DNB Working Paper
No. 659 / November 2019

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DeNederlandscheBank
EUROSYSTEEM

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* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

Working Paper No. 658

October 2019

De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

Mortgage lending, monetary policy, and prudential measures in small euro-area economies: Evidence from Ireland and the Netherlands

Mary Everett[a], Jakob de Haan[b,c,d], David-Jan Jansen[b], Peter McQuade[a], and Anna Samarina[b,c]

[a] Central Bank of Ireland, Dublin, Ireland

[b] De Nederlandsche Bank, Amsterdam, The Netherlands

[c] University of Groningen, The Netherlands

[d] CESifo Munich, Germany

November 2019

Abstract

This paper examines whether the increased use of macroprudential policies since the global financial crisis has affected the impact of (euro area and foreign) monetary policy on mortgage lending in Ireland and the Netherlands, which are both small open economies in the euro area. Using bank-level data on domestic lending in both countries during the period 2003-2018, we find that restrictive euro area monetary policy shocks reduce the growth of mortgage lending. We find evidence that stricter domestic prudential regulation mitigates this effect in Ireland, but not so in the Netherlands. There is weak evidence for an international bank lending channel.

Keywords: monetary policy, prudential policy, mortgage lending, European monetary union

JEL Codes: G21, E42, F36

We thank Jack Bekooij, Suzan Janjetovic, Pieter Stam, Thang Tran, Henk van Kerkhoff, and Peter van Oudheusden from De Nederlandsche Bank and Lorenz Emter from the Central Bank of Ireland for providing statistical and research assistance, respectively. For useful feedback, we thank Dimitris Mokas, Jan Kakes, Jan Willem van den End, participants at a DNB research seminar, the IBRN meetings at the Banque de France (March 2019) and the New York Federal Reserve (July 2019), and at the IMF/IBRN Workshop on Policy Interactions and International Spillovers in the Global Economy (October 2019). Views expressed in this paper are the authors' own and do not necessarily coincide with those of De Nederlandsche Bank, the Central Bank of Ireland or the Eurosystem.

1. Introduction

The global financial crisis of 2007/2008 has had a deep impact on both monetary and macroprudential policies world-wide. In response to the macroeconomic fall-out of the crisis, central banks quickly lowered short-term interest rates, sometimes to levels below zero. In some countries additional policy steps, such as asset purchase programs, were deemed necessary (Blinder et al., 2017). Measures of macroprudential policy had already been in place before the crisis, but in the wake of the crisis these instruments have been used much more widely and frequently in advanced countries in order to prevent a build-up of financial vulnerabilities and to increase the financial system's resilience to shocks. The range of prudential policies is wide and includes instruments such as quantitative restrictions on borrowers, capital requirements, or limits on financial institutions' balance sheets (Cerutti et al., 2017b).

In a setting where both monetary and prudential policies are used actively and simultaneously, the possible interaction between both policies comes to the forefront (Beyer et al., 2017; Collard et al., 2017). As pointed out by Beau et al. (2014), an important reason for the possible interaction of monetary and macro-prudential policies is that the latter will (partly) work through the very same transmission channels as monetary policy, the most likely being the bank lending and the balance sheet channels. Furthermore, monetary policy affects financial conditions but could also increase future financial vulnerabilities, especially if it remains accommodative for an extended period (Adrian and Liang, 2018).

It is also important to recognise that business cycles, which are the focus of monetary policy, and credit cycles, on which prudential policies are based, are not necessarily synchronised, such that the two policies' frameworks could potentially conflict at times (Repullo and Suarez, 2011). Angelini et al. (2014) argue that, in "normal" times this could lead to suboptimal results in the absence of cooperation between the respective competent authorities. They also suggest, however, that there is a high degree of complementarity between monetary and macroprudential policies if financial shocks, rather than real economic shocks, are dominant.

The existing literature offers contradictory findings and, to date, empirical papers studying how prudential policies interact with the transmission of monetary policy are scarce. On the one hand, there are a number of papers indicating that tighter regulations should reduce the effectiveness of monetary policy by providing an additional constraint on the behaviour of

banks.[1] On the other hand, there is also an emerging body of research that suggests that the opposite is the case. Financial sectors that are better regulated will tend to be healthier ex ante, providing better conditions to facilitate the pass-through of accommodative monetary policy during an economic cyclical downswing or crisis (Maddaloni and Peydro, 2013; Dell'Ariccia et al., 2017). Some recent papers provide evidence that monetary and prudential policies may work in the same direction. For the case of the UK, De Marco and Wieladek (2015) find that monetary policy and capital requirements reinforce each other when tightened, but only for small banks; and Forbes et al. (2017) find evidence indicating that monetary policies can amplify the effects of regulatory policy. However, for the case of Belgium, De Jonghe et al. (2016) report that there is a trade-off between prudential capital requirements and monetary policy as their results suggest that a balance sheet expansion of the European Central Bank (ECB) has a weaker impact on credit supply for banks with higher capital requirements.

With the aim of extending the empirical evidence on the interaction between monetary and prudential policies, this paper investigates how monetary policy shocks affect growth in mortgage lending in Ireland and the Netherlands and how this effect depends on the domestic prudential policy stance.[2] Ireland and the Netherlands represent particularly interesting cases for the study of the interaction between prudential policy and monetary policy. First, they are relatively small members of a large monetary union, namely the euro area (EA). Consequently, the monetary policy stance of the EA as a whole is not necessarily in line with that of domestic business and financial cycles. Second, housing markets showed strong volatility in both countries recently. Ireland experienced a credit boom and a housing bubble against a background of negligible regulatory response, which was succeeded by one of the costliest banking crisis in recent times from an economic and fiscal perspective (Laeven and Valencia, 2010; Beck, 2014). The housing market in the Netherlands also experienced a boom-bust cycle in the period under consideration. During the crisis, house prices showed a strong decline, but

[1] See, among others, Kashyap and Stein (2000), Gambacorta and Mistrulli (2004), Disyatat (2010), Aghion and Kharroubi (2013), and Budnik and Bochmann (2016).

[2] There is some theoretical work that analyses the interaction of monetary and macroprudential policies with a focus on housing. For instance, using a DSGE model with housing, Kannan et al. (2012) show that both policies can help stabilizing the economy, depending on the shock that hits the economy. When financial or housing demand shocks drive the credit and housing boom, using a macroprudential instrument that reacts to credit growth will improve welfare. However, the optimal macro-prudential policy under productivity shocks is to not intervene. Therefore, it is crucial to understand the source of house price booms for design of monetary and macroprudential policies. Lambertini et al. (2013) also study potential gains of monetary and macroprudential policies that lean against house-price and credit cycles, finding that the optimal policy for borrowers and savers is different.

have now risen again by over 25% compared to the post-crisis low in 2013. Price increases have been especially large in the four major Dutch cities (Nijskens and Lohuis, 2019).

Third, in the post-crisis period both countries have implemented prudential policies aimed at increasing the resilience of the banking system and alleviating the amplitude of the credit cycle. This occurred during a period of continued accommodative monetary policy in the EA, amid relatively strong economic recoveries in Ireland and the Netherlands. Finally, as small open economies with significant trade and financial linkages with the UK and the US, the monetary policy stance of these major economies may also matter for domestic financial conditions in both economies (Coates and Everett, 2013, Everett, 2015; Lane, 2015). These linkages mean that monetary policies of these economies could potentially have large inward spillovers that affect financial conditions in Ireland and the Netherlands. This is particularly true of non-standard monetary policies as there is evidence that their primary transmission channel is via the exchange rate (Beck et al., 2019).

We focus on mortgage lending for two reasons. First, in both Ireland and the Netherlands growth in housing prices and mortgage credit to households were well above those in the EA before the financial crisis, while they were substantially below the euro-area average after the crisis (see Figure A1). Developments in the housing market have a major impact on the real side of the economy. As owner-occupied homes generally make up a substantial proportion of the gross assets of households, fluctuations in house prices have a major impact on household spending. This is particularly true of households that have high levels of debt or negative equity (DNB, 2015a). Second, in both countries several of the macroprudential decisions taken were aimed at the mortgage market (see section 2 for more details). This makes mortgage lending ideal for the joint analysis of the impact of monetary and prudential policies.

Using bank-level quarterly data on domestic lending by banks in Ireland and the Netherlands during the period 2003-2018, we find that restrictive EA monetary policy shocks reduce the growth of mortgage lending. Concerning interactions, we find that stricter domestic prudential regulation mitigates the effects of monetary policy shocks in the case of Ireland, but not so for the Netherlands. We find only weak evidence for an international bank lending channel. As in earlier work within the International Banking Research Network (IBRN), this paper is able to make use of granular and confidential data on bank lending. This allows us to give a unique and detailed analysis of the transmission of both monetary and prudential policies.

The paper proceeds as follows. Section 2 sketches an overview of the banking systems and trends in mortgage lending in Ireland and the Netherlands, while section 3 outlines monetary and prudential policies in these countries. Section 4 describes the data, section 5 discusses the methodology and section 6 presents the estimation results. Section 7 concludes.

2. Banking system and mortgage lending in Ireland and the Netherlands

Table 1 provides some key statistics of the banking systems and the mortgage markets in Ireland and the Netherlands.

[Insert Table 1 here]

The Irish banking system is complex, consisting of three broad business structures, namely international investment banks, retail banks and small savings and loan (cooperative local) banks, colloquially known as credit unions. International investment banks are hosted as part of Ireland's International Financial Services Centre (IFSC), and primarily engage with international counterparts. While they account for nearly 40 per cent of total assets of the banking system, they have little engagement with the domestic economy apart from employment and export of financial services. Credit unions operate according to a small savings and loan type of business model and do not engage in cross-border activities.

As of end-2018, there were 329 credit institutions in Ireland, with 41 categorised as IFSC banks. The "domestic market group" consists of the remaining 20 domestic retail banks, as well as leasing companies, and approximately 268 credit unions. In the case of Ireland, it is the domestic market group of institutions to which the figures in Table 1 refer. Given that credit unions concentrate on the domestic market, and the interaction between IFSC banks and the domestic economy is minimal, the focus of the empirical analysis is on Irish resident banks active in the retail banking market, comprising both Irish-owned banks and affiliates (both subsidiaries and branches) of European-owned banks.

There have been a number of distinct phases in the evolution of the mortgage market in Ireland during the analysed period. Prior to the global financial crisis, there was a dramatic upswing in the financial cycle in Ireland coinciding with the beginning of our sample period in 2003, as the credit and house prices growth accelerated to unsustainable levels (see Figures A2.1-A2.2). In addition to the inadequate regulation and supervision, described below, this was

also partly driven by the arrival of foreign banks into the domestic retail banking market, which spurred greater competition and contributed to the credit boom in Ireland. Much of this was funded using international wholesale funding, not only from the EA, but also from the US and UK. While the scale of foreign currency funding has fallen significantly in the post-crisis period, the composition of the currency bank liabilities has not changed substantially.

After the property market crash and the associated bank bail-outs, the domestic Irish banks struggled with high levels of non-performing loans and weak profitability. There was also a decline in competition in retail banking in Ireland following the exit of a number of banks from the market during the crisis. As a consequence, non-standard monetary policy measures combined with low interest rate polices implemented by the ECB were not fully passed through, and domestic retail borrowing rates in Ireland remained substantially above those observed in other EA Member States (see Figure A2). As households and banks continued to repair their balance sheets, consistent net credit growth did eventually return in 2016 reflecting a further upswing in the Irish financial cycle. In contrast to the pre-crisis period, this has primarily been funded by domestic deposits.

Even though there has been a downward trend in recent years, the size of the Dutch banking sector remains relatively large compared to the Dutch economy.[3] Prior to the global financial crisis, the size of the Dutch banking sector increased, with its total assets reaching over 600% of GDP in 2007. Since the crisis, the total size of the banking sector shrunk and equalled close to 320% of GDP as of end-2018. The sector remains large from an international perspective, in proportion to the economy's size. The Dutch banking sector is internationally active, highly concentrated and dominated by a small number of large national banks undertaking a wide range of activities. The five largest domestic banks account for 85% of total assets of the banking sector.

During the last several decades, the Dutch banking sector has become more homogeneous. Since the 1980s, a process of harmonisation and consolidation led to mergers, acquisitions, and formation of financial conglomerates. As a result, the distinction between the segments became blurred. Commercial banks evolved into universal banks, aiming to satisfy the growing demand of Dutch businesses and households for financial products and services. Since the crisis, Dutch banks have concentrated more on their core activities, by scaling down real estate and insurance activities and also focusing on the domestic market. This is partially a result of state support

[3] This part draws on DNB (2015b).

measures adopted during the crisis.[4] Additionally, banks shifted their emphasis from investment banking towards traditional lending. For large banks, being a universal bank offering a broad range of products and services to various customer segments remains the dominant business model.

Household mortgages constitute the largest share of lending by financial institutions in the Netherlands. Although banks dominate in mortgage lending (mainly provided by the largest banks), an increasingly large portion of household mortgage loans is provided by non-bank financial institutions such as pension funds and insurance companies (Frost et al, 2019). The stocks of mortgage loans have increased substantially in the last two decades and are one of the highest in the EA, both as a share of GDP and as a fraction of total domestic credit (DNB, 2018). During the past few decades, fluctuations in the housing market have had a visible impact on economic growth in the Netherlands. Increases in house prices at the end of the 1990s had a procyclical effect on economic growth. According to recent estimates, this increased GDP by 1 pp. in 1999 and 2000 (DNB, 2015a). According to calculations made by the Netherlands Bureau for Economic Policy Analysis (CPB), the fall in house prices has held back the annual growth in consumption by 0.5 pp. since 2010 (Lukkezen and Elbourne, 2015). Overall, imbalances in the housing market are often perceived as a main threat to financial stability in the Netherlands (DNB, 2019a).

3. Monetary and prudential policies in Ireland and the Netherlands

As members of the EA, monetary policy in Ireland and the Netherlands is set by the ECB, with the objective of maintaining price stability.[5] As such, it aims to stabilise the EA business cycle only in so far as it is reflected in aggregate EA headline HICP inflation. Numerous dimensions of the broader economic cycle are not directly targeted by monetary policy, including economic growth, employment and the financial cycle. In addition, the small weights of the Irish and Dutch economies in total EA output, as reflected in the ECB's capital key, means that economic developments in these countries have only a limited influence on EA aggregates (Figure A3).[6]

[4] The European Commission required certain actions before approving government support to banks. ING, for instance, was forced to separate its banking and insurance activities.
[5] The ECB defines price stability as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below, but close to 2%, over the medium term for the EA as a whole.
[6] The capital of the ECB comes from the national central banks (NCBs) of all EU Member States. The NCBs' shares in this capital are calculated using a key, which reflects the respective country's share in the total population and gross domestic product of the EU. These two determinants have equal weighting.

As a consequence, we argue that the ECB's monetary policy is, to a considerable extent, exogenous to the domestic business cycles in these countries.

In contrast, prudential policy in Ireland and the Netherlands is set on the basis of domestic economic and financial cycles by domestic competent authorities. In recent years, both countries have introduced and calibrated a number of prudential policy measures (Table 2). As in other advanced economies, the recent more pro-active approach of the competent authorities is partly a reaction to the painful lessons learnt during the global financial crisis.

Prudential policy in Ireland is set by the Central Bank of Ireland empowered as the competent authority. Following EA membership, Irish nominal and real interest rates fell dramatically and remained low for an extended period. Subsequently, increased access to global liquidity, facilitated by relatively loose monetary policy in major advanced economies, combined with greater foreign competition in the retail banking market, gave rise to a credit boom in Ireland. This was against a background of "deference" by the financial regulator to the banking sector in an environment of principles-based regulation, coupled with "diffidence" towards corrective prudential policy (Honohan et al., 2010; Regling and Watson, 2010).

Nevertheless, the Financial Regulator (then one of the two constituent institutions of the Central Bank and Financial Services Authority of Ireland) did eventually respond to the boom in house prices by introducing increased risk weights on residential mortgages for the calculation of capital requirements in May 2006. Although generally considered to be "too little too late", the measures did represent a notable regulatory tightening (Honohan et al., 2010).

Annual house prices in Ireland peaked in 2007Q2 and had just started their precipitous 6-year decline when Basel II came into full effect on January 1st 2008. Basel II represented another regulatory tightening, notable because it included changes to risk weights for mortgage lending across the scale of loan-to-value ratios. Ireland went on to have one of the costliest banking crisis in recent times (Laeven and Valencia, 2010; Beck, 2014).

A dramatic economic recovery in Ireland took hold from 2014, and saw a restoration of a positive market sentiment and a rapid increase in residential property prices in Ireland, particularly in the capital, Dublin (Figure A2.2). Reflecting a new more proactive approach, the Central Bank of Ireland responded through the introduction of macroprudential mortgage measures in 2015, which aimed to dampen the pro-cyclicality of credit and house prices, and to prevent the emergence of a damaging credit-driven house price spiral (Cassidy and Hallissey, 2016; Central Bank of Ireland, 2018). The announcement and implementation of the

loan-to-income and loan-to-value limits coincided with a pronounced deceleration in rate of house price increases and dampened market expectations (Cassidy and Hallissey, 2016).[7] This occurred despite the fact that the housing market at that time was dominated to a considerable extent by cash buyers, as net credit growth in the economy remained negative.[8]

For the case of the Netherlands, the prudential measures that are currently being used have a strong focus on banks (via buffer requirements) and households (via loan standards). Table 2 provides further details. In terms of macroprudential objectives, there is a strong focus on ensuring resilience and less so on actively managing the financial cycle (DNB, 2019b). Concerning borrower-based measures, a key policy step was to reduce the maximum limit for loan-to-value ratios. Traditionally, LTV ratios were well above 100% for Dutch mortgages. The maximum for the LTV ratio has been reduced gradually over a number of years to its current value of 100%. Concerning lender-based measures, a first component of prudential policies are general capital requirements in line with the Basel regulatory standards. Specific to macroprudential policy, five Dutch banks are currently subject to systemic capital buffers, which range between 1% and 3%.[9]

In terms of governance, the Financial Stability Committee (FSC) acts as a forum for discussions and coordination on Dutch macroprudential policy. The task of the FSC is to identify risks to financial stability and make recommendations regarding these risks. The FSC meets at least twice a year and is chaired by the president of De Nederlandsche Bank (DNB). Two other institutions that are represented are the AFM (the Dutch Authority for the Financial Markets) and the Ministry of Finance. The Netherlands Bureau of Economic Analysis (CPB) participates in an advisory role. The FSC does not decide on macroprudential policy measures itself. Macroprudential measures for banks are taken by DNB, while the Dutch Ministry of Finance is responsible for policy concerning limits on loan-to-value and debt-to-income ratios.

[Insert Table 2 here]

[7] House prices had been increasing by approximately 15% year-on-year nationally (over 25% in Dublin) at the time when the measures were announced in 2014. By 2015Q3, two quarters after the implementation of LTI and LTV limits in 2015Q1, national house price increases had slowed to approximately 7% (less than 3% in Dublin).
[8] Negative net credit growth was also attributable to deleveraging by the household sector in the wake of the domestic banking crisis.
[9] For the latest status of macroprudential instruments in the Netherlands, see https://www.dnb.nl/en/about-dnb/duties/financial-stability/macroprudentiele-instrumenten/index.jsp .

4. Data description

Bank-level data

As in earlier IBRN initiatives, we are able to make use of granular and confidential data on bank lending available to central bank researchers. This allows us to give a unique and detailed analysis of the transmission of both monetary and prudential policies. We use quarterly bank-level data over the period 2003Q1-2018Q2 for Ireland and 2003Q1-2018Q3 for the Netherlands. Three types of bank-level data are compiled: mortgage lending, bank balance sheet characteristics, and channel variables. Mortgage lending corresponds to domestic lending by banks to households for purchase of housing. Balance sheet variables include total assets, capital, liquid assets, and core deposits. The channel variables are based on the composition of bank liabilities (deposits) by currency of funding (in euro, dollar, or sterling) as well as by geography of funding (counterparties residing in the EA, the US or the UK). In what follows we describe bank-level data collection separately for Ireland and the Netherlands.

Individual bank balance sheet data for Irish banks are drawn from the data collected for the compilation of the EA Monetary Financial Statistics. These data are collected according to the residency principle and cover the balance sheets of subsidiaries and branches located in Ireland. Both flow and balance sheet information are available at the level of individual banks. An advantage of the flow data is that they account for exclusion of securitisations, write-offs, and valuation effects (price and exchange rate movements), thereby providing an accurate measure of credit growth to domestic borrowers. This is an important feature of the dataset given the extent of non-transaction based effects on bank balance sheets during the analysed period, such as securitisation activities during the mid-2000s and loan transfers to Ireland's "bad bank" - the National Asset Management Agency - during the crisis. Variables sourced from this database include mortgage lending, total assets, capital, core deposits, and liquid assets.[10] We focus on net mortgage lending (new lending minus repayments) as net mortgage lending turned negative during the period under review in the wake of the domestic banking crisis.

The channel variables are based on cross-border activities of banks, captured by the bank-level data underlying the International Banking Statistics reported to the Bank for International

[10] The measure of capital is based on a residency concept and differs from Tier 1 capital on a consolidated bank basis in that it comprises all capital (including capital contributions, i.e., payments into the reserves of a reporting institution by its parent for no consideration, which are not repayable except at the option of a reporting institution), reserves (except taxation reserve), accumulated retained profits, preference shares, and subordinated loan capital.

Settlements (BIS). These data are also compiled in line with the residency principal and on a first counterpart basis.

The data are cleaned for outliers, and banks with less than 12 quarterly observations for channel variables are dropped. The final sample for Ireland consists of 7 banks which represent 76% of all assets of Irish retail banks at mid-2018.

Similarly, for the Netherlands, the detailed bank-level lending data are also drawn from sources collected to construct the Monetary and Financial Statistics. Quarterly gross flows of domestic household mortgages (new lending) are used, which include new loans and renegotiations. The motivation for using new mortgage lending flows instead of outstanding stocks is that policy changes (both monetary and prudential) are more likely to work on the margin and influence new lending decisions rather than accumulated stocks. The bank-level lending data for the Netherlands are available for the analysed period for *gross* flows of new mortgage lending. Bank-level data on *net* flows (i.e. new lending minus redemptions) are available only from the end of 2014 onwards.[11]

The data on mortgage lending are complemented with information on bank balance sheet characteristics from supervisory reporting sources.[12] These variables include total assets, Tier 1 capital, liquid assets (including cash, deposits, and bonds with maturity up to one year), and core deposits. All data from supervisory sources are on a consolidated basis. Banks' liabilities and deposits by currency and geography of funding are sourced from the Monetary and Banking Statistics.

The final sample for the Netherlands includes 7 banks which are active in the Dutch banking sector and provide mortgage loans to households. They account for 79% of all assets and 93% of all mortgage lending in the Dutch banking sector.

The dependent variable in our analysis is mortgage lending growth which is proxied by the gross flows of new mortgage lending for the Netherlands, and net flows (new lending minus redemptions) for Ireland, both scaled by total stocks from the previous period.

Table 3 offers some descriptive statistics. During the period 2003-2018, banks in the Netherlands received on average 51% of funding in the form of deposits, suggesting a smaller

[11] This is due to the fact that before 2014 Dutch banks did not report the data on lending renegotiations to DNB. These data are necessary in order to calculate redemptions and, subsequently, net new lending.

[12] The supervisory data had to be assembled from different reporting standards covering the periods 2000-2004, 2004-2007, 2008-2013 and 2014-present (the latter in accordance with the EU Capital Requirements Directive IV). The resulting structural breaks have been corrected to the greatest extent possible. See also Frost et al. (2017).

role for wholesale funding. In Ireland the period includes a number of distinct phases in terms of sources of funding, with wholesale funding playing a dominant role in the pre-crisis period, before deposit funding becoming dominant in the post-crisis period. In the Netherlands, liquid assets constituted 29% of total assets, but with a relatively wide standard deviation. In Ireland liquid assets constituted nearly 40% of total assets, but with an even wider standard deviation, reflecting the difficulties experienced in the banking system during the financial crisis. The average Tier 1 capital ratio was about 4.5% of total assets in the Netherlands, while the average capital ratio was about 13% in Ireland. The large difference in these ratios between the two countries comes from differences in measurement: as noted earlier (see footnote 10), the measure of capital in the Irish data is much broader than the Tier 1 capital measured in the Dutch data. In addition, in interpreting these numbers, it should be noted that the denominator is total assets rather than risk-weighted assets.

[Insert Table 3 here]

Prudential policy measures

The data on prudential policy measures for Ireland and the Netherlands are sourced from the IMF-IBRN database of Cerutti et al. (2017a), recently updated until 2018Q3. We complement these with data from the ECB's Macro-prudential Policies Evaluation database (MaPPED) and domestic sources. MaPPED is a comprehensive dataset, recently constructed and continuously updated, which collects information on a wide range of macro- and micro-prudential measures implemented by EU countries (see Budnik and Kleibl (2018) for details).

Each prudential instrument is assigned a value +1 when the policy stance is tightened, a value -1 when the stance becomes more accommodative, and 0 if no change occurred. The aggregate prudential index is constructed as a sum of prudential instruments implemented at quarter *t*. Since reserve requirements are often treated as a monetary policy tool, we exclude them as prudential instruments.[13]

Additionally, to examine how transmission of monetary policy to mortgage lending varies depending on the dimension of prudential policies, we construct two prudential indexes: i) *Lender*-based and ii) *Borrower*-based. *Lender*-based measures are aimed at improving the resilience of the financial system. These include capital-based measures, such as capital

[13] Our results hold when instead we use the aggregate prudential policy index with reserve requirements.

requirements, buffers, risk weights, concentration and exposure limits, and taxes on assets/liabilities. *Borrower*-based measures are oriented towards borrowers with an objective of smoothing the credit cycle and focus on the asset side of bank balance sheets, namely through loan-to-value and debt-to-income ratios.

To proxy the prudential policy stance we rely on cumulated measures, in the absence of data on the intensity of implemented prudential policies. In a baseline analysis, we proxy the stance with cumulated prudential actions over 2 years before the monetary policy shock to account for time lags in transmission of prudential policy as well as to avoid potential endogeneity bias. As a robustness check, we use accumulation of prudential policy actions over 3-year and 5-year periods prior to the monetary policy shock; the results hold.

Monetary policy measures

We use monetary policy shocks for the EA, the US, and the UK, constructed by the IBRN methodology team from structural vector autoregression (VAR) models using high-frequency identification techniques. The shocks are exogenous with respect to other macroeconomic factors that could drive interest rate changes. The identification strategy follows the external instrument VAR approach of Mertens and Ravn (2013) and Stock and Watson (2018), applied to monetary policy in the US (Gertler and Karadi, 2015) and the UK (Cesa-Bianchi et al., 2016; Gerko and Rey, 2017). Interest rate surprises, capturing movements in financial markets in short windows around central bank announcements, are used as instruments to identify structural monetary policy shocks.

The US and UK shocks are estimated by extending the methodology of, respectively, Gertler and Karadi (2015) and Gerko and Rey (2017) to 2018Q3, using the same data and identification assumptions as in the original papers. EA shocks are constructed using monetary policy surprises from Andrade and Ferroni (2018) to estimate monetary policy shocks within an EA VAR, similar to the setup of Gertler and Karadi (2015) for the US.

Macroeconomic and financial controls

We take into account several domestic and global factors that might affect mortgage lending in both countries. In the case of the Netherlands, we control for the domestic business cycle using y-on-y quarterly real GDP growth. For Ireland, modified domestic demand is included, based on information from the Central Statistics Office (CSO), which excludes some effects of

multinationals, which distort the measurement of economic activities in Ireland.[14] To control for credit demand, we follow Altavilla et al. (2018) by using confidential bank-level data taken from the Irish and Dutch contributions to the ECB's quarterly Bank Lending Survey. It includes information on self-reported demand developments by individual banks and contains a specific question on the credit demand of households. Global risk is proxied using the VIX index from the Chicago Board Options Exchange (CBOE), where the VIX index is a measure of US stock market volatility compiled from the prices of short-dated options on the S&P 500. Table A.1 in the Appendix provides details on the construction and data sources of all variables.

5. Methodology

5.1. Domestic transmission

For analysing domestic transmission, we investigate how ECB monetary policy shocks affect growth in mortgage lending in Ireland and the Netherlands and how this effect interacts with the domestic prudential policy stance. We do so by running panel regressions separately for Irish and Dutch banks over the period 2003-2018. This regression approach is common in the empirical banking literature (e.g. Gambacorta and Marques-Ibanez, 2011; Buch et al., 2019). We start with a model of domestic transmission, specified as follows:

$$Y_{b,t} = \alpha_0 + \alpha_1 Pru_{b,t-4}^{home} + \alpha_2 MP_{t-3}^{EA} + \alpha_3 MP_{t-3}^{EA} \cdot Pru_{b,t-4}^{home} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{t-1} + f_b + \epsilon_{b,t} \quad (1)$$

where $Y_{b,t}$ is the flow of new mortgage lending by Irish/Dutch bank *b* at quarter *t*, scaled by total stocks. MP_{t-3}^{EA} are EA monetary policy shocks, included with a third lag (k=3) to allow one-year transmission.[15] $Pru_{b,t-4}^{home}$ denotes the domestic (IE or NL*)* prudential policy stance prior to the monetary policy shock. We proxy the policy stance using the 4th lag of 2-year cumulated prudential policy actions. $X_{b,t-1}$ is a vector of time-varying bank-level control variables, including: log of total real assets, capital ratio (Tier 1 for the Netherlands), liquid assets ratio, and core deposits ratio. $Z_{b,t-1}$ denotes domestic and global factors, which include a proxy for domestic economic activity (real GDP growth for the Netherlands and modified

[14] Specifically, the Modified Domestic Demand (MDD) indicator excludes trade in aircraft related to aircraft leasing companies and R&D-related intellectual imports from the traditional Total Domestic Demand indicator. See Avdjiev et al. (2018) and Fitzgerald (2018) for greater detail on the distortions in the national accounts and measures of economic growth arising from the activities of global firms .

[15] As a robustness check, we include also the first and the second lags of monetary policy shocks to capture dynamic effects. The results are robust to this modification (results are available on request).

domestic demand for Ireland), domestic credit demand, and global risk. f_b are unobserved time-invariant bank-fixed effects, capturing e.g., bank business model or risk appetite. $\epsilon_{b,t}$ is an idiosyncratic error term with mean 0. Standard errors are clustered at the bank level.

We first estimate equation (1) without interaction terms. Next, we include interactions to examine how prudential policies condition the impact of monetary policy shocks on mortgage credit growth.

5.2. Inward transmission

In order to investigate how domestic prudential policy affects the transmission of foreign monetary policy to mortgage lending we use the following specification:

$$Y_{b,t} = \alpha_0 + \alpha_1 Pru_{b,t-4}^{home} + \sum_{ctry} \alpha_2 MP_{t-3}^{ctry} + \sum_{ctry} \alpha_3 MP_{t-3}^{ctry} \cdot Pru_{b,t-x}^{home} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{t-1} + f_b + \epsilon_{b,t} \quad (2)$$

This is similar to specification (1) except that MP_{t-3}^{ctry} now includes monetary policy shocks in the US and the UK, in addition to the ones for the EA.

5.3. Inward transmission – extension using channel variables

One challenge in identifying the effects of prudential policies is that they do not vary at the bank-level. This is the case for Ireland and also, to a large extent, for the Netherlands.[16] Therefore, to explore the possible channels through which prudential and monetary policy (and their interactions) may affect mortgage lending we use the following alternative specification:

$$\begin{aligned} Y_{b,t} = \alpha_0 + \alpha_1 Pru_{b,t-4}^{home} + \sum_{ctry} \alpha_2 MP_{t-3}^{ctry} + \sum_{ctry} \alpha_3 MP_{t-3}^{ctry} \cdot Pru_{b,t-4}^{home} + \alpha_4 Pru_{b,t-4}^{home} \\ \cdot Channel_{b,t-4} + \sum_{ctry} \alpha_5 MP_{t-k}^{ctry} \cdot Channel_{b,t-4} \\ + \sum_{ctry} \alpha_6 MP_{t-3}^{ctry} \cdot Pru_{b,t-4}^{home} \cdot Channel_{b,t-4} + \alpha_7 X_{b,t-1} + \alpha_8 Z_{t-1} + f_b \\ + \epsilon_{b,t} \quad (3) \end{aligned}$$

[16] For instance, as discussed in Section 2, the systemic buffer in the Netherlands currently applies to 5 banks. However, given our sample size, this still does not allow sufficient between-bank variation for further analysis.

By interacting monetary and prudential policies with channel variables, this specification aims to identify precisely which banks are most affected by monetary/prudential policy variables. This idea of identification through heteroskedasticity traces back to earlier work on the bank lending channel by Gilchrist and Zakrajšek (1995). We anticipate that the transmission of monetary policy to banks may depend on the extent to which banks are exposed to foreign monetary policy. Specifically, $Channel_{b,t-4}$ controls either for geography (EA, the UK, the US) or currency of funding (euro, sterling, dollar). Channel variables are measured, respectively, as a share of liabilities from EA/US/UK in total liabilities or a share of liabilities in euro/dollar/sterling in total liabilities.[17]

These channels provide an important additional source of variation, especially in the Irish case in the pre-crisis period, as Irish banks frequently obtained funding from the UK, or denominated in sterling or dollars rather than in euros. For Dutch banks the funding in foreign currency or of foreign origin has been less relevant and constituted a smaller fraction of their liabilities. It is interesting, therefore, to examine how the differences in the banking systems of Ireland and the Netherlands affect the transmission of monetary and prudential policies to mortgage lending.

[17] Some recent theoretical papers analyse how US monetary policy may spill over to other countries. For instance, Akinci and Queralto (2019) use a 2-country New Keynesian model with financial frictions. A rise in US rates transmits to domestic economies via tighter credit market conditions abroad. These effects are magnified by the balance sheet channel: a US rate hike initiates results in a decline in foreign borrowers' net worth. As balance sheets deteriorate, the cost of borrowing for non-financial firms rises, depressing investment and pushing down GDP. The cost of borrowing in local currency increases more than the cost in foreign currency, especially for banks with large non-core liabilities. In the model of Aoki et al. (2016), the transmission of foreign monetary policy shocks operates through the exchange rate and bank balance sheet channels. An increase in the foreign interest rate leads to a domestic currency depreciation that initially has an expansionary impact via expenditure switching, but eventually leads to a recession as depreciation reduces the net worth and intermediation capacity of banks exposed to foreign currency liabilities.

6. Empirical results

6.1 Domestic transmission

Table 4 presents the findings for the baseline specification (i.e. equation (1) without the interaction terms). The results for Ireland are displayed in columns (1)-(3), and for the Netherlands in columns (4)-(6). We first include an aggregate prudential policy variable and then separately consider two key subcategories of prudential policies - *Borrower*-based and *Lender*-based, as described in section 4.

[Insert Table 4 here]

Column (1) in Table 4 shows that a tightening of aggregate prudential policies has a dampening effect on mortgage credit growth in Ireland, as the prudential policy variable is negative and statistically significant. Quantitatively, the coefficient estimate implies that measures aimed at tightening prudential policy have reduced mortgage credit growth by approximately 1 percentage point twelve months after implementation. The monetary policy variable is also found to be negative and statistically significant, suggesting that a surprise tightening of ECB monetary policy reduces mortgage credit growth in Ireland.[18] The overall fit of the model is good, as the adjusted R^2 statistic indicates that the model explains approximately 43 per cent of the variation in mortgage credit growth.

The coefficient on the *Borrower*-based prudential policy variable, shown in column (2), also has the expected negative sign, but is insignificant. This is likely to be due to the fact that, although house prices were growing rapidly when the loan-to-value and loan-to-income limits were introduced in 2015Q1, the housing market at that time was dominated by cash buyers, as net mortgage credit growth remained negative in the wake of the domestic financial crisis.

The coefficient on *Lender*-based prudential policies is negative and significant, indicating that tighter prudential policy tools targeted at banks are associated with lower mortgage credit growth to households (column (3)). The magnitude of the coefficient plausibly implies that less than 2 percentage points of the decline in mortgage credit growth are explained by the imposition of these measures. The estimated effect of prudential policy on mortgage credit growth represents only a fraction of the dramatic decline in Ireland during the crisis, when net

[18] The results suggest that larger and better capitalised Irish retail banks exhibited lower mortgage lending growth as indicated by the negative coefficients on the log total real assets and capital ratio. One plausible explanation for this result is that Irish banks required unprecedented state interventions in the form of state capital injections during the domestic banking crisis.

mortgage credit growth went from a peak of over 30% year-on-year in 2004 to approximately –10% in 2009 (see Figure A2.1).

In contrast to the results for Ireland, for the Netherlands we find no evidence for the direct effect of prudential policy stance on mortgage lending growth, although the sign of the coefficient estimates is negative, as expected. This holds for the aggregate prudential index as well as its subcategories.[19] We find that *Lender*-based prudential policies reduce mortgage lending growth in the Netherlands under certain model specifications, but this result is only weakly significant. In interpreting the absence of significant effects of prudential policies, two considerations seem relevant. First, even though prudential regulation in the Netherlands has by all means become stricter, it may still be the case that it is not yet binding enough for it to have a clear impact on the financial cycle. Second, it is important to recall that most of the prudential measures, in particular the lender-based macroprudential ones, have been primarily directed at building up resilience.

Concerning monetary policy, we find that a surprise tightening (reflected in the increase in EA monetary policy shock) significantly decreases the growth of mortgage credit in Ireland as well as in the Netherlands. This evidence is in line with the traditional bank lending channel of monetary policy (Bernanke and Blinder, 1988; Bernanke and Gertler, 1995).[20] While a one percentage point surprise tightening in EA monetary policy is associated with a 1.5 percentage point decline in mortgage lending for Ireland, the magnitude of the effect is five times larger than the effect for the Netherlands.

In the models for both countries, the business cycle matters. We find that higher domestic economic activity in both countries stimulates growth in mortgage lending. In addition, Dutch banks that experienced a stronger household credit demand have increased mortgage lending more. None of the other bank-specific controls has a significant impact on mortgage lending.

Turning to the key research question regarding policy interactions, we now include the interaction term $MP_{t-k}^{ECB} \cdot Pru_{b,\sum t-x}^{home}$ in the model (equation 1). Table 5 shows the results, following the same set-up as Table 4. When this variable is included, the coefficients on prudential policy retain the negative sign for the Irish case and are of similar magnitude and significance to the baseline results. Tighter aggregate and *Lender*-based prudential policies are

[19] Additional analyses show this result is not driven by any specific changes in mortgage lending (flows or stocks), by individual banks in the sample or the post-crisis years.

[20] For the Netherlands, this is a much stronger indication of a bank-lending channel than so far has been reported in the empirical literature (e.g. Kakes, 2000; De Haan, 2003; Garretsen and Swank, 2003).

correlated with lower mortgage credit growth. The interaction terms are positive, implying that prudential policy dampens the effect of monetary policy on mortgage credit growth (and vice-versa). However, the coefficient is significant only in the case of *Borrower*-based measures, reported in column (2). This implies that the loan-to-value and loan-to-income measures introduced in 2015 may have offset the expansionary impulse to mortgage lending in Ireland associated with subsequent accommodative non-standard monetary policy actions taken by the ECB. This effect could be considered desirable from an Irish perspective given the dramatic economic recovery in Ireland from 2014, largely reflecting the strong performance of the multinational corporate (MNE) sector, but also associated with a restoration of confidence in the domestic Irish economy.

In contrast to the Irish case, for the Netherlands we do not find evidence suggesting that prudential policy stance mitigates the transmission of EA monetary policy (see columns (4)-(6) in Table 5). This may be related to the earlier finding that there is no strong significant relationship between prudential policy and credit growth to begin with. As in Table 4, positive ECB's monetary policy surprises reduced the growth of mortgage lending by Dutch banks.

[Insert Table 5 here]

In a first extension, we test whether the results for prudential policy are driven by specific types of prudential measures. To do so, we conduct a sensitivity analysis using a narrow prudential index that includes the most important measures considered as binding from each country's perspective. For the Netherlands these are loan-to-value and debt-service-to-income ratios, capital requirements, and capital buffers. Next, we include separately individual prudential measures, as described in Table 2. We re-estimate the models for domestic transmission without and with the prudential policy interaction terms.[21] For the Netherlands, the results of this analysis are similar to the main ones, suggesting that none of individual prudential measures nor the narrow prudential index have a significant (direct or conditioning) effect on mortgage lending.

For the case of Ireland, given that prudential measures are driven by very few and specific policies as discussed in section 3, we extend the analysis to explore an alternative channel of transmission, whereby lending to non-financial corporates is included as the dependent variable. Consistent with results for the baseline specification, a tightening of prudential

[21] The results of these two sensitivity analyses are available on request.

policies has a negative effect on credit growth to non-financial corporates in Ireland, driven by tighter policy aimed at the lender.

In a second extension, we consider the asymmetric effects of EA monetary policy shocks. We test whether episodes of accommodative monetary policy have a different impact on mortgage lending compared to episodes of tight monetary policy. For this purpose, we construct a dummy variable which takes the value 1 when monetary policy shocks are positive, and 0 when shocks are negative. For both Ireland and the Netherlands, we find no evidence for asymmetric effects of EA monetary policy. In addition, tighter prudential regulation mitigates the positive impact of expansive monetary shock, but amplifies the negative effect of restrictive monetary shock on mortgage credit growth; the mitigating effect of prudential policies under monetary easing is stronger in terms of magnitude than the amplifying effect under monetary tightening. For the Netherlands this amplification effect is found for both aggregate, borrower-based and lender-based prudential policies, whereas for Ireland the amplification is only relevant for borrower-based prudential policies.[22]

Overall, the estimates for the domestic policy transmissions do not always point in the same direction. In particular, conclusions on prudential policies differ. Prudential policies (notably those targeted at the lender) are significant determinants of the growth of mortgage lending by Irish banks. We also find evidence that prudential policies (notably those targeted at the borrower) dampen the transmission of EA monetary policy to mortgage lending in Ireland. In contrast, mortgage credit growth of Dutch banks is only influenced by the monetary policy shocks, while prudential policy stance does neither have a direct nor mitigating effect.

6.2 Inward transmission

We now turn to the role of monetary policies originating outside of the EA. Ireland's domestically-owned banking system sourced substantial levels of international wholesale financing during the pre-crisis period, which contributed to a domestic property bubble, fuelling one of the largest banking crises in history. International financing played a less important role for the Dutch banking sector and has been rather stable over time. As a next step of the analysis, we examine the transmission of foreign monetary policies to the domestic mortgage markets in Ireland and the Netherlands.

[22] The results are available on request.

The regression results for equation (2) are reported in Table 6; they include interaction terms between the prudential policy stance and foreign monetary policy.[23] We consider the monetary policies of the UK and the US, in light of the close links of both Ireland and the Netherlands to these economies. Furthermore, prior to 2008 both sterling and dollar denominated funding were significant components of the international funding of Irish banks.

In the case of Ireland, none of the foreign monetary policy shocks or their interaction terms are significant, although the explanatory power of the model, as implied by the adjusted R^2, is similar to that of the baseline model. Consistent with the baseline results, the coefficients on the aggregate and *Lender*-based prudential policy measures remain statistically significant in columns (1) and (3). In contrast, tightening of monetary policy in the UK and the US jointly reduces mortgage lending in the Netherlands, although only the coefficient on UK monetary policy shocks is individually significant. This provides some evidence for an international bank lending channel. There is some (weak) evidence that this effect is mitigated by stricter *Lender*-based domestic prudential regulation.

[Insert Table 6 here]

In Table 7, in addition to UK and US monetary policy shocks, we also include EA monetary policy shocks as well as their interactions with prudential policy variables. Consistent with the previous results, only the interaction term between *Borrower*-based prudential index and EA monetary policy is individually significant in explaining mortgage credit growth in Ireland (column (2)). The coefficients on the aggregate and *Lender*-based prudential policy measures remain significant.

Although only significant for the Netherlands (columns (4) and (6)), the sign on the interaction term is the opposite to that on the coefficients on monetary policy shocks. This could suggest that monetary and prudential policies act as substitutes rather than complements. Moreover, the interaction terms are jointly significant and positive, while the joint monetary policy variable coefficient is negative. Taken together, these results could suggest that prudential policy (notably *Lender*-based) mitigates the negative effect of foreign monetary policy tightening on mortgage lending by Dutch banks.

[23] Controls for domestic macroeconomic conditions, global risk, and bank-level time-varying characteristics are included throughout the regressions but are not reported due to space constraints. The detailed results are available on request.

[Insert Table 7 here]

6.3 Inward transmission through channels

Due to the lack of variation in prudential policy at the individual bank-level, we next introduce a channel variable to capture the extent to which a bank is likely to be exposed to changes in foreign monetary policy. Table 8 reports the estimation results for specification (3) where we include additional interaction terms with channel variables.

We first use geography – i.e., the share of EA, US or UK liabilities in total bank liabilities – as a channel variable. These channels have different effects in Ireland compared to the Netherlands. In Ireland banks with higher funding from EA sources reduce mortgage lending *less* when *Borrower*-based prudential measures are implemented. The significant negative sign on the triple interaction term $MPS^{EA} \times Pru \times Channel^{EA}$ in column (2) implies that Irish banks with larger EA-sourced funding reduce mortgage lending *more* when *Borrower*-based prudential policy coincides with tighter EA monetary policy. In addition, higher UK-sourced funding amplifies the negative effect of aggregate prudential (and *Lender*-based) regulation on mortgage lending. For the Netherlands, we find that banks with higher EA-sourced funding reduce mortgage lending *less* after EA monetary tightening. In addition, higher funding from US sources mitigates the negative effect of *Lender*-based prudential regulation, when it is implemented independently or coinciding with tighter US monetary policy. The significant negative sign on the triple interaction terms for UK and EA monetary policy implies that Dutch banks with larger EA/UK-sourced funding reduce mortgage lending *more* when *Borrower*-based prudential policy coincides with tighter EA/UK monetary policy.

[Insert Table 8 here]

In Table 9 we use the currency of funding as a channel instead of geography. In contrast to previous results, external funding in foreign currency is not a mitigating factor of mortgage lending in Ireland. This implies that while funding sourced from the UK matters, it is not necessarily denominated in sterling. Euro-funding seems to matter: Irish banks with larger funding in euros reduce mortgage lending *less* when *Borrower*-based regulation is tightened. For the Netherlands the results are to some extent in line with the ones for the geography channel. That is, Dutch banks with higher funding in dollars decrease mortgage lending *less*

when tightening of prudential rules coincides with US monetary tightening; while banks with larger funding in euro or sterling reduce mortgage lending *more* when stricter prudential policy coincides with tighter EA or UK monetary policy.

[Insert Table 9 here]

7. Conclusions

This paper adds novel empirical evidence to a new but growing literature on the interactions between monetary and prudential policies. The focus is on the transmission of policies via bank lending. Using confidential bank-level data on mortgages, we provide an in-depth analysis of policy interactions in two small open EA economies. Despite a number of similarities, such as the importance of the housing markets to both countries, there are some interesting differences in terms of policy transmission. There are three main findings.

First, the results for domestic transmission indicate that prudential policies (notably those targeted at the lender) are significant determinants of the mortgage credit growth by Irish banks. Moreover, prudential policies (notably those targeted at the borrower) dampen the transmission of euro area monetary policy to mortgage lending in Ireland. In contrast, mortgage credit growth of Dutch banks is only influenced by the monetary policy shocks while there is no evidence for the significant impact of prudential policies on mortgage lending.

Second, foreign monetary policy does not affect mortgage credit growth in Ireland, but has a significant effect on banks' mortgage lending in the Netherlands. This provides some evidence for an international bank lending channel. For the latter, we also find some weak evidence that this effect is mitigated by stricter *Lender*-based prudential regulation.

Third, Irish banks with larger EA sourced funding reduce mortgage lending *more* when *Borrower*-based prudential policy coincides with tighter ECB monetary policy. In contrast, Dutch banks with higher EA sourced funding reduce mortgage lending *less* after ECB monetary policy tightening.

Overall, these findings provide insights for policymakers by shedding light on the interaction between monetary policy set at the monetary union level and macro-financial stabilisation policies implemented at the national level. In general, macro-prudential and monetary policies may have complementary, conflicting or independent outcomes on financial

stability. Our results suggest that prudential policies can mitigate monetary policy shocks, but this does not necessarily have to be the case. Future work could focus on the precise circumstances in which prudential policies could affect the transmission of policy shocks. For instance, it may be instructive to further consider both the intensity and the intentions of prudential policy measures, as in Richter et al. (2019).

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Tables and Figures

Table 1. Banking system and domestic mortgage market (status as of 2018Q4)

Indicator	Ireland	Netherlands
Size of banking system: total assets (as % GDP)	104.7%	317.9%
Banking concentration: share of 5 largest banks in total banking sector assets	72.6%	84.7%
Share of mortgage lending in total bank lending to private non-financial sector	57.5%	58.7%
Share of mortgage lending by banks (as % GDP)	23.9%	61.8%
Share of foreign-currency-denominated liabilities in total bank liabilities	9.4%	27.8%

Sources: Central Bank of Ireland, De Nederlandsche Bank. Domestic bank lending is included, that is only within the Netherlands or within Ireland.

Table 2. Prudential policies in the Netherlands and Ireland during 2003-2018

Measure	Ireland	Netherlands
	Borrower-based	
LTV limit	*2015Q1* – introduction of limits on LTV of 90% for first-time buyers (FTBs), 80% for second-time and subsequent buyers (SSBs), and 70% for buy-to-let (BTL). Some new lending allowed above limits: 15% of total new lending for primary dwellings. 5% of new lending to FTBs can be above the 90% limit, 20% for SSBs, 10% for BTLs. For *first-time buyers* (FTBs) the cap of 90% applies to the first €220,000 of the value of the house, while 80% LTV applies to value of home above €220,000. *2017Q1* – share of new lending allowed above limits changed: 5% of new lending to FTBs can be above the 90% limit, 20% for SSBs, and 10% for BTLs. The property value threshold of €220,000 was removed.	*2010Q1* - introduction of maximum loan-to-foreclosure-value (LTFV) ratio of 112%, the part above 100% to be redeemed in 7 years. *2011Q3* - Code of Conduct for Mortgage Financing was revised. Households no longer permitted to borrow more than 104% of the home's market value plus transfer tax (2%). *2013 till 2018* - LTV cap reduced from 106% to 100% in yearly steps of 1 pp.
DSTI/LTI limit	*2015Q1* – Loan-to-income limit of 3.5 times gross income, assessed on the combined gross income in the case of joint borrowers. Only applies to mortgages on primary residences.	*2013Q1* - DSTI cap is set between 10% and 38% of gross income based on 30-year annuity loan and current 10-year mortgage interest rates.

	2018Q1 – Recalibration of existing proportionate LTI. The change permitted a proportion of mortgage lending above the LTI limit to be considered separately for first-time-buyers (FTBs) and second and subsequent buyers (SSBs). The revision allowed for 20 per cent of the value of new mortgage lending to FTBs to be above the LTI cap and 10 per cent of the value of new mortgage lending to SSBs to be above the LTI cap. Up to end-2017, the LTI allowance had been set at 20 per cent of the combined value of FTB and SSB lending.	
Maturity and amortization restrictions		*2013Q1* - new mortgage loans have to be repaid within 30 years, following an annuity or a linear amortization scheme, to qualify for tax deductibility of interest.
Other restrictions on lending standards		*2011Q3* - interest-only mortgages allowed up to 50% of the house's market value.
Lender-based		
General capital requirements	Implemented in line with Basel regulatory standards: *2012Q1* - Basel II.5 *2014Q1* - Basel III *2015Q1* - Capital conservation buffer (CCOB) applied from January 1, 2015, but phased in gradually such that the buffer was 0% in 2015, 0.625% in 2016, 1.25% in 2017, 1.875% in 2018 and 2.5% in 2019.	Implemented in line with Basel regulatory standards: *2012Q1* - Basel II.5 *2014Q3* - Basel III
Countercyclical capital buffer	*2019Q3* – will be increased from 0% to 1%.	Currently set at 0%
Systemic risk buffer/G-SII/O-SII	*2015Q4, 2016Q4, 2017Q4, 2018Q4* - O-SIIs identified and corresponding O-SII buffer rates set. Initial review identified 2 O-SIIs, but subsequently increased to 7. As of 2018Q4, 6 O-SIIs identified. Central Bank may require each O-SII to maintain O-SII buffer of up to 2% of the total risk exposure amount.	*2016Q1, 2017Q1, 2018Q1* - systemic buffers announced in 2014, implemented in phases between 2016 and 2019. As of 2019, it entails an additional capital requirement of 3% on risk-weighted assets of three systemic banks (ING, Rabobank and ABN AMRO) and 1% for Volksbank and BNG Bank.
Risk-weights (RWs) on loans backed by residential property	*2006Q2* - Effective May, RW on portion of a mortgage that exceeded 80% of the value of the property (at the time of origination increased to 100% from 50%. *2008Q1* - The CRD that implemented Basel II is introduced. RWs change throughout the scale of LTVs. Mortgages with LTVs below 75% were assigned a RW of 35%. Exposures with LTVs greater than 75% were assigned a 75% RW under special circumstances, and a	*2007Q1* – Exposures secured by mortgages on residential property are assigned RW of 35% if they do not exceed 75% of the value of that property. Above that limit a 100% RW is assigned. *2014Q1* – policy loosening due to adoption of CRR. Exposures secured by mortgages on residential property are assigned RW of 35% if they do not exceed 80% of the value of that property. Above that limit a 100% RW is assigned.

	100% RW otherwise. The authorities considered this a tightening in policy.	
Risk weights (RWs) on loans backed by commercial property	*2006Q1* - CRE was risk weighted at 100% under the Solvency Directive in EU (implementing Basel 1). With the introduction of CRD in 2006, the Central Bank availed of discretions provided under CRD regarding secured mortgage exposures. The Central Bank did not exercise the discretion for CRE to permit 50% risk weight and 100% risk weight applied. *2014Q1* - Under the CRR, the Central Bank used its discretion to keep the minimum risk weight on commercial property lending at 100%. RW of 150% on speculative CRE became the norm under the CRR.	*2007Q1* – policy loosening. RWs on portion of mortgages secured by commercial property with LTV below 75% were set at 35%. Above that limit a 100% RW is assigned. *2014Q1*- policy tightening due to adoption of CRR. RWs on portion of mortgages secured by commercial property with LTV below 50% were set at 50%. Above that limit a 100% RW is assigned.
Concentration limits	*2011Q1* - Exposures to related clients, except financial institutions, limited to 15% of own funds. Tightening relative to the 30% effective previously. *2013Q2* - The deactivation of the aggregate large exposures limit of 800% of own funds was considered a loosening in policy. Effective in 2014Q1. In addition, the limit on single exposures was maintained at 25% of own funds, but now takes into account the effect of credit risk mitigation.	*2009Q4* - introduction of alternative limits for small banks with eligible capital up to 600 million euro. *2014Q1* - definition of eligible capital was tightened and the number of exemptions was limited as a result of introduction of CRD IV/CRR (1/1/2014).
Interbank exposure limits		*2009Q4* - intragroup exposure limit of 20% was tightened by limiting possibilities for exemptions.
Tax on assets/liabilities		*2012Q4* – tax on liabilities of banks in the Netherlands. The tax base is total bank liabilities minus BIS capital, guaranteed deposits, and liabilities of insurance business. The tax differentiates between short- (0.044%) and long-term (0.022%) liabilities.

Sources: Cerutti et al. (2017a), Budnik and Kleibl (2018), domestic sources.

Table 3. **Descriptive statistics for banks in Ireland and the Netherlands**

Ireland					
	Obs.	Mean	St. dev.	25th percentile	75th percentile
Mortgage lending flows (% stocks)	386	1.75	4.30	-0.84	4.11
Log total real assets	386	24.54	0.81	23.74	25.20
Capital ratio (% total assets)	386	13.25	9.54	5.76	18.63
Liquid assets ratio (% total assets)	386	37.95	48.46	0.15	100
Core deposits ratio (% total assets)	386	34.64	14.12	25.55	44.53
The Netherlands					
	Obs.	Mean	St. dev.	25th percentile	75th percentile
Mortgage lending flows (% stocks)	349	1.55	0.83	1.01	1.93
Log total real assets	349	11.73	1.70	9.85	13.41
Capital ratio (% total assets)	349	4.46	1.33	3.30	5.40
Liquid assets ratio (% total assets)	349	28.80	17.81	14.53	43.01
Core deposits ratio (% total assets)	349	51.13	17.94	41.78	63.94

Note: Summary statistics for quarterly data on mortgage lending and balance sheet characteristics for a balanced panel of Irish and Dutch banks. The sample period is 2003Q1-2018Q2 for Ireland and 2003Q1-2018Q3 for the Netherlands.

Table 4. Domestic transmission (equation (1) without interactions)

VARIABLES	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
Aggregate Pru $_{t-4}$	-0.819**			-0.006		
	(0.246)			(0.047)		
Borrower Pru $_{t-4}$		-0.172			-0.008	
		(0.555)			(0.060)	
Lender Pru $_{t-4}$			-2.159**			-0.008
			(0.604)			(0.096)
MPS^{EA}_{t-3}	-1.479**	-0.779	-1.256**	-0.308**	-0.307**	-0.314*
	(0.535)	(0.441)	(0.466)	(0.098)	(0.096)	(0.136)
Log total real assets $_{t-1}$	-1.029	-3.823	-0.117	-0.481	-0.482	-0.477
	(3.215)	(2.501)	(3.327)	(0.662)	(0.664)	(0.646)
Tier 1 ratio $_{t-1}$	-4.043	-12.632	-2.695	0.141	0.140	0.139
	(4.629)	(7.137)	(4.391)	(0.268)	(0.272)	(0.256)
Liquid assets ratio $_{t-1}$	-1.654	-1.989	-1.376	-0.003	-0.003	-0.003
	(1.092)	(1.436)	(1.014)	(0.012)	(0.012)	(0.012)
Core deposits ratio $_{t-1}$	2.820	-8.300	4.593	-0.015	-0.015	-0.015
	(8.144)	(8.126)	(8.095)	(0.012)	(0.012)	(0.012)
Real GDP growth $_{t-1}$	0.275***	0.320***	0.207**	0.136***	0.136***	0.137***
	(0.061)	(0.051)	(0.071)	(0.020)	(0.020)	(0.022)
Domestic credit demand $_{t-1}$	0.163	0.070	0.278	0.168**	0.168**	0.167**
	(0.241)	(0.341)	(0.249)	(0.060)	(0.061)	(0.052)
VIX $_{t-1}$	0.012	-0.017	0.022	-0.002	-0.002	-0.002
	(0.031)	(0.029)	(0.031)	(0.008)	(0.007)	(0.009)
Observations	308	308	308	307	307	307
R^2	0.449	0.400	0.463	0.311	0.311	0.311
Adjusted R^2	0.433	0.382	0.447	0.290	0.290	0.290

Notes: This table reports the panel OLS regression results with standard errors clustered at the bank level in parentheses. The dependent variable is the gross/net flow of household mortgage lending by banks in the Netherlands/Ireland, scaled by total stocks. All regressions include bank fixed effects. Constant included (not shown). ***, **, and * denote significance at the 1%, 5% and 10% significance levels, respectively.

Table 5. Domestic transmission (equation 1 with interactions)

VARIABLES	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
Aggregate Pru $_{t-4}$	-0.813**			-0.012		
	(0.250)			(0.047)		
Borrower Pru $_{t-4}$		-0.054			-0.022	
		(0.530)			(0.057)	
Lender Pru $_{t-4}$			-2.180**			-0.010
			(0.610)			(0.097)
MPS^{EA}_{t-3}	-3.410	-0.895*	-4.004	-0.381**	-0.355***	-0.354**
	(2.463)	(0.442)	(2.816)	(0.118)	(0.084)	(0.135)
MPS^{EA}_{t-3}× Agg Pru $_{t-4}$	0.502			0.072		
	(0.619)			(0.102)		
MPS^{EA}_{t-3} × BorPru $_{t-4}$		1.467**			0.158	
		(0.527)			(0.264)	
MPS^{EA}_{t-3} × LendPru $_{t-4}$			1.574			0.054
			(1.569)			(0.101)
Log total real assets $_{t-1}$	-0.727	-3.765	0.500	-0.472	-0.472	-0.473
	(3.303)	(2.490)	(3.529)	(0.658)	(0.665)	(0.646)
Tier 1 ratio $_{t-1}$	-4.332	-12.792	-2.997	0.146	0.151	0.138
	(4.702)	(7.129)	(4.407)	(0.264)	(0.268)	(0.258)
Liquid assets ratio $_{t-1}$	-1.647	-1.954	-1.378	-0.004	-0.004	-0.004
	(1.100)	(1.443)	(1.013)	(0.012)	(0.012)	(0.012)
Core deposits ratio $_{t-1}$	3.369	-8.237	5.755	-0.014	-0.014	-0.015
	(8.045)	(8.108)	(8.085)	(0.012)	(0.012)	(0.012)
Real GDP growth $_{t-1}$	0.283***	0.324***	0.218**	0.139***	0.141***	0.137***
	(0.067)	(0.051)	(0.077)	(0.019)	(0.017)	(0.022)
Domestic credit demand $_{t-1}$	0.121	0.064	0.207	0.166**	0.170**	0.164**
	(0.232)	(0.339)	(0.245)	(0.062)	(0.060)	(0.056)
VIX $_{t-1}$	0.007	-0.016	0.015	-0.002	-0.001	-0.002
	(0.033)	(0.029)	(0.033)	(0.008)	(0.007)	(0.010)
Observations	308	308	308	307	307	307
R^2	0.451	0.401	0.468	0.312	0.312	0.311
Adjusted R^2	0.433	0.381	0.450	0.289	0.289	0.288

Notes: This table reports the panel OLS regression results with standard errors clustered at the bank level in parentheses. The dependent variable is the gross/net flow of household mortgage lending by banks in the Netherlands/Ireland, scaled by total stocks. All regressions include bank fixed effects. Constant included (not shown). ***, **, and * denote significance at the 1%, 5% and 10% significance levels, respectively.

Table 6. Inward transmission – interaction of domestic Pru with foreign MP

VARIABLES	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
Aggregate Pru $_{t-4}$	-0.830**			0.001		
	(0.256)			(0.048)		
Borrower Pru $_{t-4}$		-0.155			0.005	
		(0.510)			(0.063)	
Lender Pru $_{t-4}$			-2.157**			0.006
			(0.595)			(0.092)
MPS^{UK}_{t-3}	-0.429	-0.299	-0.661	-0.163*	-0.136	-0.216**
	(1.628)	(0.531)	(1.706)	(0.072)	(0.074)	(0.068)
MPS^{US}_{t-3}	-0.940	0.007	-0.135	-0.003	0.146	-0.078
	(1.363)	(0.236)	(1.188)	(0.103)	(0.125)	(0.083)
MPS^{UK}_{t-3} × Pru $_{t-4}$	-0.070	-0.146	0.048	0.018	-0.009	0.069
	(0.288)	(0.651)	(0.711)	(0.050)	(0.063)	(0.130)
MPS^{US}_{t-3} × Pru $_{t-4}$	0.375	0.134	0.497	0.105	0.032	0.347*
	(0.367)	(0.562)	(0.791)	(0.079)	(0.134)	(0.147)
Observations	308	308	308	307	307	307
R^2	0.449	0.399	0.463	0.317	0.309	0.334
Adjusted R^2	0.427	0.374	0.441	0.289	0.281	0.307
Joint MPS	-1.368	-0.292	-0.796	-0.167*	0.010	-0.294***
p-values	0.243	0.625	0.453	0.091	0.932	0.001
Joint MPS×Pru	0.305	-0.012	0.545	0.123**	0.024	0.416**
p-values	0.159	0.966	0.21	0.043	0.808	0.014

Notes: This table reports the panel OLS regression results with standard errors clustered at the bank level in parentheses. The dependent variable is the gross/net flow of household mortgage lending by banks in the Netherlands/Ireland, scaled by total stocks. All regressions include bank fixed effects. Constant, bank balance sheet variables, macroeconomic and financial controls are included (not shown). ***, **, and * denote significance at the 1%, 5% and 10% significance levels, respectively.

Table 7. Inward transmission – interaction of domestic Pru with MP

VARIABLES	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
Aggregate Pru $_{t-4}$	-0.857**			0.001		
	(0.258)			(0.050)		
Borrower Pru $_{t-4}$		0.055			-0.007	
		(0.501)			(0.065)	
Lender Pru $_{t-4}$			-2.310***			0.010
			(0.579)			(0.093)
MPS^{EA}_{t-3}	-3.515	-0.953	-5.415	-0.405**	-0.453***	-0.226*
	(3.106)	(0.536)	(3.765)	(0.129)	(0.079)	(0.131)
MPS^{UK}_{t-3}	0.501	0.060	0.452	0.021	0.039	-0.114*
	(1.725)	(0.638)	(1.690)	(0.055)	(0.059)	(0.047)
MPS^{US}_{t-3}	-0.263	0.019	1.259	-0.002	0.173	-0.091
	(1.650)	(0.241)	(1.601)	(0.102)	(0.126)	(0.077)
MPS^{EA}_{t-3} × Pru $_{t-4}$	0.555	2.184**	2.340	0.085	0.269	-0.053
	(0.784)	(0.683)	(2.039)	(0.096)	(0.241)	(0.081)
MPS^{UK}_{t-3} × Pru $_{t-4}$	-0.178	-0.304	-0.344	-0.020	-0.074	0.048
	(0.286)	(0.702)	(0.667)	(0.041)	(0.049)	(0.129)
MPS^{US}_{t-3} × Pru $_{t-4}$	0.237	-0.364	-0.172	0.099	0.009	0.357*
	(0.434)	(0.697)	(0.998)	(0.079)	(0.136)	(0.148)
Observations	308	308	308	307	307	307
R^2	0.455	0.402	0.472	0.323	0.321	0.340
Adjusted R^2	0.429	0.373	0.447	0.291	0.288	0.308
Joint MPS	-3.276	-0.875	-3.704	-0.386**	-0.241*	-0.431***
p-values	0.213	0.180	0.222	0.014	0.067	0.006
Joint MPS×Pru	0.613	1.516*	1.825	0.164	0.205	0.352**
p-values	0.313	0.061	0.243	0.113	0.440	0.045

Notes: This table reports the panel OLS regression results with standard errors clustered at the bank level in parentheses. The dependent variable is the gross/net flow of household mortgage lending by banks in the Netherlands/Ireland, scaled by total stocks. All regressions include bank fixed effects. Constant, bank balance sheet variables, macroeconomic and financial controls are included (not shown). ***, **, and * denote significance at the 1%, 5% and 10% significance levels, respectively.

Table 8. Interaction of Pru with MP, channel: share of EA/US/UK liabilities in total

VARIABLES	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
Aggregate Pru $_{t-4}$	-0.647***			-1.285		
	(0.153)			(1.315)		
Borrower Pru $_{t-4}$		-0.286			-0.992	
		(0.400)			(1.690)	
Lender Pru$_{t-4}$			-1.820***			-3.805
			(0.356)			(2.596)
MPS^{EA} $_{t-3}$	-5.209	-0.528	-5.978	-1.816**	-0.527	-2.543**
	(4.338)	(0.635)	(5.267)	(0.548)	(0.442)	(0.804)
MPS^{UK} $_{t-3}$	-0.592	0.889	-0.914	-0.118	0.039	-0.298*
	(2.628)	(0.883)	(2.685)	(0.118)	(0.064)	(0.152)
MPS^{US} $_{t-3}$	-0.596	-0.693	1.906	0.071	0.264*	-0.073
	(1.479)	(0.632)	(1.327)	(0.125)	(0.115)	(0.121)
MPS^{EA} $_{t-3}$ ×Channel^{EA} $_{t-4}$	0.026	-0.012	-0.052	0.017**	0.001	0.027**
	(0.278)	(0.039)	(0.317)	(0.006)	(0.004)	(0.010)
MPS^{UK} $_{t-3}$ ×Channel^{UK} $_{t-4}$	0.054	-0.054	0.075	0.020*	-0.002	0.027
	(0.184)	(0.065)	(0.170)	(0.011)	(0.008)	(0.017)
MPS^{US} $_{t-3}$ ×Channel^{US} $_{t-4}$	0.223	0.154	-0.054	-0.024	-0.044	0.002
	(0.488)	(0.134)	(0.296)	(0.036)	(0.027)	(0.032)
MPS^{EA} $_{t-3}$ × Pru $_{t-4}$	1.135	3.404**	3.081	0.687	-1.407	1.899***
	(1.004)	(1.088)	(2.752)	(0.424)	(1.543)	(0.366)
MPS^{UK} $_{t-3}$ × Pru $_{t-4}$	0.067	-1.068	0.416	0.078	0.018	0.213
	(0.490)	(1.007)	(1.193)	(0.061)	(0.067)	(0.172)
MPS^{US} $_{t-3}$ × Pru $_{t-4}$	0.250	0.548	-0.540	0.003	-0.173	0.232
	(0.342)	(0.988)	(0.738)	(0.088)	(0.128)	(0.200)
Pru $_{t-4}$ ×Channel^{EA} $_{t-4}$	0.005	0.064***	0.006	0.013	0.009	0.038
	(0.005)	(0.017)	(0.020)	(0.013)	(0.017)	(0.026)
Pru $_{t-4}$ ×Channel^{UK} $_{t-4}$	-0.027**	-0.111	-0.055***	0.019	0.024	0.042
	(0.008)	(0.067)	(0.011)	(0.031)	(0.021)	(0.044)
Pru $_{t-4}$ ×Channel^{US} $_{t-4}$	0.028	0.569	0.085	0.045	0.036	0.144**
	(0.035)	(0.340)	(0.055)	(0.025)	(0.049)	(0.049)
MPS^{EA} $_{t-3}$ ×Pru $_{t-4}$×Channel^{EA} $_{t-4}$	-0.022	-0.095**	-0.013	-0.007	0.019	-0.022***
	(0.056)	(0.033)	(0.146)	(0.006)	(0.020)	(0.005)
MPS^{UK} $_{t-3}$ ×Pru $_{t-4}$×Channel^{UK} $_{t-4}$	-0.012	0.140	-0.044	-0.018	-0.022**	-0.024
	(0.037)	(0.081)	(0.075)	(0.010)	(0.009)	(0.019)
MPS^{US} $_{t-3}$ ×Pru $_{t-4}$×Channel^{US} $_{t-4}$	-0.062	-0.656	0.016	0.029*	0.072***	0.014
	(0.136)	(0.530)	(0.182)	(0.013)	(0.017)	(0.031)
Observations	308	308	308	307	307	307
R^2	0.480	0.435	0.495	0.397	0.377	0.438
Adjusted R^2	0.438	0.389	0.454	0.348	0.327	0.392
Joint MPS	-6.397	-0.332	-4.986	-1.864**	-0.224	-2.914**
P-value	0.280	0.817	0.450	0.029	0.614	0.023
Joint MPS×Channel	0.303	0.087	-0.031	0.013	-0.045	0.057
P-value	0.655	0.618	0.961	0.760	0.157	0.225

Joint MPS×Pru	1.452	2.885*	2.956	0.768	-1.562	2.344***
P-value	0.258	0.095	0.359	0.123	0.344	0.003
Joint Pru×Channel	0.005	0.521	0.036	0.077	0.069	0.224
P-value	0.898	0.128	0.572	0.263	0.422	0.102
Joint MPS×Pru×Channel	-0.097	-0.611	-0.0413	0.004	0.069**	-0.032
P-value	0.563	0.298	0.895	0.819	0.027	0.380

Notes: This table reports the panel OLS regression results with standard errors clustered at the bank level in parentheses. The dependent variable is the gross/net flow of household mortgage lending by banks in the Netherlands/Ireland, scaled by total stocks. All regressions include bank fixed effects. Constant, bank balance sheet variables, macroeconomic and financial controls are included (not shown). ***, **, and * denote significance at the 1%, 5% and 10% significance levels, respectively.

Table 9. Interaction of Pru with MP, channel: share of EUR/USD/GBP liabilities in total

VARIABLES	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
Aggregate Pru $_{t-4}$	-0.712**			0.468		
	(0.201)			(2.691)		
Borrower Pru $_{t-4}$		-0.543			1.165	
		(0.635)			(3.384)	
Lender Pru$_{t-4}$			-1.790***			2.137
			(0.481)			(6.714)
MPS^{EA} $_{t-3}$	-4.797	0.239	-9.112	-0.771	-0.095	-2.260*
	(3.239)	(1.228)	(6.039)	(0.774)	(0.704)	(1.042)
MPS^{UK} $_{t-3}$	1.881	0.732	1.813	-0.003	0.103	-0.251
	(1.362)	(0.598)	(2.402)	(0.102)	(0.087)	(0.146)
MPS^{US} $_{t-3}$	-4.994	-0.747	-2.493	-0.042	0.224	-0.183
	(2.686)	(0.670)	(2.047)	(0.170)	(0.130)	(0.170)
MPS^{EA} $_{t-3}$ ×Channel^{EUR} $_{t-4}$	0.030	-0.047	0.142	0.004	-0.004	0.023
	(0.084)	(0.055)	(0.125)	(0.008)	(0.007)	(0.012)
MPS^{UK} $_{t-3}$ ×Channel^{GBP} $_{t-4}$	-0.089	-0.065	-0.100	-0.000	-0.037*	0.054
	(0.189)	(0.039)	(0.232)	(0.026)	(0.018)	(0.042)
MPS^{US} $_{t-3}$ ×Channel^{USD} $_{t-4}$	0.775	0.103	0.545	0.006	-0.006	0.012
	(0.557)	(0.058)	(0.307)	(0.011)	(0.009)	(0.010)
MPS^{EA} $_{t-3}$ × Pru $_{t-4}$	1.082	3.476**	4.752	-0.121	-1.951	1.446*
	(0.848)	(1.085)	(3.245)	(0.712)	(1.659)	(0.611)
MPS^{UK} $_{t-3}$ × Pru $_{t-4}$	-0.383	-0.830	-0.800	0.064	-0.007	0.257
	(0.317)	(0.638)	(1.230)	(0.051)	(0.072)	(0.180)
MPS^{US} $_{t-3}$ × Pru $_{t-4}$	1.101*	0.280	1.448	0.007	-0.209	0.257
	(0.499)	(0.898)	(0.967)	(0.089)	(0.125)	(0.226)
Pru $_{t-4}$ ×Channel^{EUR} $_{t-4}$	-0.010	0.069**	-0.023	-0.005	-0.013	-0.023
	(0.007)	(0.020)	(0.015)	(0.027)	(0.034)	(0.067)
Pru $_{t-4}$ ×Channel^{GBP} $_{t-4}$	-0.011	-0.043	-0.027	0.005	0.018	-0.029
	(0.011)	(0.024)	(0.017)	(0.033)	(0.060)	(0.065)
Pru $_{t-4}$ ×Channel^{USD} $_{t-4}$	-0.019	0.033	-0.017	0.002	-0.010	-0.001
	(0.023)	(0.181)	(0.060)	(0.034)	(0.042)	(0.082)
MPS^{EA} $_{t-3}$ ×Pru $_{t-4}$×Channel^{EUR} $_{t-4}$	-0.024	-0.116	-0.107	0.002	0.024	-0.017*
	(0.016)	(0.079)	(0.064)	(0.009)	(0.021)	(0.008)
MPS^{UK} $_{t-3}$ ×Pru $_{t-4}$×Channel^{GBP} $_{t-4}$	0.016	0.090	0.040	-0.043**	-0.039	-0.097*
	(0.046)	(0.060)	(0.125)	(0.015)	(0.020)	(0.048)
MPS^{US} $_{t-3}$ ×Pru $_{t-4}$×Channel^{USD} $_{t-4}$	-0.183	-0.276	-0.285	0.012*	0.030***	0.012
	(0.153)	(0.340)	(0.212)	(0.006)	(0.007)	(0.015)
Observations	308	308	308	307	307	307
R^2	0.475	0.429	0.490	0.398	0.377	0.429
Adjusted R^2	0.432	0.382	0.449	0.349	0.326	0.383
Joint MPS	-7.910*	0.224	-9.792*	-0.816	0.232	-2.694*
P-value	0.074	0.790	0.075	0.398	0.759	0.078
Joint MPS×Channel	0.716	-0.008	0.587	0.010	-0.047	0.089
P-value	0.164	0.838	0.085	0.785	0.132	0.169

Joint MPS×Pru	1.799*	2.926**	5.400*	-0.049	-2.167	1.959**
P-value	0.072	0.023	0.067	0.948	0.242	0.038
Joint Pru×Channel	-0.040	0.059	-0.068	0.001	-0.005	-0.053
P-value	0.125	0.703	0.250	0.987	0.969	0.809
Joint MPS×Pru×Channel	-0.190	-0.302	-0.352	-0.029**	0.015	-0.101*
P-value	0.198	0.353	0.129	0.042	0.373	0.053

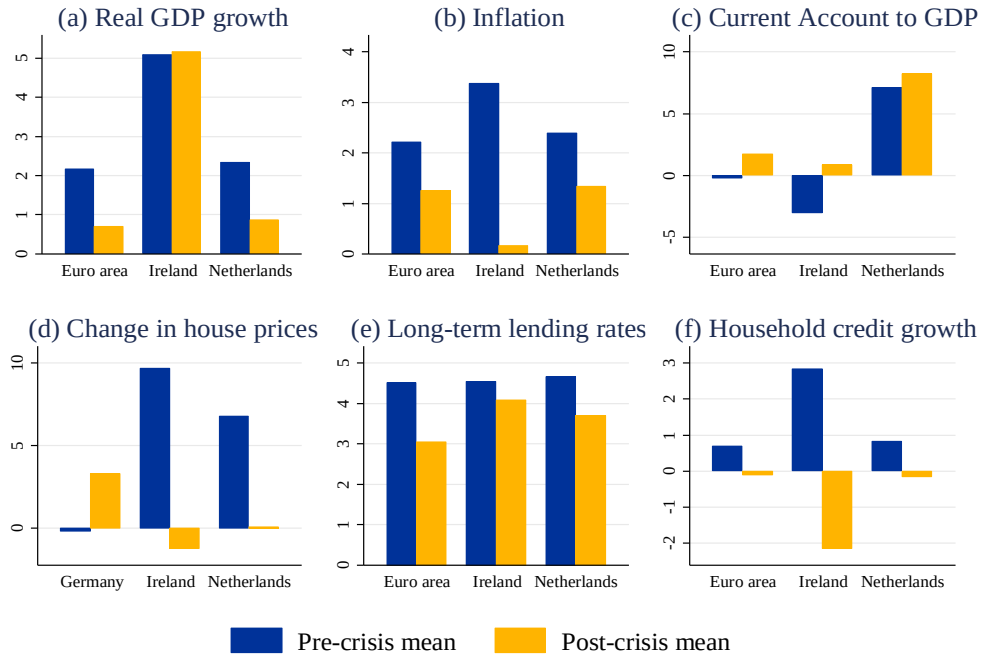
Notes: This table reports the panel OLS regression results with standard errors clustered at the bank level in parentheses. The dependent variable is the gross/net flow of household mortgage lending by banks in the Netherlands/Ireland, scaled by total stocks. All regressions include bank fixed effects. Constant, bank balance sheet variables, macroeconomic and financial controls are included (not shown). ***, **, and * denote significance at the 1%, 5% and 10% significance levels, respectively.

Online appendix

Table A1. Data description and sources

Variable	Description	Data source
Mortgage lending	Mortgage lending flow, scaled by total stocks. Ireland: net flow (new lending minus repayments) Netherlands: gross flow (new lending)	Central Bank of Ireland, DNB
Bank balance sheet variables	Total real assets (deflated by HICP, in log) Tier 1 capital ratio (in % total assets) Liquid assets ratio (in % total assets) Core deposits ratio (in % total assets)	Central Bank of Ireland, DNB
Channel variables	Currency of funding: share of bank liabilities in euro/US dollar/sterling in total liabilities (in %) Geography of funding: share of bank liabilities from EA/US/UK in total bank liabilities	DNB, Central Bank of Ireland
Monetary policy shocks	Monetary policy shocks for the EA, the US, and the UK, constructed from structural VAR models using high-frequency identification	IBRN team's calculations
Prudential policy stance	Aggregate, *Borrower*- and *Lender*-based indexes. Stance: cumulated prudential actions over 2 years before a monetary policy shock.	Cerutti et al. (2017a), MaPPED
Domestic economic activity	Ireland: modified domestic demand Netherlands: real GDP growth	Eurostat, Central Statistics Office
Domestic credit demand	Bank-level qualitative answers to question 18.1: "Over the past 3 months… how has the demand for loans to households (for house purchase) changed at your bank?" The answers are coded: 1- decreased considerably; 2 - decreased somewhat; 3 - remained basically unchanged; 4 - increased somewhat; 5- increased considerably.	Eurosystem Bank Lending Survey
Global risk	VIX index. Measures U.S. stock market volatility, from prices of short-dated options on the S&P 500	Chicago Board Options Exchange

Figure A1. Economic and financial indicators

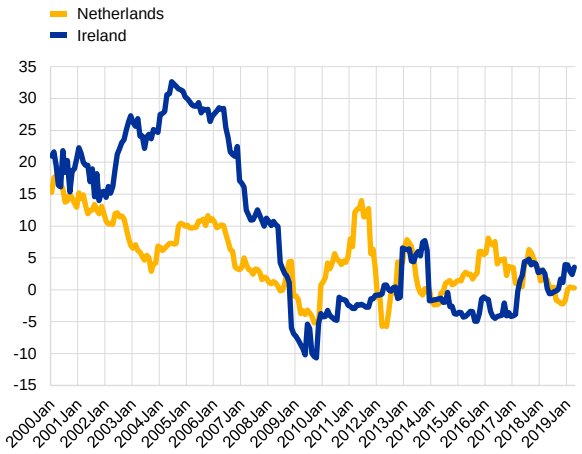


Notes: Units are in per cent.

Source: Seasonally adjusted real GDP and current account balance to GDP ratio from Eurostat; y-o-y change in HICP inflation and long-term household lending rates from the ECB; change in house prices and household credit in % of GDP from the BIS.

Figure A2. Domestic mortgage lending and house prices

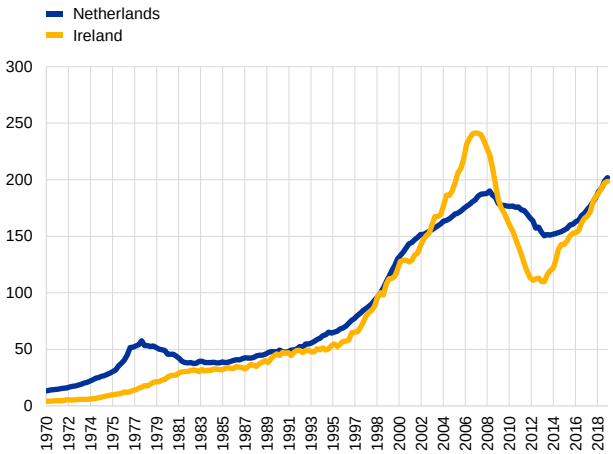
A2.1: Domestic household mortgage lending by banks (2000-2018)



Note: Annual percentage change

Source: ECB SDW

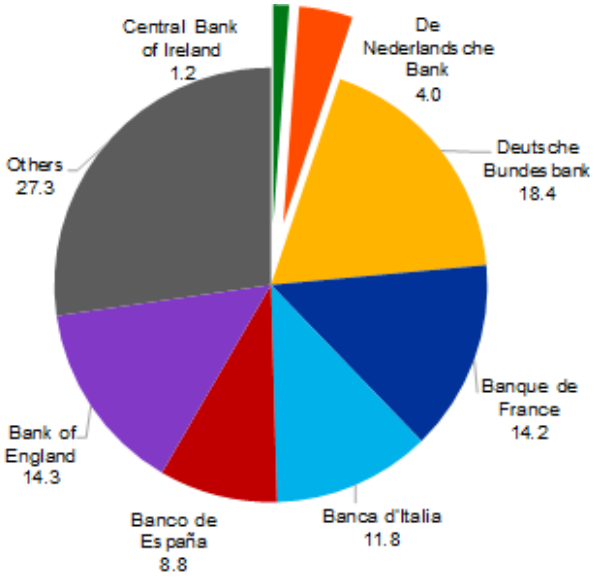
A2.2: House price index (1970-2018)



Note: Index 1999Q1=100

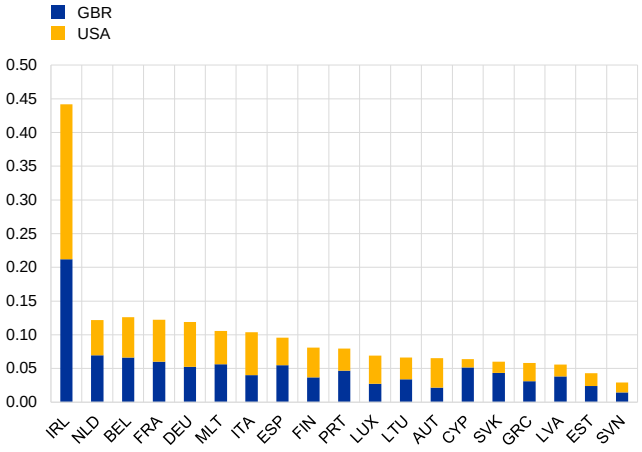
Source: BIS

Figure A3. Capital key



Notes: Units are per cent of total ECB capital.
Source: ECB

Figure A4. Trade exposures



Notes: Units are per cent of total trade. Values are the average of export and import shares in 2017.
Source: IMF Direction of Trade Statistics

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De Nederlandsche Bank N.V.
Postbus 98, 1000 AB Amsterdam
020 524 91 11
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