University of Trier Working Paper No 1210.5987.

Callaway, D. S., Newman, M. E. J., Strogatz, S. H. and Watts, D. J. (2000), "Network robustness and fragility: Percolation on random graphs", *Physical Review Letters*, Vol. 85, pp. 5468-5471.

Calzolari, G., Colliard, J.-E. and Loranth, G. (2019), "Multinational Banks and Supranational Supervision", *Review of Financial Studies*, Vol. 32(8), pp. 2997-3035. See also HEC Paris Research Paper No FIN-2016-1152.

Carletti, E., Dell'Ariccia, G. and Marquez, R. (2016), "Supervisory incentives in a banking union", International Monetary Fund.

Cenedese, G., Della Corte, P. and Wang, T. (2017), "Currency Mispricing and Dealer Balance Sheet", mimeo.

Cerutti, E., Claessens, S. and Laeven, L., (2017), "The Use and Effectiveness of Macroprudential Policies: New Evidence", *Journal of Financial Stability*, Vol. 28, pp. 203-224.

Cerutti, M. E. M., Correa, M. R., Fiorentino, E. and Segalla, E. (2016), "Changes in prudential policy instruments – a new cross-country database", International Monetary Fund.

Cetorelli, N. and Goldberg, L. S. (2012), "Liquidity Management of U.S. Global Banks: Internal Capital Markets in the Great Recession", *Journal of International Economics*, Vol. 88, pp. 299-311.

Cihak, M., Demirkuc-Kunt, A., Feyen, E. and Ross, L. (2012), "Benchmarking financial systems around the world", World Bank Policy Research Working Paper No WPS 6175.

Cizel, J., Frost, J., Houben, A. and Wierts, P. (2016), "Effective Macroprudential Policy: Cross-Sector Substitution from Price and Quantity Measures", IMF Working Paper No 94.

Claessens, S., Zoltan, P., Ratnovski, L. and Singh, M. (2012), "Shadow banking: Economics and policy", IMF Staff Discussion Note.

Claessens, S. (2016), "Macroprudential and Capital Flows Management Policies in a World with Demand for Safe Assets", South African Reserve Bank Conference, Pretoria, 27-28 October.

Colliard, J.-E. (2020), "Optimal Supervisory Architecture and Financial Integration in a Banking Union", *Review of Finance*, Vol. 24(1), pp. 129-161.

Cont, R. and Schaaning, E. (2017), "Fire sales, indirect contagion and systemic stress testing".

Cornett, M. M. and Tehranian, H. (1994), "An examination of voluntary vs. involuntary security issuances by commercial banks", *Journal of Financial Economics*, Vol. 35, pp. 99-122.

Correa, R., Paligorova, T., Sapriza, H. and Zlate, A. (2017), "Cross-Border Bank Flows and Monetary Policy: Implications for Canada", Bank of Canada Staff Working Paper No 2017-34.

Covi, G., Gorpe, Z. and Kok, C. (2019), "CoMap: A contagion mapping tool for the euro area banking sector", *Working Paper Series*, No 2224, ECB.

Covitz, D., Liang, N. and Suarez, G. (2013), "The evolution of a financial crisis: Collapse of the asset-backed commercial paper market", *Journal of Finance*, Vol. 68(3), pp. 815-848.

Dalen, D. M. and Olsen, T. E. (2003), "Regulatory competition and multi-national banking", CESifo Working Paper No 971.

Damar, H. E. and Mordel, A. (2017), "International Banking and Cross-Border Effects of Regulation: Lessons from Canada", *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Daniels, T., Duijm, P., Liedorp, F. and Mokas, D. (2017), "A top-down stress testing framework for the Dutch banking sector", DNB Occasional Studies No 15-3.

Danisewicz, P., Reinhardt, D. and Sowerbutts, R. (2017), "On a tight leash: does bank organisational structure matter for macroprudential spillovers?", *Journal of International Economics*, Vol. 109, pp. 174-194.

Davies, S. (2008), "Cross-border derivatives exposures: How global are derivatives markets?", Federal Reserve Board IFC Bulletin No 31.

Darracq Pariès, M., Kok, C. and Rodriguez Palenzuela, D. (2011), "Macroeconomic Propagation under Different Regulatory Regimes: Evidence from an Estimated DSGE Model for the Euro Area", *International Journal of Central Banking*, Vol. 7(4), pp. 49-113.

Darracq Pariès, M., Jacquinot, P. and Papadopoulou, N. (2016), "Parsing financial fragmentation in the euro area: a multi-country DSGE perspective", *Working Paper Series*, No 1891, ECB.

Darracq Pariès, M., Kok, C. and Rancoita, E. (2019), "Cross-border Banking, Macroprudential Policy and Monetary Policy in a Monetary Union", *Working Paper Series*, No 2260, ECB.

de Bandt, O. and Hartmann, P. (2000), "Systemic risk: A survey", *Working Paper Series*, No 35, ECB.

Dedola, L., Karadi, P. and Lombardo, G. (2013), “Global implications of national unconventional policies”, *Journal of Monetary Economics*, Vol. 60, pp. 66-85.

Dees, S., Henry, J. and Martin, R. (2017), “STAMP€: Stress Test Analytics for Macroprudential Purposes in the euro area”, ECB, February.

Degryse, H. and Nguyen, G. (2007), “Interbank Exposures: An Empirical Examination of Contagion Risk in the Belgian Banking System”, *International Journal of Central Banking*, Vol. 3(2), pp. 123-171.

Dembiermont, C., Drehmann, M. and Muksakunratana, S. (2013), “How much does the private sector really borrow? A new database for total credit to the private non-financial sector”, *BIS Quarterly Review*, March, pp. 65-81.

Dempsey, K. P. (2017), “Safer banks, riskier economy? Capital requirements with non-bank finance”, manuscript.

Dent, K., Westwood, B. and Segoviano, M. (2016), “Stress testing of banks: an introduction”, Bank of England Quarterly Bulletin 2016 Q3.

D’Errico, M., Battiston, S., Peltonen, T. and Scheicher, M. (2017), “How does risk flow in the credit default swap market?”, *Journal of Financial Stability*, Vol. 5.

Diamond, D. W. and Dybvig, P. (1983), “Bank runs, deposit insurance, and liquidity”, *Journal of Political Economy*, Vol. 91(3), pp. 401-419.

Diamond, D. W. and Rajan, R. G. (2005), “Liquidity shortages and banking crises”, *Journal of Finance*, Vol. 60(2), pp. 615-647.

Diamond, D. W. and Rajan, R. G. (2011), “Fear of fire sales, illiquidity seeking, and credit freezes”, *The Quarterly Journal of Economics*, Vol. 126(2), pp. 557-591.

Du, W., Verdelhan, A. and Tepper, A. (2017), “Deviations from Covered Interest Rate Parity”, NBER Working Paper No 23170.

Eisenberg, L. and Noe, T. H. (2001), “Systemic Risk in Financial Systems”, *Management Science*, Vol. 47(2), pp. 236-249.

Elsinger, H., Lehar, A. and Summer, M. (2006), “Risk Assessment for Banking Systems”, *Management Science*, Vol. 52(9), pp. 1301-1314.

Elysiani, E., Mester, L. J. and Pagano, M. (2013), “Large capital infusions, investor reactions, and the return and risk-performance of financial institutions over the business cycle”, *Journal of Financial Stability*, Vol. 11(C), pp. 62-81.

Errico, L., Harutyunyan, A., Loukoianova, E., Walton, R., Korniyenko, Y., Amidžić, G., Hanan AbuShanab, H. and Shin, H. S. (2014), “Mapping the Shadow Banking System Through a Global Flow of Funds Analysis”, IMF Working Paper No 14/10.

Euromoney (2016), “Europe’s student loan market turns to non-banks”.

European Central Bank (2016), “The role of euro area non-monetary financial institutions in financial intermediation”, *Economic Bulletin*, Issue 4.

European Central Bank (2017), “Report on Financial Structures”, October.

European Investment Fund (2014), “Institutional non-bank lending and the role of Debt Funds”, Working Paper No 2014/25.

European Systemic Risk Board (2014), “The ESRB handbook on operationalising macro-prudential policy in the banking sector”, March.

European Systemic Risk Board (2016), “Margins and Haircuts as Macroprudential Tools”, Joint Report by the ATC Task Force on Central Counterparties, the ATC Instruments Working Group and the Joint ATC-ASC Expert Group on Shadow Banking.

Fahr, S. and Żochowski, D. (2015), “A framework for analysing and assessing cross-border spillovers from macroprudential policies”, *Financial Stability Review*, ECB, May.

Fève, P. and Pierrard, O. (2017), “Financial Regulation and Shadow Banking: A Small-Scale DSGE Perspective”, Toulouse School of Economics Working Paper No 17-829.

Fiechter, J., Ötker, M. I., Ilyina, A., Hsu, M., Santos, M. A. and Surti, J. (2011), “Subsidiaries or branches: does one size fit all?”, IMF Staff Discussion Note, International Monetary Fund.

Financial Times (2014), “EU companies turn to non-bank lenders”, May.

Forbes, K., Fratzscher, M., Kostka, T. and Straub, R. (2016), “Bubble thy neighbor: portfolio effects and externalities from capital controls”, *Journal of International Economics*, Vol. 99, pp. 85-104.

Forster, K., Vasardani, M. and Ca’ Zorzi, M. (2011), “Euro area cross-border financial flows and the global financial crisis”, *Occasional Paper Series*, No 126, ECB.

Franch, F., Nocciola, L. and Żochowski, D. (2017), “Cross-border effects of macroprudential policy – Evidence from the euro area”, mimeo.

Frost, J., de Haan, J. and van Horen, N. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from the Netherlands”, *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Gabrieli, S. and Georg, C.-P. (2014), “A network view of interbank freezes”, Banque de France Working Paper No 531.

Gabrieli, S., Salakhova, D. and Vuillemey, G. (2015), “Cross-border interbank contagion in the euro area banking sector”, Banque de France Working Paper No 545.

Gajewski, K. and Krzesicki, O. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Poland”, *International Journal of Central Banking*, Vol. 13(2), pp. 35-64.

Gauthier, C., Souissi, M. and Li, X. (2014), “Introducing funding liquidity risk in a macro stress-testing framework”, *International Journal of Central Banking*, December.

Gennaioli, N., Shleifer, A. and Vishny, R. W. (2013), “A model of shadow banking”, *Journal of Finance*, Vol. 68(4), pp. 1331-1363.

Goldstein, I. and Pauzner, A. (2005), “Demand-deposit contracts and the probability of bank runs”, *Journal of Finance*, Vol. 60(3), pp. 1293-1327.

Goodhart, C., Kashyap, A. K., Tsomocos, D. and Vardoulakis, A. (2012), “Financial Regulation in General Equilibrium”, NBER Working Paper No 17909.

Goodhart, C., Kashyap, A. K., Tsomocos, D. and Vardoulakis, A. (2013), “An Integrated Framework for Analyzing Multiple Financial Regulations”, *International Journal of Central Banking*, Vol. 9(1), pp. 109-143.

Gonzalez, F. (1995), “Bank regulation and risk-taking incentives: An international comparison of bank risk”, *Journal of Banking and Finance*, Vol. 29(5), pp. 1153-1184.

Gornicka, L. A. (2016), “Banks and shadow banks: Competitors or complements?”, *Journal of Financial Intermediation*, Vol. 27, pp. 118-131.

Gorton, G. and Metrick, A. (2012), “Securitized banking and the run on repo”, *Journal of Financial Economics*, Vol. 104(3), pp. 425-451.

Gorton, G. and Tallman, E. W. (2016), “How Did Pre-Fed Banking Panics End?”, NBER Working Paper No 22036.

Gross, M., Kok, C. and Żochowski, D. (2016), “The impact of bank capital on economic activity: evidence from a mixed cross-section GVAR model”, *Working Paper Series*, No 1888, ECB.

Hałaj, G. (2007), “Contagion Effect in Banking System – Measures Based on Randomised Loss Scenarios”, *Bank i Kredyt*, Vol. 6, pp. 69-80.

Hałaj, G. and Kok, C. (2013), “Assessing interbank contagion using simulated networks”, *Working Paper Series*, No 1506, ECB.

Hałaj, G. and Kok, C. (2015), “Modelling the emergence of the interbank networks”, *Quantitative Finance*, Vol. 15(4), pp. 653-671.

Hałaj, G., Kochanska, U. and Kok, C. (2015), “Emergence of the EU corporate lending network”, *Journal of Network Theory in Finance*, Vol. 1(1), pp. 33-76.

Hanson, S. G., Shleifer, A., Stein, J. C., and Vishny, R. W. (2015), “Banks as patient fixed income investors”, *Journal of Financial Economics*, Vol. 117(3), pp. 449-469.

Harris, M., Opp, C. C. and Opp, M. M. (2014), “Higher capital requirements, safer banks? Macroprudential regulation in a competitive financial system”, mimeo, University of Chicago, University of California, Berkeley, and University of Pennsylvania.

Heise, S. and Kühn, R. (2012), “Derivatives and Credit Contagion in Interconnected Networks”, *European Physical Journal B*, Vol. 85(4).

Henry, J. and Kok, C. (eds.) (2013), “A macro stress testing framework for assessing systemic risks in the banking sector”, *Occasional Paper Series*, No 152, ECB.

Hills, R., Reinhardt, D., Sowerbutts, R. and Wieladek, T. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from the United Kingdom”, *International Journal of Central Banking*, Vol. 13(2), pp. 404-433.

Hirtle, B. and Lehnert, A. (2014), “Supervisory stress tests”, Federal Reserve Bank of New York Staff Report No 696.

Ho, K., Wong, E. and Tan, E. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong”, *International Journal of Central Banking*, Vol. 13(2), pp. 195-221.

Hofmann, B., Shim, I. and Shin, H. S. (2016), “Sovereign yields and the risk-taking channel of currency appreciation”, BIS Working Paper No 538.

Houston, J. F., Lin, C. and Ma, Y. (2012), “Regulatory arbitrage and international bank flows”, *Journal of Finance*, Vol. 67(5), pp. 1845-1895.

Hurd, T. R. and Gleeson, J. (2013), “On Watts’ Cascade Model with Random Link Weights”, *Journal of Complex Networks*, manuscript.

Jara, A. and Cabezas, L. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Chile”, *International Journal of Central Banking*, Vol. 13(2), pp. 95-127.

Jeanne, O. (2014), “Macroprudential policies in a global perspective”, technical report, National Bureau of Economic Research.

Kang, H., Vitek, F., Bhattacharya, R., Jeasakul, P., Muñoz, S., Wang, N. and Zandvakil, R. (2017), “Macroprudential Policy Spillovers: A Quantitative Analysis”, IMF Working Paper No 17/170

Kapinos, P. S. and Mitnik, O. A. (2015), “A top-down approach to stress-testing banks”, FDIC Center for Financial Research Working Paper No 2015-02.

Kara, G. I. (2016), “Systemic risk, international regulation, and the limits of coordination”, *Journal of International Economics*, Vol. 99, pp. 192-222.

Kearns, J. and Patel, N. (2016), “Does the Financial Channel of Exchange Rates Offset the Trade Channel?”, *BIS Quarterly Review*, December.

Kitamura, T., Kojima, S., Nakamura, K., Takahashi, K. and Takei, I. (2014), “Macro Stress Testing at the Bank of Japan”, BOJ Reports & Research Papers.

Kodres, L. E. and Pritsker, M. (2002), “A rational expectations model of financial contagion”, *Journal of Finance*, Vol. 57(2), pp. 769-779.

Korinek, A. (2014), “International Spillovers and Guidelines for Policy Cooperation: A Welfare Theorem for National Economic Policymaking”, manuscript.

Krishnamurthy, A. (2010), “How debt markets have malfunctioned in the crisis”, *Journal of Economic Perspectives*, Vol. 24(1), pp. 3-28.

Krishnamurthy, A., Nagel, S. and Orlov, D. (2014), “Sizing up repo”, *Journal of Finance*, Vol. 69(6), pp. 2381-2417.

Kuttner, K. N. and Shim, I. (2013), “Can Non-Interest Rate Policies Stabilize Housing Markets? Evidence from a Panel of 57 Economies”, NBER Working Paper No 19723.

Lambert, F. J., Ramos-Tallada, J. and Rebillard, C. (2011), “Capital controls and spillover effects: Evidence from Latin-American countries”, Banque de France Working Paper No 357.

Levin-Konigsberg, G., López, C., López-Gallo, F. and Martínez-Jaramillo, S. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Mexico”, *International Journal of Central Banking*, Vol. 13(2), pp. 249-271.

Li, H., Liu, H., Siganos, A. and Zhou, M. (2016), “Bank regulation, financial crisis and the announcement effects of seasoned equity offerings of US commercial banks”, *Journal of Financial Stability*, Vol. 25, pp. 37-46.

Lim, C., Columba, F., Costa, A., Kongsamut, P., Otani, A., Saiyid, M., Wezel, T. and Wu, X. (2011), “Macroprudential Policy: What Instruments and How to use them?”, IMF Working Paper No 11/238.

Liu, A., Paddrik, M., Yang, S. and Zhang, X. (2016), “Interbank contagion: An agent-based model approach to endogenously formed networks”, OFR Working Paper No 16-14.

Luck, S. and Schempp, P. (2016), “Regulatory arbitrage and systemic liquidity crises”, mimeo, Board of Governors of the Federal Reserve System and Max Planck Institute for Research on Collective Goods.

Malatesta, F., Masciantonio, S. and Zaghini, A. (2016), “The shadow banking system in the euro area: definitions, key features and the funding of firms”, *Italian Economic Journal*, Vol. 2(2), pp. 217-237.

Matheson (2016), “New options emerging as non-traditional credit grows share of Irish market”, March.

Mendicino, C. and Punzi, M. T. (2014), “House prices, capital inflows and macroprudential policy”, *Journal of Banking and Finance*, Vol. 49, pp. 337-355.

Merrill, C. B., Nadauld, T. D., Stulz, R. M. and Sherlund, S. (2012), “Did Capital Requirements and Fair Value Accounting Spark Fire Sales in Distressed Mortgage-Backed Securities?”, NBER Working Paper No 18270.

Minoiu, C. and Reyes, J. A. (2011), “A network analysis of global banking: 1978-2009”, IMF Working Paper No WP/11/74.

Mitchell, M. and Pulvino, T. (2012), “Arbitrage crashes and the speed of capital”, *Journal of Financial Economics*, Vol. 104(3), pp. 469-490.

Montagna, M. and Kok, C. (2016), “Multi-layered interbank model for assessing systemic risk”, *Working Paper Series*, No 1944, ECB.

Moody’s Investors Service (2007), Moody’s Ultimate Recovery Database, Special Comment.

Moreira, A. and Savov, A. (2017), “The macroeconomics of shadow banking”, *Journal of Finance*, Vol. 72(6), pp. 2381-2432.

Nocciola, L. and Żochowski, D. (2016), “Cross-border spillovers from macroprudential policy in the euro area”, in *Macroprudential policy*, BIS Papers No 86, Bank for International Settlements, pp. 45-48.

Ohls, J., Pramor, M. and Tonzer, L. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Germany”, *International Journal of Central Banking*, Vol. 13(2), pp. 129-162.

Ongena, S., Popov, A. and Udell, G. F. (2012), “‘When the cat’s away the mice will play’: does regulation at home affect bank risk-taking abroad?”, *Journal of Financial Economics*, Vol. 108(3), pp. 727-750.

Ordoñez, G. (2018), “Sustainable shadow banking”, *American Economic Journal: Macroeconomics*, Vol. 10(1), pp. 33-56.

Palek, J. and Schwanebeck, B. (2015), “Optimal monetary and macroprudential policy in a currency union”, technical report, Joint Discussion Paper Series in Economics.

Park, H. and Lee, J. (2017), “International Banking and Cross-Border Effects of Regulation: Lessons from Korea”, *International Journal of Central Banking*, Vol. 13(2), pp. 271-292.

Plantin, G. (2015), “Shadow banking and bank capital regulation”, *Review of Financial Studies*, Vol. 28(1), pp. 146-175.

Potineau, J. C. and Vermandel, G. (2015), “Cross-border Banking Flows Spillovers in the Eurozone: Evidence from an Estimated DSGE Model”, *Journal of Economic Dynamics and Control*, Vol. 51, pp. 378-403.

Pozsar, Z. and Singh, M. (2011), “The nonbank-bank nexus and the shadow banking system”, IMF Working Paper No 11/289. Pozsar, Z., Adrian, T., Ashcraft, A. B. and Boesky, H. (2013), “Shadow banking”, *Economic Policy Review*, Vol. 19, pp. 1-16.

Quint, D. and Rabanal, P. (2014), “Monetary and Macroprudential Policy in an Estimated DSGE Model of the Euro Area”, *International Journal of Central Banking*, Vol. 10(2), pp. 169-236.

Raddant, M. and Kenett, D. (2016), “Interconnectedness in the global financial markets”, OFR Working Paper No 16-09.

Rawdanowicz, Ł., Bouis, R., Brezillon, J., Christensen, A. K. and Inaba, K. I. (2014), “Spillover Effects from Exiting Highly Expansionary Monetary Policies”, OECD Economics Department Working Paper No 1116.

Reichert, A. and Shyu, Y.-W. (2003), “Derivative activities and the risk of international banks: A market index and a VAR approach”, *International Review of Financial Analysis*, Vol. 12(5), pp. 489-511.

Reinhardt, D. and Sowerbutts, R. (2015), “Regulatory arbitrage in action: evidence from banking flows and macroprudential policy”, Bank of England Working Paper No 546.

Réka, A. and Barabási, A. L. (2002), “Statistical mechanics of complex networks”, *Review of Modern Physics*, Vol. 74(1), pp. 47-97.

Repullo, R. (2018), “Hierarchical Bank Supervision”, *Journal of the Spanish Economic Association*, Vol. 9, pp. 1-26.

Reuters (2015), “In new trend, European fund firms become banks in all but name”, May.

Robe, I. O., Fiechter, J., Surti, J., Hsu, M., Santos, A. O. and Ilyina, A. (2011), “Subsidiaries and Branches: Does One Size Fit All?”, IMF Staff Discussion Note No 11/04.

Rochet, J. C. and Tirole, J. (1996), “Interbank Lending and Systemic Risk”, *Journal of Money, Credit and Banking*, Vol. 28(4), pp. 733-762.

Roncoroni, A., Battiston, S., D’Errico, M., Hałaj, G. and Kok, C. (2019), “Interconnected Banks and Systemically Important Exposures”, Working Paper Series No. 2331, ECB.

Ross, S. A. (1977), “The determination of financial structure: The incentive-signaling approach”, *Bell Journal of Economics*, Vol. 8, pp. 23-40.

Rubio, M. (2014), “Macroprudential policy implementation in a heterogeneous monetary union”, Universitat de Girona.

Rubio, M. and Carrasco-Gallego, J. A. (2016), “Coordinating macroprudential policies within the Euro area: The case of Spain”, *Economic Modelling*, Vol. 59(C), pp. 570-582.

Schmieder, C., Hasan, M. and Puhr, C. (2011), “Next Generation Balance Sheet Stress Testing”, IMF Working Paper No 11/83.

Schmieder, C., Hesse, H., Neudorfer, B., Puhr, C. and Schmitz, S. W. (2012), "Next Generation System-Wide Liquidity Stress Testing", IMF Working Paper No 12/3.

Shleifer, A. and Vishny, R. (2011), "Fire Sales in Finance and Macroeconomics", *Journal of Economic Perspectives*, Vol. 25(1), pp. 29-48.

Stein, J. C. (2012), "Monetary policy as financial stability regulation", *The Quarterly Journal of Economics*, Vol. 127(1), pp. 57-95.

Turner, P. (2016), "Macroprudential policies, the long-term interest rate and the exchange rate", BIS Working Paper No 588.

Upper, C. (2007), "Using counterfactual simulations to assess the danger of contagion in interbank markets", BIS Working Paper No 234.

Vandenbussche, J., Vogel, U. and Detragiache, E. (2015), "Macroprudential Policies and Housing Prices: A New Database and Empirical Evidence for Central, Eastern, and Southeastern Europe", *Journal of Money, Credit and Banking*, Vol. 47(S1), pp. 343-377.

Vitek, F. (2017), "Policy, Risk and Spillover Analysis in the World Economy. A Panel Dynamic Stochastic General Equilibrium Approach", IMF Working Paper No 17/89.

Appendices

Appendix A: Overview of models and evidence

Table A.1

Structural models – overview

Reference	Type of model	Type of macroprudential policy	The role of banking	Spillover channels	Mechanism	Scenarios considered
Dalen and Olsen (2003)	A multinational bank with subsidiaries (or branches) in two different countries (not dynamic)	Required amount of risk-free assets held by the bank, and the insurance premium (outside equity)	Collects deposits and grants loans to firms with risky investment projects	A regulatory introduced contagion between two countries	If one country experiences an economic downturn, the quality of loans is affected in both countries. Two effects are in play: (i) marginal costs associated with a certain level of quality increases, (ii) (in opposite direction) loan extraction by the supervisor is less important	
Bengui (2014)	A two-country, three-period model with two assets (liquid and illiquid) and two states of the world (normal and distressed)	Setting of investment in liquid assets (by national or global regulators)	None	International spot markets (interest rate)	A regulation-induced decrease in liquidity risk-taking in one country increases liquidity risk-taking in the other county. Extra amount of liquidity set aside in the regulated country lowers the interest rates during future crisis. Macroprudential policies are strategic substitutes. A tightening if regulation in one country reduces the benefits of regulation for another country	1. Spain does not implement macroprudential policies but the rest of the euro area (EUR) does, i.e. the no-coordination case 2. Spain implements macroprudential policies as well as the euro area (SP and EUR), i.e. the coordination case
Jeanne (2014)	Large number of two-period economies	Pigouvian taxes (or equivalent quantity-based measures) that aim at reducing excessive leverage	None	Capital flows	Individual borrowers do not take into account the impact of their borrowing on the risk of default for the other borrowers. Raising the domestic macroprudential tax in a country lowers the global demand for investment and so the global interest rate. The other countries respond to the lower global interest rate by increasing their tax rates on domestic or external borrowing	1. Stabilisation under a standard Taylor rule 2. Stabilisation under a standard Taylor rule extended with credit 3. Country-level macroprudential policy 4. Coordinated macroprudential policy

					Macroprudential policies are strategic complements	
Korinek (2014)	A multi-country economy with a continuum of private agents and a domestic policymaker (general framework nesting a set of general equilibrium models)	Controls on capital inflows (aggregate demand policy) and current account policies (FX stabilisation policy)	None	Trade channel (transaction channel)		1.Cooperative regulation 2. Non-cooperative regulation
Kara (2016)	A two-county, three-period, two-good model with independent regulators	Caps on risky investments of banks (analogous to capital regulation)	Continuum of banks borrowing consumption goods from local deposit markets and investing them in a long-term productive asset	International asset markets and asset prices (during times of distress)	When liquidity shocks hit, banks sell some of their long-term assets to less productive global investors in exchange for liquid resources. The price of the productive asset is determined in a spot market	
Rubio (2014)	A two-country, two-sector, monetary union, DSGE model with housing and collateral constraints (allowing for cross-country differences in mortgage and housing markets)	An LTV rule which responds countercyclically to credit booms	A financial intermediary in each country accepts deposits from domestic savers and extends both fixed and variable rate loans to domestic borrowers	Trade (intermediate tradable good) and international financial markets		
Rubio and Carrasco-Gallego (2016)	As above	As above	As above	As above		1. Spain does not implement macroprudential policies but the rest of the euro area (EUR) does, i.e. the no-coordination case 2. Spain implements macroprudential policies as well as the euro area (SP and EUR), i.e. the coordination case
Quint and Rabanal (2014)	A two-country, two-sector, monetary union, DSGE and a default risk of households (idiosyncratic quality shock to housing stock)	An instrument that influences fraction of liabilities banks can lend	A financial intermediary in each country accepts deposits from domestic savers and extends loans to domestic borrowers	Trade (intermediate tradable good) and international financial markets (C/A)		1. Stabilisation under a standard Taylor rule 2. Stabilisation under a standard Taylor rule extended with credit 3. Country-level macroprudential policy 4. Coordinated macroprudential policy
Mendicino and Punzi (2014)	Two-country infinite horizon DSGE with heterogeneous households and collateralised debt (asymmetric with the focus on home country)	LTV ratio countercyclically responding to credit, house prices, and house price differential (home/abroad), GDP	None	Trade channel (final good) and international financial markets (C/A)		1.Performace of the home economy (following domestic and capital flow shocks) with an extended Taylor rule incl. credit or house prices 2. Performance of the home economy with LTV rule with credit, house prices, GDP and the differential between domestic and foreign real estate prices

Brzoza-Brzezina et al. (2015)	Two-country infinite horizon DSGE in a monetary union and with housing	LTV rule including real loans, house prices and output	Continuum of monopolistically competitive banks accepting deposits from patient households and offering loans to impatient households, and participating in international interbank market	Trade channel (intermediate goods) and international financial markets (C/A)	Search for welfare-maximising LTV rule
Palek and Schwanbeck (2015)	Two-country infinite horizon DSGE in a monetary union and cash-in-advance constraint in goods markets and credit-constrained labour input (which has to be paid by entrepreneurs ahead of its use in production, with loans taken against collateral)	An instrument affecting borrowing costs of entrepreneurs	None	Trade channel (final good) and international financial markets (C/A)	1.Union and country-wide macroprudential tool setting under a set of domestic shocks and based on second-order approximation of the welfare function 2. As above but with a rule-based macroprudential instrument based on credit spread
Vitek (2017)	Multi-country infinite horizon DSGE with three types of households (bank intermediated, capital market intermediated, credit constrained). Bank-intermediated households accumulate deposits in banks and trade real estate in domestic property markets; capital market-intermediated households access domestic and foreign capital markets, trading money, bond and stock market securities. Financial accelerator mechanisms linked to borrowing by developers and firms collateralised against the values of the housing and physical capital stocks, respectively	Regulatory capital ratio and LTV ratio limits (for households and corporates). Macroprudential authority with three policy rules corresponding to three instruments	The representative intermediate bank transforms deposit and money market funding into risky, differentiated, intermediate mortgage and corporate loans Lending rates are sticky Banks obtain funding from deposits, from domestic money market via loans, and from retained earnings	Bank lending, foreign exchange, asset price (debt and equity) channel, commodity price channel, trade channel and international financial markets (C/A)	One-country shock to a policy instrument (1) capital ratio, (2) LTV limit on household mortgage loans, (3) LTV limits on corporate loans
Darracq-Paries et al. (forthcoming)	Two-country, three-sector, infinite horizon DSGE in a monetary union	Total capital requirements, sectoral risk weights and LTV caps	Explicitly modelled; a monopolistic banking sector facing various financial frictions (imperfect interest rate pass-through, risk-sensitive capital requirements, costs related to capital adjustments)	Interbank, cross-border credit and trade channels	

Table A.2

Macro-level data-based evidence – overview

Reference	Data on: - cross-border claims - prudential dataset	Sample: - period - countries	Method: - main LHS variable - estimation	Inward SE (for activating country)	Outward SE (from activating country)
Beirne & Friedrich (2017)	- BIS LBS and IMF IFS - Focus on foreign currency-based prudential measures, drawn from IMF AREAER	-1999-2012 - 66 r	- YoY % change of r banking sector liabilities to non-resident banks over GDP - Panel OLS		- Tighter macroprudential (CFMs) index in the neighboring region s ↑ cross-border bank flows to r - only for r advanced economies - when neighbor countries s are have well-regulated and efficient banking sectors (in the opposite case, ↓ inflows to r)
Cerutti et al (2017)	- BIS external positions of reporting banks - Own macroprudential dataset using an IMF survey (GMPI)	-2000-2013 - 119 r (108 in the spillovers regression)	- YoY % change in the share of cross-border over total liabilities of r NFS - Panel GMM, IV	- Tighter macroprudential regulation index in r ↑ the share of r cross border liabilities (ie. ↑ inflows)	
Houston et al (2012)	- BIS CBS immediate borrower - Barth et al (1999-2011)	- 1996-2007 - 26 s, 120 r	- YoY % change in foreign bank claims: i) aggregate inflow for each r; ii) aggregate outflow for each s; iii) bilateral (s,r) - Panel OLS, GMM, IV, Probit	- Tighter capital regulation index in r ↓ r liabilities to foreign banks, both aggregate and bilateral (s,r) (ie. ↓ inflows) - less likely the presence of foreign affiliates from s in r	- Tighter capital regulation index in s ↑ foreign bank claims held by s, both aggregate and bilateral (s,r) (ie. ↑ outflows) - more likely the presence of foreign affiliates from s in r
Bremus & Fratzscher (2015)	- BIS CBS immediate borrower - Barth et al (1999-2011)	- Change between the average 2005-07 and the average 2010-12 - 15 s, 46 r	- % Change in bilateral (s,r) cross-border bank claims - Cross-country OLS		- Tighter capital regulation index in s relative to r ↑ cross-border claims from s to r in the post-crisis period relative to the pre-crisis (ie. ↑ outflows) - particularly when controlling for the bank system structure - but result might be driven by the relative stance of monetary policies - among EA countries, ↓ cross-border claims from s to r
Reinhardt & Sowerbutts (2015)	- BIS CBS ultimate risk - Own macroprudential dataset from various sources	-2005q1-2014q4 - 37	- Quarterly % change in bilateral (s,r) foreign bank claims - Event study, Panel OLS	- Tighter capital instruments in r ↑ r liabilities to foreign banks on a bilateral (s,r) basis (i.e. ↑ inflows) - Enhanced by the presence of foreign branches in r	- Tighter borrower instruments (LTV, DTI, etc.) and reserve requirements in s ↑ r liabilities to foreign banks on a bilateral (s,r) basis (i.e. ↑ outflows)
Kang et al (2017)	- BIS LBS - Own macroprudential dataset	- 2000q1-2015q1	- YoY % change in bilateral (s,r) cross-border bank loans	- Tighter liquidity instruments (loan-to-deposit, maturity mismatch, RR,	- Tighter borrower instruments (LTV, DTI, etc.) in s

	extending Lim et al (2013)	- 64	- Event study, Panel IV	etc.) in r ↑ cross-border bank credit to r on a bilateral (s,r) basis (i.e. ↑ inflows) - Particularly in countries with an open financial account - Larger size of spillovers in Europe	↑ cross-border bank credit to r on a bilateral (s,r) basis (i.e. ↑ outflows) - Larger size of spillovers in Europe
Avdjiev et al (2017)	- BIS CBS immediate borrower - IBRN macroprudential dataset (Cerutti et al, 2017)	-2000q1-2014q4 - 16 s, 53 r	- Quarterly % change in bilateral (s,r) international bank claims - Panel OLS	- Tighter LTV limits and local currency reserve requirements in r ↑ international bank claims to r on a bilateral (s,r) basis (i.e. ↑ inflows) - Both effects enhanced when banking sectors in s have high capitalization and liquidity ratios	

Notes: Only the main significant results at a 90% confidence level at least are reported in the table. s = source country; r = recipient country. Unless otherwise specified, inflows and outflows are bank financial flows from the activating country perspective. Foreign claims include cross-border and domestic lending by foreign affiliates to the domestic sector of the recipient country. International claims include cross-border and domestic lending by foreign affiliates in foreign currency to the domestic sector of the recipient country.

Table A.3

Micro-level data-based evidence – overview

Reference	Sample: - period - countries	Method: - main LHS variable - estimation	Results/Conclusions
Buch and Goldberg (2017)	2010 - 2014	IRBN summary Bank Lending	The effects of prudential instruments on lending are conditional on balance sheet characteristics and business models of banks, as well as internal liquidity management via banks' internal capital markets. Cyclical considerations do not appear as important for the spillovers of regulations to international lending activity.
Aiyar et al. (2014)	1998-2007 Lending from UK banks to other countries	Capital requirements expressed in basis points, not dummies	Total foreign lending growth falls by -5.5 percentage points over a four- quarter period following a 100 basis point rise in the banks' capital requirement. Lending to core countries (defined by the relative magnitude of the lending relationship) tends to be reduced by less.
Aiyar, Calomiris and Wieladek (2014)	1998-2007	Focus on the leakages that arise when an instrument covers domestic banks but is not applied to the branches of foreign banks operating in the domestic market.	Regulatory leakage from foreign branches amounted to just under one-third (32.9%) of lending.
Danisewicz et al. (2017)	1997-2014	Uses difference-in-difference approach with the type of affiliate (subsidiary or branch) in a cross term with the macropru regulation change.	Tighter capital regulation in the home country has a stronger effect on lending provided by multinational banks' branches compared to subsidiaries. But this heterogeneity in response to capital requirements is only observed in the case of lending to other banks.
Hills et al. (2017)	2000 - 2014	IBRN Exchange-rate-adjusted log change in the stock of loans	Prudential policy actions taken by a single foreign jurisdiction do not appear to affect the United Kingdom, given the United Kingdom's role as a major international financial center. At the sectorial level, when a foreign authority takes a lending standards action, U.K.-resident affiliates owned in that jurisdiction expand private non-financial corporation and household lending in the United Kingdom.
Ongena, Popov, and Udell (2013)	2005 - 2008	Specification with a cross-term composed of a variable capturing regulation from home country of banking acting in a country and a variable capturing the level of transparency of firms in the country.	The type of home-country regulation that reduces the scope of bank activities in domestic markets results in higher risk taking abroad, implied by relatively more lending to informationally opaque firms. Such behaviour can imply that these banks are making up abroad for the inability to engage in high risk-high return lending at home.
Cetorelli and Goldberg (2012)	2006-2010	Difference-in-difference. Uses "net due" positions as depended variable and identified period of shocks in the right hand side.	Parent banks, when hit by a funding shock, reallocate liquidity in the organization according to a locational pecking order. Affiliate locations that are important for the parent bank revenue streams are relatively protected from liquidity reallocations in the organization, while traditional funding locations are more extensively used to buffer shocks to the parent bank balance sheets.
Franch, Nocciola and Żochowski (2017)	2007-2014	Panel models for 248 banks from 16 euro area countries	Outward spillover effects: domestic banks reduce lending after the tightening of capital requirements in other countries, while they increase lending when loan-to-value limits or reserve requirements are tightened abroad. Moreover, foreign affiliates increase lending following the tightening of sector-specific capital buffers in the countries where their parent banks are headquartered.

Table A.4

Papers on cross-border reach of derivatives and banks

Reference	Data on: - cross-border claims - prudential dataset	Sample: - period - countries	Method: - main LHS variable - estimation	Results/Conclusions
Swartz (2015)	-	-	Introductory (descriptive) literature on contracts and markets in cross-border derivatives. Document is very much US focused.	
Alan Reichert and Yih-Wen Shyu (2003) **Very good paper as a starting-point**	Comparison between banks in the US, Europe and Japan.	1995-1997	Three-factor multi-index model and a modified VaR.	The use of options increases the interest rate beta for all banks, while both interest rate and currency swaps generally reduce risk. The results are the strongest and the most consistent for U.S. dealer banks, followed by European banks, and then Japanese banks.
Gonzalez (2005)	251 banks 36 countries	1995-1999	Impact of bank regulation on bank charter value and risk-taking	The results indicate that regulatory restrictions increase banks' risk-taking incentives by reducing their charter value. Banks in countries with stricter regulation have a lower charter value, which increases their incentives to follow risky policies. These results corroborate a negative relation between regulatory restrictions and the stability of a banking system. Deposit insurance has a positive influence on bank charter value, mitigating the risk-shifting incentives it creates. This positive influence disappears when we control for the possible endogeneity of deposit insurance.

Appendix B: Indicators

Table B.1

Indicators used in national frameworks

a) Bank lending channel

Formula	Inward	Outward		ESRB Handbook	Chapter 1 Equivalence	Observation
	Domestic on domestic	Domestic on foreign	Foreign on domestic			
$\Delta \frac{\text{Loans granted to domestic NFCs or HH by } \frac{\text{branches}}{\text{subs}} \text{ of foreign financial institutions}}{\text{Total domestic loans or total loans or total assets or total loans to NFCs or HHs}}$	x		x	Yes	2	Various specifications used.
$\Delta \frac{\text{Cross-border loans granted to NFCs or HHs}}{\text{Total domestic loans or total loans to NFCs or HHs}}$		x		Yes	2	Various specifications used, some further split. Calculated at the individual bank level as well as the bank system-level.
$\Delta \frac{\text{Relevant (measure-related) activity of foreign institutions}}{\text{Total (measure-related) market activity in domestic market}}$	x		x	No, but similar	2, 4 and 5	
$\Delta \frac{\text{Relevant (measure-related) activity of domestic institution(s)in activating member state}}{\text{Total (measure-related) market activity in activating member state}}$			x	No	7	
$\frac{\text{Institution-specific relevant (measure-related)cross-border activity of domestic institution in c}}{\text{Total (measure-related) market activity in other MS}}$		x			No	
Δ FX loans of non-financial sectors by foreign financial institutions (incl. branches)	x			Yes	No	One authority used this indicator to measure adjustments in levels of mortgage lending by foreign institutions to domestic households.
Δ Cross-border FX loans (direct or through branches) to borrowers abroad		x		Yes	No	
$\Delta \frac{\text{Direct cross-border } \frac{\text{credit}}{\text{loans}} \text{ exposure to selected sectors}}{\text{Assets or total } \frac{\text{credit}}{\text{loans}} \text{ held by domestic institutions}}$		x		Yes	1 and 2	
Δ Rate spread between foreign and domestic lending	x	x		Yes	16	
$\Delta \frac{\text{Cross-border credit exposures}}{\text{Total credit exposures or total assets}}$	x	x		Yes	1 and 2	Various specifications used.
$\frac{\text{Cross-border loans, direct or through branches}}{\text{Total assets or total foreign loans}}$		x		Yes	1, 2 9 and 10	
$\frac{\text{Cross-border loans, direct or through branches, to selected sectors}^{*}}{\text{Assets}}$ * collateralized by immovable properties – CRE and RRE		x		Yes	No	

Formula	Inward	Outward		ESRB Handbook	Chapter 1 Equivalence	Observation
	Domestic on domestic	Domestic on foreign	Foreign on domestic			
$\Delta \frac{\text{Loans granted (in terms of original exposures) by domestic banks to foreign borrowers}}{\text{Total credit of borrowing country}}$		x		No	No	
Δ Claims of domestically owned banks on foreign country (scaled by foreign country's GDP)		x		No	No	The objective is to assess how much lending abroad of domestic banks would be impacted by a capital requirement rise and what the potential (welfare) implications for foreign economies are.
Δ Article 124 CRR Risk Weight Requirements	x			No	No	
$\Delta \frac{\text{Combined loans + securities exposures}}{\text{Total loan + securities exposures held by domestic institutions}}$	x		x	Yes	No	
Δ Cross-border exposures of domestically owned banks in comparison to all other BIS reporting banking systems on the Euro Area and all countries		x		No	No	
$\Delta \frac{\text{Total cross-border loans, loans per country of origin or destination}}{\text{Total loan held by domestic banks}}$				Yes	No	Calculated at the individual bank level as well as the bank system-level.
Δ aggregated activity from all non-reciprocating MS to activating MS	x			No	No	
Modified Herfindahl-Index: $\sum_i \frac{Activity\ of\ banks\ from\ MS_y\ in\ MS_z}{Activity\ of\ all\ banks\ active\ in\ MS_z}$	x			No	8	Denominator: all banks for which data is available
Effect on capital of foreign banks' lending to the domestic economy (in $) = X%* average risk-weight * (Foreign banks' PNF exposures to domestic country / Foreign banks' PNF exposures to all countries) * Foreign banks' total exposures to all countries		x		No	No	X% is the increase in the CCyB rate, PNF is private non-financial sector and "all countries" includes domestic economy. This is an indicator that gives a rough first idea of effects of tightening of domestic capital regulations when reciprocity arrangements are in place.

b) Other bank channels

Formula	Inward	Outward		ESRB Handbook	Chapter 1 Equivalence	Observation
	Domestic on domestic	Domestic on foreign	Foreign on domestic			
$\Delta \frac{\text{Total assets foreign branches or foreign subsidiaries}}{\text{Total assets of all banks}}$	x	x	x	Yes	10	Various specifications used.
Δ Number of affiliates (branches and subsidiaries) of foreign banking groups located in domestic market	x	x		No	No	
Δ Number of foreign affiliates (branches and subsidiaries) of domestic banking groups located in activating MS			x	No	8	

Formula	Inward	Outward		ESRB Handbook	Chapter 1 Equivalence	Observation
	Domestic on domestic	Domestic on foreign	Foreign on domestic			
$\Delta \frac{\text{Sovereign / NFC securities holdings (by all or by foreign banks)}}{\text{Total assets, securities or sovereign securities}}$	x	x	x	Yes	No	Various specifications used.
$\Delta \frac{\text{Foreign sovereign securities held by domestic banks by country}}{\text{GDP of foreign country}}$		x			No	
$\Delta \frac{\text{Outstanding securitised assets}}{\text{Total credit}}$	x	x	x	Yes	No	
Δ Distribution of capital ratios at solo level across jurisdictions	x		x	Yes	11	
Δ Capital ratio contribution of foreign entities to the home group	x			Yes	11	
$\Delta \frac{\text{Capital of subsidiaries of foreign banks}}{\text{Total capital of domestic banks}}$	x	x	x	Yes	No	
Δ Own funds contribution to total home country own funds	x	x	x	Yes	No	
Δ Distribution of liquid assets over total assets at solo level across jurisdictions	x	x	x	Yes	11	
$\Delta \frac{\text{Liabilities from cross-border sources}}{\text{Total liabilites}}$	x	x	x	Yes	1	
Δ Interbank security holdings to total security holdings	x			Yes	5	
Δ Asset prices	x			Yes	No	
$\Delta \frac{\text{Intragroup} - \text{exposures}}{\text{Domestic assets}}$		x	x	No	12	
$\Delta \frac{\text{Institution-specific relevant (measure-related) cross-border funding}^{*}}{\text{Total funding of domestic banking group}}$ *** funding of domestic institution from other MS via credit markets, capital markets, deposits, other liability positions**		x	x	No	No	Funding via credit markets, capital markets, deposits, other liability positions
$\Delta \frac{\text{Institution-specific relevant (measure-related) cross-border activity of domestic institution}}{\text{Total relevant (measure-related) market activity in other MS}}$		x		No	No	
Aggregated market share of domestic institutions in all other MS		x			7	
$\Delta \frac{\text{Cross-border equity exposures}}{\text{Total home own funds}}$		x		Yes	No	

c) Non-bank channel

Formula	Inward	Outward		ESRB Handbook	Chapter 1 Equivalence	Observation
	Domestic on domestic	Domestic on foreign	Foreign on domestic			

Formula	Inward	Outward		ESRB Handbook	Chapter 1 Equivalence	Observation
	Domestic on domestic	Domestic on foreign	Foreign on domestic			
$\Delta \frac{\text{Assets held by foreign investment funds and foreign financial vehicle cooperations}}{\text{Total financial sector}}$	x			Yes	No	
Δ Holding of NFC Long-Term Liabilities by OFIs	x			Yes	No	
$\Delta \frac{\text{Assets held by domestic non-bank financial intermediaries}}{\text{Assets held by banks}}$	x			No	No	
$\Delta \frac{\text{Credit by non-bank financial intermediaires}}{\text{Total credit by financial intermediaires}}$	x	x		No	No	
$\Delta \frac{\text{Foreign assets held by domestic non-bank financial intermediaries by country}}{\text{GDP of foreign country}}$	x	x		No	No	
$\frac{\text{Institution-specific relevant cross-border activity of domestic non-bank financial institutions}}{\text{Total relevant market activity in other MS}}$		x		No	No	
Δ Liabilities issued by domestic financial intermediaries held by foreign investors			x	Yes	No	

Table B.2

Data sources used for assessing cross-border spillover effects

Indicator category	Additional spillover channels	Data source	Comments on data source
Cross-border risk adjustment			
Cross-border activity* of domestic banks in foreign markets ***: assets (e.g.: loans) and liabilities (e.g.: funding)**	- Regulatory arbitrage	Supervisory statistics (COREP, FINREP) BIS data (locational and consolidated banking statistics) ECB MFI statistics Financial account statistics Financial reports of financial institutions National confidential supervisory data	Institution-specific data; reporting restrictions Aggregated data; approximation due to consolidation Aggregated data; approximation due to consolidation
Cross-border activity of foreign banks in domestic market ***: assets (e.g.: loans) and liabilities (e.g.: funding)**	- Regulatory arbitrage - Network formation and contagion	Supervisory statistics (COREP, FINREP) BIS data (locational and consolidated banking statistics) ECB MFI statistics Financial reports of financial institutions National confidential supervisory data EBA transparency exercises	Institution-specific data on subsidiaries and branches of foreign banks located domestically; reporting restrictions Aggregated data; approximation due to consolidation Aggregated data; approximation due to consolidation Institution-specific data; Panel size depending on specific exercise
(cross-border)* activity of non-banks ***: Some MS include also the assessment of domestic non-bank activity in their framework**	- Regulatory arbitrage - Network formation and contagion	a) MFI statistics b) Financial account statistics c) Financial reports of institutions	e) e.g.: CBRE

Indicator category	Additional spillover channels	Data source	Comments on data source
Cross-border risk adjustment			
		d) National confidential supervisory data e) Market data	
Outstanding securitised assets	-	Supervisory statistics (COREP, FINREP) MFI statistics National confidential supervisory data	Institution-specific data; reporting restrictions
Foreign currency loans	-	MFI statistics National confidential supervisory data	-
Cross-border equity exposure as a share of home own funds (proxy for cross-border risk appetite)	-	Supervisory statistics (COREP, FINREP)	Institution-specific data; reporting restrictions
Capital of subsidiaries of foreign banks located in domestic market	-	Supervisory statistics (COREP)	Institution-specific data; reporting restrictions
Asset prices	-	a) Supervisory statistics (FINREP) b) Market data	e.g.: SNL
Regulatory arbitrage			
Distribution of liquid assets	-	Supervisory statistics (FINREP) Financial reports of financial institutions Market data	Institution-specific data; reporting restrictions e.g.: SNL (provides data on assets by foreign group entities)
Distribution of capital ratio of domestic banks and foreign banks located in domestic market (and their contribution to foreign home group)	-	Supervisory statistics (FINREP) Financial reports of financial institutions	Institution-specific data; reporting restrictions Potential inconsistencies due to different definitions used by reporting banks
Number (i) of affiliates of foreign banks in domestic market and (ii) of affiliates of domestic banks in foreign markets	-	a) National confidential supervisory data	Indicator only supplementary to indicators on cross-border market share (in case specific data on cross-border activity via foreign branches and direct exposure is limited)
Network formation and contagion			
Cross-border security holdings (e.g.: sovereign securities, NFC securities)	- Network formation and contagion	Supervisory statistics (COREP, FINREP) Financial account statistics Financial reports of financial institutions National confidential supervisory data	Institution-specific data; reporting restrictions Holdings by foreign investors Holdings by domestic institutions
Altering relative cross-border cost of funding			
Rate spread between foreign and domestic lending	-	a) National confidential supervisory data	-

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