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

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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 quarterly bank-level data on domestic lending in both countries for 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 some weak evidence for an international bank lending channel that can be mitigated by stricter lender-based domestic prudential regulation.

JEL CLASSIFICATION

E42; F36; G21

1 | INTRODUCTION

The global financial crisis of 2007/2008 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 the 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., 2017).

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 macroprudential 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 the financial conditions but could also increase the future financial vulnerabilities, especially if it remains accommodative for an extended period (Adrian & Liang, 2018).

It is also important to recognize that business cycles, which are the focus of monetary policy, and credit cycles, on which prudential policies are based, are not necessarily synchronized, such that the two policies' frameworks could potentially conflict at times (Repullo & Suarez, 2013). 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 behavior 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 (Dell'Ariccia et al., 2017; Maddaloni & Peydro, 2013). Some recent papers provide evidence that monetary and prudential policies may work in the same direction. For the case of the United Kingdom, 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. (2020) 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 (Beck, 2014; Laeven & Valencia, 2010). 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

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

Third, in the postcrisis 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 United Kingdom and the United States, the monetary policy stance of these major economies may also matter for domestic financial conditions in both economies (Coates & Everett, 2013; Everett, 2015; Lane, 2015). These linkages mean that monetary policies of these economies could potentially have large inward spillovers that affect the financial conditions in Ireland and the Netherlands. This is particularly true for nonstandard 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 2003–2018 period, 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.

2.1 | Banking systems

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

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	317.3
Banking concentration: share of five largest banks (in % of total banking sector assets)	72.6	84.7
Share of mortgage lending in total bank lending to private nonfinancial sector	57.5	58.6
Share of mortgage lending by banks (as % GDP)	23.9	60.8
Share of foreign-currency-denominated liabilities in total bank liabilities	9.4	4.2
Market-average interest rate on mortgages	2.8	2.4
Mortgage lending as % of total domestic assets (banks included in the sample)	43.5	22.3
Mortgage lending as % of total domestic assets (total banking sector)	40.2	19.2
Mortgage-to-deposit ratio (total household mortgages to total household deposits)	36.1	109.4

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

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% 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 categorized 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.

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 (see, Table 1). The sector remains large from an international perspective, in proportion to the economy's size. In contrast to the Irish banking system, the Dutch banking sector is 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 about 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 harmonization 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 measures adopted during the crisis.⁴ Additionally, banks shifted their emphasis from investment banking toward 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. Dutch banks are very active internationally.

2.2 | Mortgage markets

As shown in Figures A2.1–A2.2 in the online Appendix, both countries have seen large swings in mortgage lending and house prices. While house prices in Ireland and the Netherlands developed fairly similar, mortgage lending developed different in both countries. Most mortgage lending in both countries is provided by domestic banks.

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. 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 United States and United Kingdom. While the scale of foreign currency funding has fallen significantly in the postcrisis 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, nonstandard monetary policy measures combined with low interest rate policies 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 precrisis period, this has primarily been funded by domestic deposits.

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 stock of mortgage loans has increased substantially in the last two decades and is 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 & Elbourne, 2015). Overall, as in Ireland, 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 stabilize 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 (see, Figure A3 in the online Appendix), means that economic developments in these countries have only a limited influence on EA aggregates.⁶ 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 A2 in the online Appendix). As in other advanced economies, the recent more proactive approach of the competent authorities is partly a reaction to the painful lessons learnt during the global financial crisis.

The governance of prudential policies differs in both countries. Prudential policy in Ireland is set by the Central Bank of Ireland empowered as the competent authority. In the Netherlands, 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. Two other institutions that are represented are the AFM (the Dutch Authority for the Financial Markets) and the Ministry of Finance. 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.

Prudential measures in both countries have been mainly directed at mortgage lending. However, the timing and intensity of these measures differ as shown in Figure A7 in the online Appendix. 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" toward corrective prudential policy (Honohan et al., 2010; Regling & 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 (Beck, 2014; Laeven & Valencia, 2010).

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 & 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 & 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 A2 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 were subject to systemic capital buffers, which ranged between 1% and 3%.⁹

4 | DATA DESCRIPTION

4.1 | 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. The sample period starts in 2003 due to data availability for most bank-specific variables in each country.¹⁰ The sample ends in 2018, given that we have data for monetary policy shocks up to that point. We have used as long a sample as possible in order to have as many observations as possible in view of the complicated models that we estimate.

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 the 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 United States, or the United Kingdom). 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 and 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 are that they account for exclusion of securitizations, 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 analyzed period, such as securitization 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.¹¹ 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 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 <12 quarterly observations for channel variables are dropped. The final sample for Ireland consists of seven 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 drawn from sources collected to construct the Monetary and Financial Statistics; they are on residency basis and, therefore, consistent with the Irish data. 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 analyzed 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 onward.¹²

The data on mortgage lending are complemented with information on bank balance sheet characteristics from supervisory reporting sources.¹³ These variables include total assets, Tier 1 capital, liquid assets (including cash, deposits, and bonds with maturity up to 1 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 on a residency principle.

The final sample for the Netherlands includes seven 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 2 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 role for wholesale

TABLE 2 Descriptive statistics for banks in Ireland and the Netherlands

	Obs.	Mean	St. dev.	25th percentile	75th percentile
<i>Ireland</i>					
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
<i>The Netherlands</i>					
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.

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 precrisis period, before deposit funding becoming dominant in the postcrisis 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 are 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.

4.2 | Prudential policy measures

We follow the IBRN methodology to construct prudential policy measures, as explained in more detail in Bussière et al. (2020). The data on prudential policy measures for Ireland and the Netherlands are sourced from the IMF-IBRN database of Cerutti et al. (2017), recently updated until 2018Q3. We complement these with data from the ECB's Macroprudential 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 macroprudential and microprudential measures implemented by EU countries (see, Budnik and Kleibl (2018) for details). As per the IBRN approach, we include all prudential policy measures taken in each country, but also differentiate between borrower- and lender-based measures in view of our focus on mortgage lending.

Each prudential instrument is assigned a value +1 when the policy stance is tightened in a specific period, 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.¹⁴

Additionally, to examine how transmission of monetary policy to mortgage lending varies depending on the dimension of prudential policies, we construct two prudential indexes: (a) *Lender-based* and (b) *Borrower-based*. *Lender-based* measures are aimed at improving the resilience of the financial system. These include capital-based measures, such as capital requirements, buffers, risk weights, concentration and exposure limits, and taxes on assets/liabilities. *Borrower-based* measures are oriented toward 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 (Bussière et al., 2020). 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- and 5-year periods prior to the monetary policy shock; the results hold. Figure A7 in the online Appendix shows the prudential policy stance (Aggregate, Borrower- and Lender-based) in the Netherlands and Ireland during 2003Q1–2018Q3, proxied with cumulated prudential measures over 2 years.

4.3 | Monetary policy measures

We use monetary policy shocks for the EA, the United States, and the United Kingdom, constructed by the IBRN methodology team from structural vector autoregression (VAR) models using high-frequency identification techniques (see, Bussiere et al., 2020 for details). 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 United States (Gertler & Karadi, 2015) and the United Kingdom (Cesa-Bianchi et al., 2016; Gerko & 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 United States and United Kingdom 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 United States.¹⁵ Figure A6 in the online Appendix shows monetary policy shocks for the euro area, the United Kingdom, and the United States over the period 2003Q1–2018Q3. As shown, in our sample period there are both positive and negative policy shocks.

4.4 | 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 year-on-year 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.¹⁶ To control for credit demand, we follow Altavilla et al. (2018) 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 500.¹⁷ Table A1 in the online 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., Buch et al., 2019; Gambacorta & Marques-Ibanez, 2011). We start with a model of domestic transmission, specified as follows:

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

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 1-year transmission.¹⁸ $Pru_{b,t-4}^{home}$ 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 domestic demand for Ireland), domestic credit demand, and global risk. f_b are unobserved time-invariant bank-fixed effects, capturing for example, bank business model or risk appetite. $\varepsilon_{b,t}$ 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:

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

This is similar to specification (1) except that MP_{t-3}^{ctry} now includes monetary policy shocks in the United States and the United Kingdom, 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.¹⁹ 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:

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

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 heteroscedasticity 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 United Kingdom, the United States) 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.²⁰

These channels provide an important additional source of variation, especially in the Irish case in the precrisis period, as Irish banks frequently obtained funding from the United Kingdom, 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. Figure A5 in the online Appendix shows the cross-border exposure of Irish and Dutch banks over the period 2003–2018, measured as a share of foreign deposits denominated in euro, sterling, or dollar, respectively, in total liabilities (using geography of funding produces similar patterns). 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.

6 | EMPIRICAL RESULTS

6.1 | Domestic transmission

Table 3 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 those 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, that is, *Borrower*-based and *Lender*-based, as described in Section 4.

Column (1) in Table 3 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 12 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.²¹ The overall fit of the model is good, as the adjusted R^2 statistic indicates that the model explains approximately 43% 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 <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 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.²² 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

TABLE 3 Domestic transmission (Equation 1 without interactions)

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

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 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 & Blinder, 1988; Bernanke & Gertler, 1995).²³ 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.²⁴

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 $MP_{t-3}^{ECB} \cdot Pru_{b,t-4}^{home}$ in the model (Equation 1). Table 4 shows the results, following the same set-up as Table 3. 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 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 nonstandard 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.²⁵

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 4). 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 3, positive ECB monetary policy shocks reduced the growth of mortgage lending by Dutch banks.

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 individual prudential measures separately, as described in Table A2. We re-estimate the models for domestic transmission without and with the prudential policy interaction terms.²⁶ For the Netherlands, the results of this analysis are similar to the main ones, suggesting that none of the 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 nonfinancial corporates is included as the dependent variable. Consistent with results for the baseline specification, a tightening of prudential policies has a negative effect on credit growth to nonfinancial corporates in Ireland, driven by tighter policy aimed at the lender.

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.

TABLE 4 Domestic transmission (Equation 1 with interactions)

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

6.2 | Asymmetric effects of monetary policy shocks

In a second extension, we consider the asymmetric effects of EA monetary policy shocks. Various papers (see, e.g., Angrist et al., 2018; Barnichon & Matthes, 2018; Cover, 1992; Santoro et al., 2014;

Tenreiro & Thwaites, 2016) find that the effects of positive monetary policy shocks (i.e., monetary policy tightening) on economic activity and the financial system can be larger than the effects of negative monetary policy shocks (i.e., monetary policy easing). The asymmetry in the monetary policy transmission could be due to a number of factors, such as risk or loss aversion by banks and borrowers, pessimistic expectations and higher borrowing costs during a downturn, or downward price and wage rigidity (Barnichon et al., 2017). Credit market imperfections and banks' balance sheet problems are also mentioned as possible causes of monetary policy asymmetries (Bernanke & Gertler, 1995; Florio, 2004). Such asymmetry could also appear in the effects of expansionary and contractionary monetary shocks on bank lending.

We test this conjecture on asymmetry by examining whether episodes of accommodative monetary policy have a different impact on mortgage lending growth 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 direct effects of EA monetary policy shocks (see, Table 5). In addition, tighter prudential regulation mitigates the positive impact of expansionary monetary shock, but amplifies the negative effect of restrictive monetary shock on mortgage credit growth. The mitigating effect of prudential policies under monetary policy easing is stronger in terms of magnitude than the amplifying effect under monetary policy tightening. For the Netherlands this amplification effect is found for aggregate as well as borrower- and lender-based prudential policies, whereas for Ireland the amplification is only relevant for borrower-based prudential policies. The findings about the asymmetric effects of monetary policy on mortgage lending suggest that domestic prudential regulation complements the EA monetary policy when both are tightened, but that domestic regulation somewhat mitigates a monetary policy impact when policies are adjusted in the opposite directions.

6.3 | 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, fueling 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.

The regression results for Equation (2) are reported in Table 6; they include interaction terms between the prudential policy stance and foreign monetary policy.²⁷ We consider the monetary policies of the United Kingdom and the United States, 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 United Kingdom and the United States 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.

TABLE 5 Domestic transmission, asymmetric effects of monetary policy shocks

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

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

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** (0.256)			0.001 (0.048)		
Borrower Pru_{t-4}		−0.155 (0.510)			0.005 (0.063)	
Lender Pru_{t-4}			−2.157** (0.595)			0.006 (0.092)
$\text{MPS}^{\text{UK}}_{t-3}$	−0.429 (1.628)	−0.299 (0.531)	−0.661 (1.706)	−0.163* (0.072)	−0.136 (0.074)	−0.216** (0.068)
$\text{MPS}^{\text{US}}_{t-3}$	−0.940 (1.363)	0.007 (0.236)	−0.135 (1.188)	−0.003 (0.103)	0.146 (0.125)	−0.078 (0.083)
$\text{MPS}^{\text{UK}}_{t-3} \times \text{Pru}_{t-4}$	−0.070 (0.288)	−0.146 (0.651)	0.048 (0.711)	0.018 (0.050)	−0.009 (0.063)	0.069 (0.130)
$\text{MPS}^{\text{US}}_{t-3} \times \text{Pru}_{t-4}$	0.375 (0.367)	0.134 (0.562)	0.497 (0.791)	0.105 (0.079)	0.032 (0.134)	0.347* (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 $\text{MPS} \times \text{Pru}$	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.

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.

6.4 | 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

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** (0.258)			0.001 (0.050)		
Borrower Pru_{t-4}		0.055 (0.501)			−0.007 (0.065)	
Lender Pru_{t-4}			−2.310*** (0.579)			0.010 (0.093)
MPS^{EA}_{t-3}	−3.515 (3.106)	−0.953 (0.536)	−5.415 (3.765)	−0.405** (0.129)	−0.453*** (0.079)	−0.226* (0.131)
MPS^{UK}_{t-3}	0.501 (1.725)	0.060 (0.638)	0.452 (1.690)	0.021 (0.055)	0.039 (0.059)	−0.114* (0.047)
MPS^{US}_{t-3}	−0.263 (1.650)	0.019 (0.241)	1.259 (1.601)	−0.002 (0.102)	0.173 (0.126)	−0.091 (0.077)
$MPS^{EA}_{t-3} \times Pru_{t-4}$	0.555 (0.784)	2.184** (0.683)	2.340 (2.039)	0.085 (0.096)	0.269 (0.241)	−0.053 (0.081)
$MPS^{UK}_{t-3} \times Pru_{t-4}$	−0.178 (0.286)	−0.304 (0.702)	−0.344 (0.667)	−0.020 (0.041)	−0.074 (0.049)	0.048 (0.129)
$MPS^{US}_{t-3} \times Pru_{t-4}$	0.237 (0.434)	−0.364 (0.697)	−0.172 (0.998)	0.099 (0.079)	0.009 (0.136)	0.357* (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 $\times$ 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.

monetary policy. Table 8 reports the estimation results for specification (3) where we include additional interaction terms with channel variables.

We first use geography—that is, 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 slightly *more* after EA monetary

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*** (0.153)			-0.382 (0.207)		
Borrower Pru_{t-4}		-0.286 (0.400)			-0.065 (0.461)	
Lender Pru_{t-4}			-1.820*** (0.356)			-0.900** (0.349)
MPS^{EA}_{t-3}	-5.209 (4.338)	-0.528 (0.635)	-5.978 (5.267)	-0.363 (0.293)	-0.090 (0.332)	-0.012 (0.222)
MPS^{UK}_{t-3}	-0.592 (2.628)	0.889 (0.883)	-0.914 (2.685)	0.012 (0.052)	0.050 (0.055)	-0.088 (0.059)
MPS^{US}_{t-3}	-0.596 (1.479)	-0.693 (0.632)	1.906 (1.327)	0.004 (0.149)	0.249** (0.105)	-0.098 (0.122)
$MPS^{EA}_{t-3} \times Channel^{EA}_{t-4}$	0.026 (0.278)	-0.012 (0.039)	-0.052 (0.317)	-0.001 (0.006)	-0.006 (0.006)	-0.006* (0.003)
$MPS^{UK}_{t-3} \times Channel^{UK}_{t-4}$	0.054 (0.184)	-0.054 (0.065)	0.075 (0.170)	0.003 (0.006)	-0.007 (0.007)	-0.002 (0.008)
$MPS^{US}_{t-3} \times Channel^{US}_{t-4}$	0.223 (0.488)	0.154 (0.134)	-0.054 (0.296)	-0.006 (0.052)	-0.052 (0.034)	0.029 (0.040)
$MPS^{EA}_{t-3} \times Pru_{t-4}$	1.135 (1.004)	3.404** (1.088)	3.081 (2.752)	0.582 (0.354)	0.672 (1.363)	0.282 (0.312)
$MPS^{UK}_{t-3} \times Pru_{t-4}$	0.067 (0.490)	-1.068 (1.007)	0.416 (1.193)	0.045 (0.058)	0.048 (0.077)	0.072 (0.146)
$MPS^{US}_{t-3} \times Pru_{t-4}$	0.250 (0.342)	0.548 (0.988)	-0.540 (0.738)	0.037 (0.090)	-0.178 (0.133)	0.262 (0.164)
$Pru_{t-4} \times Channel^{EA}_{t-4}$	0.005 (0.005)	0.064*** (0.017)	0.006 (0.020)	0.005 (0.003)	-0.001 (0.007)	0.013** (0.005)
$Pru_{t-4} \times Channel^{UK}_{t-4}$	-0.027** (0.008)	-0.111 (0.067)	-0.055*** (0.011)	0.007 (0.027)	0.019 (0.023)	0.007 (0.024)
$Pru_{t-4} \times Channel^{US}_{t-4}$	0.028 (0.035)	0.569 (0.340)	0.085 (0.055)	0.045 (0.026)	0.022 (0.037)	0.122*** (0.017)
$MPS^{EA}_{t-3} \times Pru_{t-4} \times Channel^{EA}_{t-4}$	-0.022 (0.056)	-0.095** (0.033)	-0.013 (0.146)	-0.008 (0.007)	-0.008 (0.025)	-0.004 (0.006)
$MPS^{UK}_{t-3} \times Pru_{t-4} \times Channel^{UK}_{t-4}$	-0.012 (0.037)	0.140 (0.081)	-0.044 (0.075)	-0.021 (0.014)	-0.045 (0.025)	-0.006 (0.017)
$MPS^{US}_{t-3} \times Pru_{t-4} \times Channel^{US}_{t-4}$	-0.062 (0.136)	-0.656 (0.530)	0.016 (0.182)	0.033 (0.018)	0.122*** (0.032)	0.007 (0.037)
Observations	308	308	308	307	307	307

(Continues)

TABLE 8 (Continued)

Variables	Ireland			The Netherlands		
	Aggr Pru	Borrower	Lender	Aggr Pru	Borrower	Lender
R^2	0.480	0.435	0.495	0.422	0.377	0.483
Adjusted R^2	0.438	0.389	0.454	0.375	0.326	0.441
Joint MPS	−6.397	−0.332	−4.986	−0.346	0.209	−0.198
p value	0.280	0.817	0.450	0.375	0.548	0.522
Joint MPS $\times$ Channel	0.303	0.087	−0.031	−0.004	−0.065	0.022
p value	0.655	0.618	0.961	0.940	0.104	0.644
Joint MPS $\times$ Pru	1.452	2.885*	2.956	0.665	0.542	0.616
p value	0.258	0.095	0.359	0.145	0.713	0.140
Joint Pru $\times$ Channel	0.005	0.521	0.036	0.057**	0.041	0.141***
p value	0.898	0.128	0.572	0.011	0.280	0.000
Joint MPS $\times$ Pru $\times$ Channel	−0.097	−0.611	−0.0413	0.003	0.069	−0.003
p value	0.563	0.298	0.895	0.893	0.134	0.940

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.

policy tightening. In addition, higher funding from EA and United States sources mitigates the negative effect of *Lender*-based prudential regulation. The significant positive signs on the US monetary policy shock and on the triple interaction term $MPS^{US} \times BorPru \times Channel^{US}$ imply that Dutch banks with a larger share of US-sourced funding increase mortgage lending *more* when domestic *Borrower*-based prudential policy coincides with tighter US monetary policy.

In Table A3 in the online Appendix 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 United Kingdom 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 euros reduce mortgage lending *more* after EA monetary policy tightening. Additionally, higher funding in euros and dollars alleviates the negative effect of *Lender*-based prudential regulation on mortgage lending growth in the Netherlands. Moreover, Dutch banks with higher funding in dollars decrease mortgage lending *less* when tightening of prudential measures coincides with US monetary policy tightening; while banks with larger funding in sterling reduce mortgage lending *more* when stricter prudential policy coincides with tighter UK monetary policy.

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 influenced only by 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 a larger share of EA-sourced funding reduce mortgage lending *more* when *Borrower*-based prudential policy coincides with tighter ECB monetary policy. In contrast, Dutch banks with higher funding from EA sources reduce mortgage lending *more* after EA monetary tightening, while banks with higher US-sourced funding increase mortgage lending *more* when *Borrower*-based prudential regulation coincides with tighter US monetary policy.

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 stabilization policies implemented at the national level. In general, macroprudential 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). Another suggestion would be to employ different methods, for instance Linear Local Projections.

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ENDNOTES

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 stabilising 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.

³ This part draws on DNB (2015b).

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.

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% (<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/macprudentie-instrumenten/index.jsp>.

¹⁰ The statistical reporting methodology for euro-area money and banking statistics, which our bank-level data are drawn from, was amended in 2003. These statistics supersede those collected prior to 2003 and provide greater comparability across euro-area countries.

¹¹ 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.

¹² 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.

¹³ 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).

¹⁴ Our results hold when instead we use the aggregate prudential policy index with reserve requirements.

¹⁵ The monetary policy surprise measure used are derived from changes in federal funds rates (or similar rates for the case of the BoE and ECB) in 30-min periods surrounding policy announcements. These capture the “surprise” component of policy because the futures rate at the start of the 30-min window reflects anticipated monetary policy prior to the meeting, and the only substantive macroeconomic “news” within the announcement window pertains to monetary policy, so the difference excludes potentially endogenous moves in monetary policy (expectations) in response to news about, *inter alia*, bank lending growth. Furthermore, because federal funds futures rates are forward looking, reflecting expectations of interest rates in some future month, they account for the effects of unconventional monetary policies that influenced longer term interest rates at the effective lower bound.

¹⁶ 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) for greater detail on the distortions in the national accounts and measures of economic growth arising from the activities of global firms.

¹⁷ Other equity market volatility measures are generally highly correlated with the VIX because of the considerable importance of global factors during the sample period (see, e.g., Reinhardt and Riddiough, 2015 for the MSCI index). Even indicators based on other market segments, such as the Merrill Lynch MOVE index, which covers bonds rather than equities, exhibits a correlation with the VIX of over 0.8 in the sample period.

¹⁸ 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).

- ¹⁹ 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.
- ²⁰ 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.
- ²¹ 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.
- ²² 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 postcrisis years.
- ²³ For the Netherlands, this is a much stronger indication of a bank-lending channel than previously reported in the empirical literature (e.g., Garretsen and Swank, 2003; De Haan, 2003; Kakes, 2000).
- ²⁴ In Ireland, there are two distinct forms of adjustable interest rate mortgages. The first is a standard variable mortgage which have a floating interest rate driven by the discretion of the bank. The second is a "Tracker" mortgage whereby the interest rates have a fixed margin in excess of the ECB's interest rate on the main refinancing operations. By the very design of the latter, monetary policy pass-through of interest rate changes is immediate and a legally binding contractual obligation of the bank. Between 2003 and 2008 this "Tracker" mortgage product dominated the mortgage market in Ireland. Recent literature on monetary policy transmission in Ireland has tended to focus on prices rather than quantities, as pass-through of ECB monetary policy to interest rates has been limited in recent years (Duffy and Morley, 2015). However, inadequate competition in the Irish mortgage market may allow banks to take advantage of improved funding conditions arising from accommodative ECB monetary policy to increase interest margins on new mortgages, which are now predominantly fixed rate loans (Sibley, 2018). As a consequence, accommodative monetary policy might have an unusually large effect on credit supply in Ireland. Finally, an elasticity of 1.5 percentage points is not inconsistent with existing international evidence. For instance, examining the US mortgage market, De Fusco and Paciorek (2017) estimates that a 1 percentage point increase in the rate on a 30-year fixed-rate mortgage reduces first mortgage demand by between 2% and 3%, and total mortgage debt only by 1.5% to 2%.
- ²⁵ As a robustness check, we also include a crisis dummy to account for the domestic banking crisis in Ireland. For the specifications in Tables 3 and 4, we include a crisis dummy taking a value of 1 between 2010Q4 and 2013Q4, accounting for the acute phase of the Irish banking crisis when Ireland was part of an ECB/EU/IMF financial assistance programme. The crisis dummy enters the equations with an expected negative sign but is not significant for any of the specifications. Due to space constraints these results are not included but are available on request.
- ²⁶ The results of this sensitivity analysis are available on request.
- ²⁷ 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.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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