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# IRELAND

## FINANCIAL SECTOR ASSESSMENT PROGRAM

September 2016

## TECHNICAL NOTE—NONBANK SECTOR STABILITY ANALYSES

This Technical Note on Nonbank Sector Stability Analyses on Ireland was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed in August 2016.

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August 2016

# TECHNICAL NOTE

## NONBANK SECTOR STABILITY ANALYSES

Prepared By
**Monetary and Capital Markets Department**

This Technical Note was prepared by IMF staff in the context of the Financial Sector Assessment Program in Ireland. It contains technical analysis and detailed information underpinning the FSAP's findings and recommendations. Further information on the FSAP can be found at http://www.imf.org/external/np/fsap/fssa.aspx

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# Glossary

| | |
|---|---|
| AIB | Allied Irish Banks |
| BOI | Bank of Ireland |
| BSM | Black Scholes Merton |
| BTL | Buy to Let |
| CBI | Central Bank of Ireland |
| CCR | Central Credit Registry |
| CET1 | Common Equity Tier 1 |
| CLTV | Current Loan to Value |
| CRE | Commercial Real Estate |
| CSO | Central Statistics Office |
| DMFI | Domestic Monetary Financial Institution |
| DTD | Distance to Default |
| EAD | Exposure at Default |
| EBITDA | Earnings Before Interest Taxation, Depreciation, and Amortization |
| EBS | Educational Building Society |
| FDI | Foreign Direct Investment |
| FMFI | Foreign Monetary Financial Institution |
| FSAP | Financial Sector Assessment Program |
| FTB | First-Time Buyer |
| FVC | Financial Vehicle Corporation |
| GDP | Gross Domestic Product |
| GOV | Government |
| HH | Household |
| IC | Insurance Company |
| ICR | Interest Cover Ratio |
| IMF | International Monetary Fund |
| IPD | Investment Property Databank |
| LGD | Loss Given Default |
| LLF | Loan Loss Forecasting |
| LTI | Loan to Income |
| LTV | Loan to Value |
| MFI | Monetary Financial Institution |
| MMF | Money Market Fund |
| MRSM | Markov Regime Switching Model |
| NAMA | National Asset Management Agency |
| NFC | Non-financial Corporate |
| NMIF | Non Money market Investment Funds |
| NPL | Non-performing Loan |
| OECD | Organization of Economic Cooperation and Development |
| OFI | Other Financial Institution |
| OLS | Ordinary Least Squares |

| | |
|---|---|
| OLTV | Original Loan to Value |
| PD | Probability of Default |
| PDH | Primary Dwelling Home |
| PF | Pension Fund |
| PTSB | Permanent TSB |
| QFA | Quarterly Financial Accounts |
| REIT | Real Estate Investment Trust |
| ROW | Rest of the World |
| RRE | Residential Real Estate |
| SME | Small and Medium-sized Enterprise |
| SVR | Standard Variable Rate |
| VECM | Vector Error Correction Model |
| U.K. | United Kingdom |
| U.S. | United States |

# EXECUTIVE SUMMARY

***Inter-Sectoral Interconnectedness Analysis***

**Cross-border interlinkages via Irish-domiciled funds industry and multinational companies are a key feature of the financial network.** Ireland plays a role as one of a number of significant hubs for the global funds industry. The tight linkages between the rest of the world (ROW) and non-financial corporations reflect the large presence of foreign-controlled multinational companies in Ireland. The direct bilateral connection between the ROW and Irish households is insignificant, but the household sector is indirectly exposed to global shocks through their balance sheets of insurance companies and pension funds.

**The banking sector is tightly connected with the real sectors of the Irish economy, but not with many of the other financial sectors. Banks are systemically important sources and destinations of funding in Ireland and have strong bilateral connections with households and non-financial corporates.** There are tight bank-sovereign financial linkages through banks' government bond holdings and the government's holdings of bank equity. Meanwhile, the linkages between the banking system and the funds industry, insurance companies or pension funds are very limited.

**Irish-domiciled other financial intermediaries (OFIs) do not have direct strong financial linkages with the domestic real sectors.** The connections between the two sectors mainly reflect intra-company transactions between treasury companies and their parent multinational companies. OFIs do not directly provide loans to households to any significant degree, but are largely connected through purchases of mortgage loan securitizations and loan sales from banks.

***Real Estate Market Analysis***

**Residential real estate (RRE) and commercial real estate (CRE) prices in Ireland have been rising rapidly in recent years, raising concerns about possible overvaluation and a new build-up of imbalances.** The rebound in the Irish RRE and CRE markets has been more vigorous than in other countries.

**Both non-parametric and parametric methods suggest that the RRE market is close to or moderately below its equilibrium level.** Two standard metrics of price-to-income and price-to-rent ratios show that following a protracted period of overvaluation prior to the crisis and a correction afterwards, the market has been close to its equilibrium level in recent quarters.

**Similar approaches send mixed signals regarding the valuation of current CRE prices, but early signals of new imbalances in the CRE market should not be overlooked.** The price-to-rent ratio suggests that following a sharp correction at the onset of the crisis, CRE prices increased above their historical averages in 2014 and were moderately overvalued. Frequency and HP filters show that CRE prices have recently converged to their long-term trends. Foreign investment inflows or equity funding like REITs can easily reverse if market sentiment changes, which could lead to a sharp drop in CRE values. Lenders with remaining exposures could face another hit from a collapse in collateral values via

financial "decelerator" mechanisms, as observed in the post-crisis period. Therefore, the authorities will need to continue to closely monitor CRE lending and evaluate any early signals of a build-up of new market imbalances.

**Household Sector Analysis**

**Households have deleveraged, but are still highly indebted.** Some mortgage loans remain in negative equity, and almost all mortgages have variable interest rates (tracker and standard variable interest rates). Negative equity is a well-documented cause of default besides income shocks. Interest rates on existing tracker mortgages are currently very low, reflecting the zero ECB policy rate. If interest rates rise, interest payments will increase and some households may face difficulty servicing their debt.

**Existing borrowers with high loan-to-value (LTV) ratios or standard variable rates are more vulnerable than other groups of households to the FSAP adverse scenario.** Looking explicitly at the LTV distribution, there is a strictly increasing relationship between LTV levels and the stressed probability of default.

**Going forward, it will be crucial to continue to collect loan-level data for systemic risk assessment,** and the Central Bank of Ireland should move forward with the establishment of the Central Credit Register (CCR) to ensure that individual households' credit information can be accurately verifiable.

**Corporate Sector Analysis**

**The stability analysis assesses the financial resilience of the non-financial corporate (NFC) sector. The results suggest that vulnerabilities among NFCs have moderated in recent years.** The interest cover ratio (ICR) of the median firm across all categories of firm size and sectors increased steadily in recent years, following a sharp decline in 2008-09, while the share of risky debt (i.e. owned by firms with ICR lower than one) in total debt declined to the pre-crisis level. Nevertheless, the NFC sector—especially smaller firms—remains highly vulnerable. More specifically, the analysis show that small domestic firms account for most of the firms that are under "technical default" (i.e. with ICR less than one), and that the share of risky debt among these firms constituted nearly half of their total debt, well above the shares of medium-sized and large enterprises.

**A sensitivity analysis indicates that the sector, and especially smaller firms, remains highly vulnerable even to non-extreme shocks, but, ceteris paribus, banks' regulatory capital would still be above the minimum requirement.** An adverse shock, which comprises a decline in profitability and an increase in interest rates, is likely to push many firms into a vulnerable state. The share of firms with ICR lower than one would triple to nearly fifty percent, largely reflecting the deterioration in the financial health of small firms. In such a scenario, the share of risky debt would increase to the level observed during the financial crisis, resulting in a significant increase in new corporate defaults. Nevertheless, given the moderate share of corporate loans on banks' loan books, and banks' current comfortable capital positions, the analysis indicates that banks would still be able to keep their regulatory Tier 1 capital well above the minimum requirement.

# INTER-SECTORAL FINANCIAL INTERLINKAGES[1]

## A. Introduction

**1. This note presents a map of inter-sectoral interconnectedness of various financial and real sectors in Ireland and assesses potential channels of risk contagion.** As financial interlinkages among the sectors have become complex, a system-wide perspective is required to assess financial stability. The system-wide view can produce relevant insights that are easily overlooked if one analyzes the financial system on a sector-by-sector basis. It also enables to identify which sectors can play a role in transmitting shocks within and across the Irish border.

**2. The Central Bank of Ireland has made further enhancements to the Quarterly Financial Accounts (QFA) data**.[2] It started to publish the "Whom-to-Whom" data for deposits and loans in April 2015, which can provide greater detail on inter-sectoral relationship for financial flows and positions and the transmission of risks among different sectors in Ireland (Cussen, 2015 and forthcoming). Using the QFA data, this note covers nine sectors: (1) monetary financial institutions (MFIs) including deposit-taking institutions and money market funds; (2) non-money market investment funds (NMIFs); (3) other financial intermediaries including financial vehicle corporations and holding companies (OFIs); (4) insurance companies (ICs); (5) pension funds (PFs); (6) governments (GOV); (7) households including non-profit institutions serving households (HHs); (8) non-financial corporations (NFCs); and (9) the rest of the world (ROW). MFIs are divided into three subsectors: domestic-controlled monetary financial institutions, foreign-controlled monetary financial institutions, and money market funds. Bilateral exposures of the Central Bank of Ireland are also examined.[3]

**3. The outline of this section is as follows.** Subsection B uses the Quarterly Financial Accounts data to take stock of the relative size and composition trend of balance sheets of individual sectors and describe domestic and cross-border financial linkages among sectors. Subsection C shows results from a domestic financial network analysis to identify systemically important sectors and potential transmission channels that system-wide risk can spread among sectors. Subsection D considers options to improve surveillance.

## B. Sectoral Balance Sheets: Assets and Liabilities

**4. Total financial assets in Ireland are large and well-diversified among financial sectors, and have continued to grow in the post-crisis period.** As shown in Table 1, the outstanding balance of total financial assets amounted to 2820 percent of GDP (€6053 billion) as of 2015Q4, of which 2,033 percent of GDP was captured by the financial sectors, including monetary financial institutions (533

[1] This Chapter of the Technical Note was prepared by Heedon Kang, Monetary and Capital Markets Department, in the context of the 2016 Ireland Financial Sector Assessment Program.

[2] The Central Statistics Office (CSO) compiles the Annual Financial Accounts data.

[3] As noted in Castrén and Kavonius (2009), the QFAs are not consolidated, which means that they include financial linkages not only among different sectors but also within each sector.

percent of GDP), non-money market investment funds (811 percent of GDP), other financial intermediaries (515 percent of GDP), and insurance companies and pension funds (174 percent of GDP). During 2011–13, the outstanding balance dropped by 5 percent from the previous peak level in 2010 (2,738 percent of GDP), but exceeded the peak since 2014 (Figure 1). While all the financial sectors had more or less a balanced position, the government and non-financial corporations had a large negative net financial asset position (71 and -119 percent of GDP) and households had a large positive net financial asset position (92 percent of GDP).[4]

**5. The recent recovery of total financial assets is led by a rapid growth in the non-money market investment fund industry (Figure 1).**[5] Financial assets of the investment funds have grown by three folds since the crisis (from about 270 percent of GDP in 2009 to 811 percent of GDP at 2015Q4), while those of monetary financial institutions have decreased by 45 percent, falling from first place (from 963 percent of GDP to 533 percent of GDP).[6] Other financial intermediaries also had 17 percent less financial assets in 2015Q4 (515 percent of GDP) compared with the level in 2009 (577 percent of GDP), but still account for 18 percent of total financial assets in Ireland.[7] On the other hand, insurance companies and pension funds have played a small role in financial intermediation (6 percent of total financial assets and liabilities) and have increased somewhat since the crisis.

**6. For most financial sectors, assets are mainly allocated to equities, long-term debt securities, or long-term loans, but are funded by different instruments (Table 1).** As of 2015Q3, monetary financial institutions held more than a half of their financial assets in liquid form, either cash and deposits or short-term debt securities (e.g., certificates of deposit, commercial paper, treasury bills, etc.), and they had two main sources of funding: deposits for retail banks and credit unions, and shares for money market funds. The assets of non-money market funds consisted of holdings of long-term debt securities, equities, and financial derivatives, while the lion's share of their liabilities was fund shares (77 percent). The bulk of the OFI assets were loans (mostly long-term), while the liabilities were from various sources, such as long-term debt securities, equities, and loans. Insurance companies owed mostly in the form of insurance premia and held non-MMF shares and long-term debt securities, while pension funds' assets consisted of equities and long-term debt securities and their liabilities were completely funded by pension entitlements.

[4] Net financial asset position is calculated as total assets minus total liabilities.

[5] Murphy (2012) notes that there are a number of natural advantages which encourage the growth of the funds industry in Ireland such as language, time-zone, favorable taxes, legal system, skilled workforce, etc. See a technical note on asset management and financial stability in Ireland for further information.

[6] Monetary financial institutions include deposit-taking institutions (e.g., retail banks and credit unions) and money market funds (https://www.centralbank.ie/polstats/stats/reporting/Documents/Oct14_FAQs_Website.pdf).

[7] The other financial intermediaries consist of financial vehicle corporations engaged in securitization transactions (FVC), security and derivative dealers, financial corporations engaged in lending, specialized financial corporations, financial auxiliaries, and holding companies (http://www.centralbank.ie/polstats/stats/qfaccounts/Documents/Quarterly%20Financial%20Accounts%20and%20the%20Implementation%20of%20ESA%202010.pdf).

## Table 1. Ireland: Balance Sheet Composition of Financial Assets and Liabilities by Sector

(Assets, percent of total financial assets of each sector, as of 2015Q4)

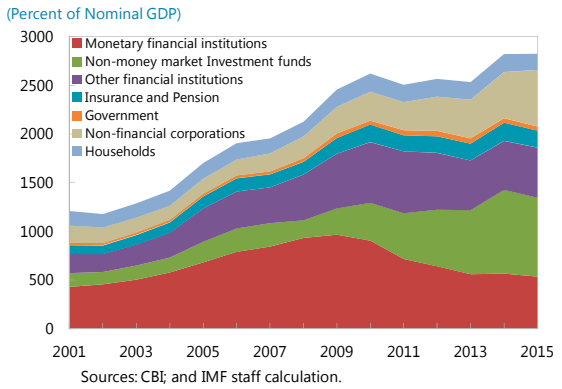
| | MFIs | NMIFs | OFIs | ICs | PFs | GOV | HHs | NFCs | Share of each instrument (Percent in total financial assets) | ROW |
|---|---|---|---|---|---|---|---|---|---|---|
| Currency & Deposits | 25 | 4 | 6 | 8 | 4 | 20 | 37 | 8 | 11 | 4 |
| Short-Term Debt Security | 30 | 2 | 5 | 1 | 2 | 2 | 0 | 0 | 7 | 0 |
| Long-Term Debt Securities | 21 | 33 | 12 | 16 | 41 | 2 | 0 | 0 | 17 | 8 |
| Short-Term Loans | 4 | 0 | 9 | 0 | 0 | 1 | 0 | 9 | 4 | 6 |
| Long-Term Loans | 15 | 2 | 47 | 0 | 0 | 13 | 0 | 11 | 14 | 9 |
| Equity | 1 | 33 | 15 | 10 | 47 | 47 | 12 | 51 | 25 | 21 |
| MMF Shares | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 9 |
| Non-MMF Fund Shares | 0 | 11 | 0 | 40 | 3 | 4 | 0 | 1 | 5 | 27 |
| Non-life Insurance Reserves | 0 | 0 | 0 | 14 | 0 | 0 | 2 | 0 | 1 | 1 |
| Life Insurance and Annuity Entitlement | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 1 | 3 |
| Pension entitlements | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 2 | 0 |
| Fin Derivatives and Stock Options | 2 | 10 | 1 | 1 | 0 | 1 | 0 | 0 | 3 | 4 |
| Trade Credits and Advance | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 13 | 3 | 2 |
| Other Account Receivables | 1 | 6 | 4 | 3 | 2 | 9 | 2 | 7 | 4 | 5 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Size of Financial Assets (Percent of GDP) | 533 | 811 | 515 | 122 | 51 | 42 | 165 | 581 | 2820 | 2213 |
| Share in Total Financial Assets (Percent of Total Financial Assets) | 19 | 29 | 18 | 4 | 2 | 1 | 6 | 21 | 100 | |

(Liabilities, percent of total financial liabilities of each sector, as of 2015Q4)

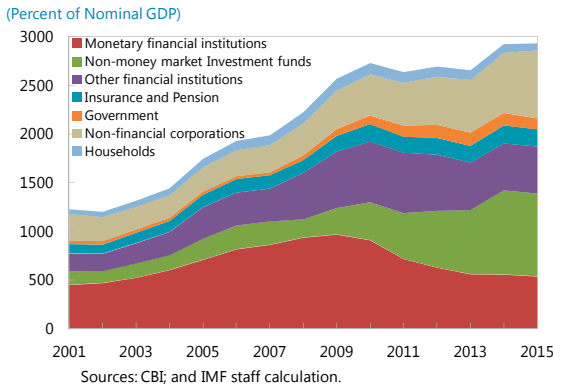
| | MFIs | NMIFs | OFIs | ICs | PFs | GOV | HHs | NFCs | Share of each instrument (Percent in total financial assets) | ROW |
|---|---|---|---|---|---|---|---|---|---|---|
| Currency & Deposits | 42 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 8 | 9 |
| Short-Term Debt Security | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 10 |
| Long-Term Debt Securities | 3 | 0 | 30 | 0 | 1 | 60 | 0 | 1 | 8 | 20 |
| Short-Term Loans | 0 | 4 | 22 | 0 | 0 | 0 | 3 | 4 | 6 | 4 |
| Long-Term Loans | 0 | 1 | 20 | 1 | 0 | 25 | 91 | 22 | 12 | 12 |
| Equity | 10 | 0 | 18 | 11 | 0 | 1 | 0 | 60 | 20 | 29 |
| MMF Shares | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| Non-MMF Fund Shares | 0 | 77 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 5 |
| Non-life Insurance Reserves | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 1 | 1 |
| Life Insurance and Annuity Entitlement | 0 | 0 | 0 | 63 | 0 | 0 | 0 | 0 | 3 | 0 |
| Pension entitlements | 0 | 0 | 0 | 0 | 99 | 0 | 0 | 0 | 2 | 0 |
| Fin Derivatives and Stock Options | 3 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 |
| Trade Credits and Advance | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 9 | 2 | 3 |
| Other Account Receivables | 1 | 9 | 6 | 3 | 0 | 3 | 5 | 4 | 5 | 4 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Size of Financial Assets (Percent of GDP) | 535 | 851 | 482 | 124 | 55 | 112 | 74 | 699 | 2931 | 2103 |
| Share in Total Financial Assets (Percent of Total Financial Assets) | 18 | 29 | 16 | 4 | 2 | 4 | 3 | 24 | 100 | |

Sources: CBI; CSO; and IMF staff calculation.

**Figure 1. Ireland: Total Financial Assets and Liabilities by Sector**



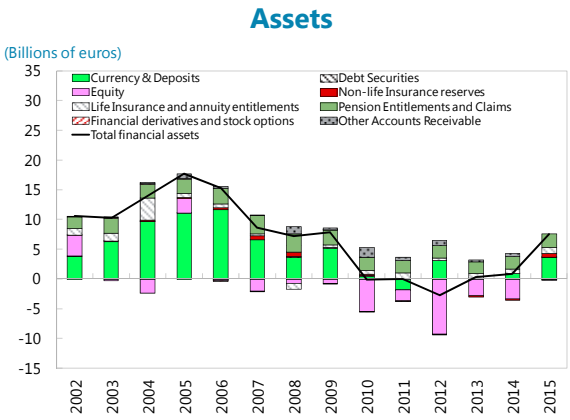

Sources: CBI; and IMF staff calculation.



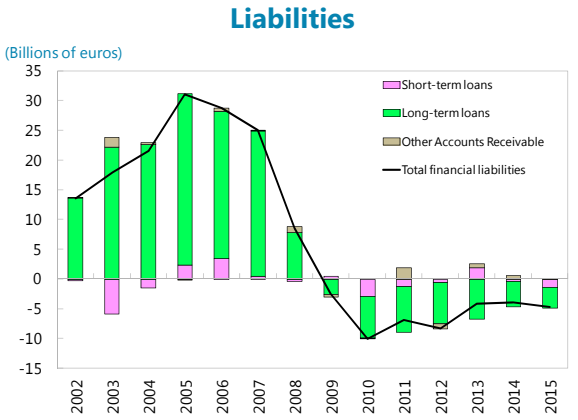

Sources: CBI; and IMF staff calculation.

**7. Household financial liabilities have been contracting in a deleveraging process since the financial crisis (Figure 2).** The outstanding balance of household debt, almost entirely in the form of long-term mortgage loans, decreased by 27 percent (-€54 billion) between 2008 and 2015Q4. On the other hand, financial assets of households have remained stable, as the increase of pension entitlements offset the decrease of other types of assets, such as deposits, equity holdings, and claims on insurance companies. As of 2015Q4, deposits and claims on pension funds accounted for about 70 percent of household financial assets. Equity holdings and claims on life insurance companies made up the rest. The household sector was a net lender, with net financial assets amounting to €197 billion (92 percent of GDP).

**Figure 2. Ireland: Changes in Financial Assets and Liabilities of Households**




Sources: CBI; and IMF staff calculation.

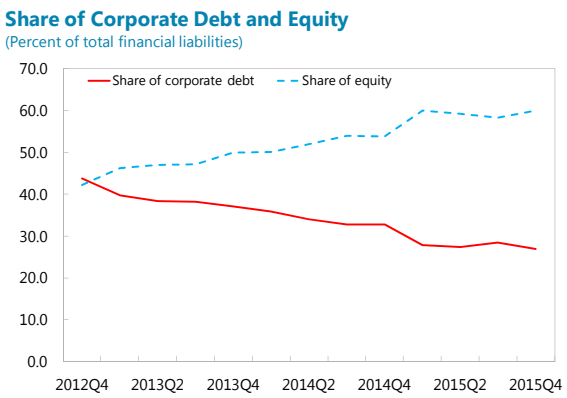


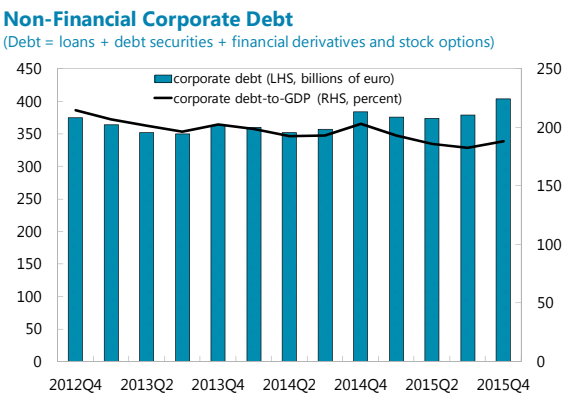

Sources: CBI; and IMF staff calculation.

**8. The volume of corporate financial assets increased 2.4 times, while liabilities doubled during the post-crisis period.** As shown in Table 1, equities had the largest share of both assets and liabilities (51 percent and 60 percent), largely due to new entrances of multinational companies. Corporate debt increased from €323 billion to €402 billion (an increase of 15 percentage points of GDP)

between 2008 and 2015Q4, but its share in total corporate liabilities has been in a gradual downward trend (Figure 3). Yet, as noted in Cussen (2015), Irish corporate debt would be substantially reduced by the exclusion of foreign-controlled multinational companies.[8] External debt, mainly owned by multinational firms, stood at €214 billion in 2015Q4, accounting for more than 50 percent of total corporate debt in Ireland.

**Figure 3. Ireland: Non-Financial Corporate Debt**



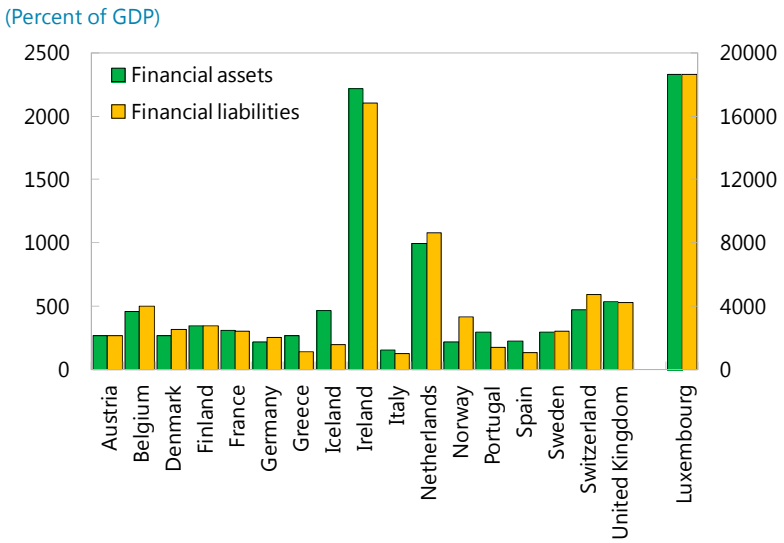




**9. The rest of the world (ROW) has a very large amount of financial assets and liabilities against Irish-domiciled entities and residents, indicating tight cross-border financial linkages (Table 1).** The volume of the ROW's assets and liabilities against Irish-domiciled entities and residents stands out among European countries, next to Luxembourg (Figure 4).[9] As of 2015Q4, the ROW's financial assets represented almost 2,214 percent of GDP. MMF and Non-MMF shares issued by Irish-domiciled funds and held by non-residents amounted to €1,748 billion or 815 percent of GDP, and accounted for 37 percent of total financial asset of the ROW, which have increased rapidly in recent years. The ROW's holdings of debt and equity reached €1,106 and €1,016 billion (515 and 473 percent of GDP) and accounted for 23 and 21 percent of the ROW's financial assets, respectively. The ROW's liabilities were slightly smaller (2,103 percent of GDP), and mainly comprised of equities, fixed-income instruments, and loans (the first two each comprise about 29 percent of total liabilities, and the last 16 percent of the total). The characteristics of cross-border financial linkages are discussed in the following subsection in detail.

[8] The CSO is working on separating the data on multinational firms' debt from that of Irish domestic firms.

[9] The cross-country comparison of the size of the ROW's financial assets and liabilities included only countries for which the outstanding stock information is available.

**Figure 4. Selected Countries: Financial Assets and Liabilities of the Rest of the World**




Sources: CEIC; WEO; and IMF staff calculation.

## C. Inter-sectoral Financial Linkages[10]

**10. Cross-border interlinkages via Irish-domiciled funds industry and multinational companies are a key feature of the financial network (Figure 5).**[11] Cross border linkages are strongest in two sectors, namely the Irish-domiciled funds industry and Irish-domiciled multinational companies: all bilateral connections over 100 percent of GDP were the ones between the ROW and domestic sectors in 2015Q2 (Table 2). Interesting features of the cross-border interconnections are as follow:

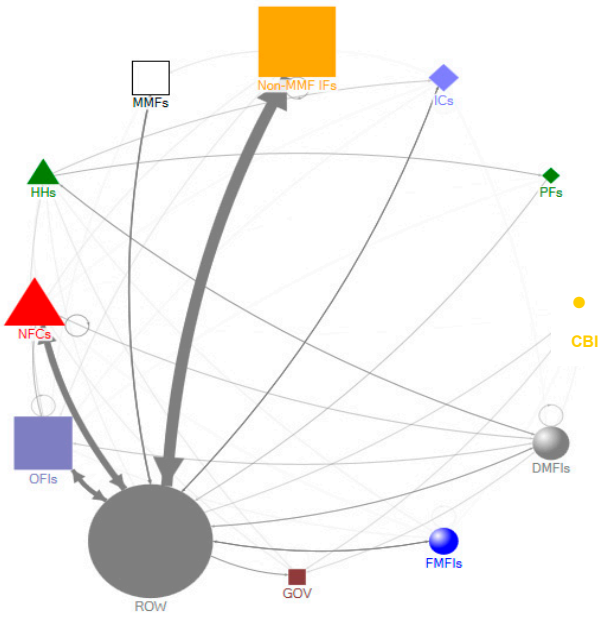
- **Ireland plays a role as one of a number of significant hubs for the global funds industry.** As of 2015Q2, non-residents held more than 90 percent of total liabilities of money market funds and non-money market investment funds in gross terms;
- **The tight linkages between the ROW and NFCs reflect the large presence of foreign-controlled multinational companies in Ireland**; and
- **The bilateral connection between the ROW and Irish households is insignificant.**

[10] While the aggregate financial asset and liability position data is available as of 2015Q3, the latest "bilateral" financial exposure data is available by 2015Q2, which is used in this subsection. The difference between two data points is insignificant. See Box 1 for detailed network properties.

[11] This note considers only links of asset positions between sectors that are greater than 1 percent of GDP as of 2015Q2. The GDP in 2015Q2 is calculated as a four quarter moving sum of quarterly nominal GDP.

## Figure 5. Ireland: Financial Network Map[1/, 2/, 3/]

(As of 2015Q2)




Note: 1/ DMFIs = Domestic Monetary Financial Institutions, FMFIs = Foreign Monetary Financial Institutions, MMFs = Money Market Funds.
2/ The size of each vertex represents the size of total financial assets.
3/ The thickness of arrows from a sector to another depicts the volume of bilateral exposures from a creditor to a debtor.
Sources: CBI; NodeXL; and IMF staff calculation.

## Table 2. Ireland: Financial Network Matrix (Gross Bilateral Position)

| Unit: Percent of GDP | | Liabilities | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CBI | DMFIs | FMFIs | MMFs | NMIFs | OFIs | ICs | PFs | GOV | NFCs | HHs | ROW | Total |
| Assets | CBI | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 8 | 29 |
| | DMFIs | 2 | 35 | 0 | 0 | 0 | 27 | 0 | 0 | 13 | 25 | 47 | 52 | 203 |
| | FMFIs | 1 | 0 | 6 | 0 | 1 | 6 | 0 | 0 | 0 | 1 | 2 | 111 | 129 |
| | MMFs | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 194 | 197 |
| | NMIFs | 0 | 0 | 1 | 15 | 48 | 12 | 0 | 0 | 0 | 7 | 0 | 802 | 885 |
| | OFIs | 0 | 14 | 0 | 4 | 3 | 30 | 1 | 0 | 1 | 42 | 22 | 387 | 504 |
| | ICs | 0 | 4 | 1 | 0 | 3 | 6 | 3 | 0 | 1 | 2 | 1 | 115 | 136 |
| | PFs | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 40 | 46 |
| | GOV | 11 | 14 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 9 | 2 | 4 | 44 |
| | NFCs | 1 | 19 | 3 | 0 | 3 | 15 | 2 | 0 | 2 | 60 | 1 | 450 | 556 |
| | HHs | 0 | 43 | 7 | 0 | 0 | 0 | 35 | 50 | 11 | 6 | 0 | 4 | 157 |
| | ROW | 23 | 41 | 102 | 193 | 852 | 393 | 98 | 0 | 70 | 535 | 5 | 0 | 2,312 |
| | Total | 38 | 176 | 121 | 212 | 911 | 496 | 140 | 51 | 116 | 687 | 81 | 2,169 | 5,198 |

| Unit: Percent of total liabilities in each sector | | Liabilities | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CBI | DMFIs | FMFIs | MMFs | NMIFs | OFIs | ICs | PFs | GOV | NFCs | HHs | ROW |
| Assets | CBI | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| | DMFIs | 5 | 20 | 0 | 0 | 0 | 6 | 0 | 0 | 12 | 4 | 58 | 2 |
| | FMFIs | 3 | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 5 |
| | MMFs | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| | NMIFs | 0 | 0 | 1 | 7 | 5 | 2 | 0 | 0 | 0 | 1 | 0 | 37 |
| | OFIs | 0 | 8 | 0 | 2 | 0 | 6 | 1 | 0 | 1 | 6 | 28 | 18 |
| | ICs | 0 | 2 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 | 5 |
| | PFs | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | GOV | 28 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 3 | 0 |
| | NFCs | 3 | 11 | 2 | 0 | 0 | 3 | 1 | 0 | 2 | 9 | 1 | 21 |
| | HHs | 0 | 25 | 5 | 0 | 0 | 0 | 25 | 99 | 10 | 1 | 0 | 0 |
| | ROW | 61 | 23 | 85 | 91 | 93 | 79 | 70 | 1 | 61 | 78 | 6 | 0 |
| | Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Sources: CBI; and IMF staff calculation.

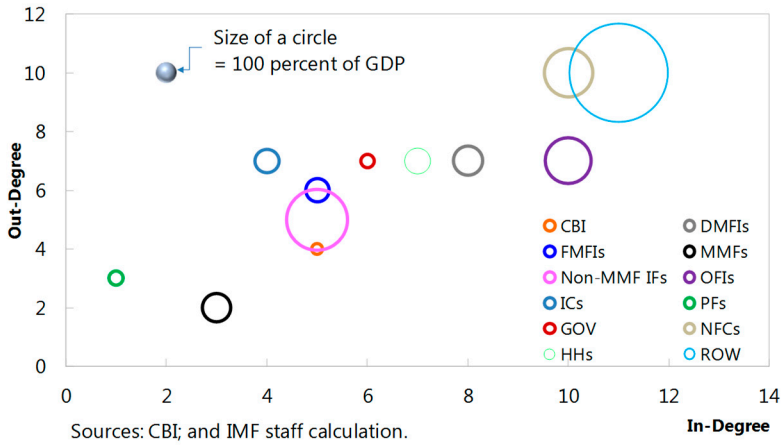
## Box 1. Properties of Financial Network in Ireland

A financial network is a set of elements called nodes (sectors) connected by links (exposures). The network is "directed," as the relationship goes from a sector to another. As of 2015Q2, it is an incomplete network because some sectors do not have bilateral exposures bigger than 1 percent of GDP.

Degree refers to the sum of incoming links (In-Degree) and outgoing links (Out-Degree) of a sector. A sector with higher degree is more central, meaning that the sectoral is highly connected. In- and Out-Degree make reference to the direction of these links.

The following figures indicate the dominance of the ROW, NFCs, OFIs, and domestic banks in the financial network. They show In-Degree, Out-Degree, and the size of total assets of each sector in Ireland. The ROW has connections with all the other sectors, NFCs are exposed to all the counterparties except MMFs and PFs, and domestic banks have very small exposures against non-money market investment funds, PFs, and foreign-controlled banks.

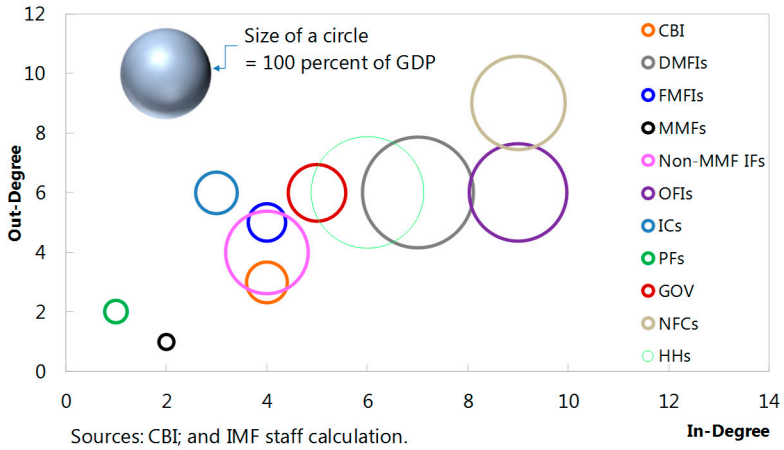
**Degree Distribution and Total Assets in the Irish Financial Network** (Number of In- and Out-Degree, Percent of GDP)




Sources: CBI; and IMF staff calculation.

Focusing on the Irish domestic financial network, the following figure crystallizes the potential role of four domestic sectors (i.e., domestic banks, OFIs, NFCs, HHs) in distributing and absorbing funding.

**Degree Distribution and Total Assets excluding the ROW**
(Number of In- and Out-Degree, Percent of GDP)




Sources: CBI; and IMF staff calculation.

**11. Several connections can act as key transmission channels of risks across borders.** First, domestic banks and foreign bank's subsidiaries hold both financial assets and liabilities against the ROW and thus are exposed to negative spillovers from credit and funding shocks that non-residents face. However, the spillovers appear to be less of a concern compared with the pre-crisis period, given the fact that both foreign banks' exposures to Ireland and Irish domestic banks' claims to non-residents have reduced significantly in recent years.[12] Second, Irish insurance companies and pension funds are net creditors to the ROW, and thus any negative shock originated outside of Ireland could be channeled through their balance sheets (Table 3). Third, the ROW possesses a large amount of government bonds. A sharp withdrawal of non-residents from the bond market could generate an interest rate shock and cause distress in the Irish financial system. Fourth, the multinational companies play an important role in connecting the Irish economy with the ROW through their external financing (e.g., inter-company loans).

**Table 3. Ireland: Financial Network Matrix (Net Bilateral Position)**
(Percent of GDP, as of 2015Q2)

| | | Liabilities | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CBI | DMFIs | FMFIs | MMFs | NMIFs | OFIs | ICs | PFs | GOV | NFCs | HHs | ROW | Total |
| Assets | CBI | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | -1 | 0 | -15 | -10 |
| | DMFIs | -3 | 0 | 0 | 0 | 0 | 14 | -4 | -1 | 0 | 6 | 4 | 12 | 27 |
| | FMFIs | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | -1 | -5 | 9 | 8 |
| | MMFs | 0 | 0 | 0 | 0 | -15 | -2 | 0 | 0 | 0 | 0 | 0 | 1 | -15 |
| | NMIFs | 0 | 0 | 0 | 15 | 0 | 9 | -3 | -1 | 0 | 4 | 0 | -49 | -27 |
| | OFIs | 0 | -14 | -6 | 2 | -9 | 0 | -5 | -3 | 0 | 26 | 22 | -5 | 8 |
| | ICs | 0 | 4 | 0 | 0 | 3 | 5 | 0 | 0 | 1 | 0 | -34 | 17 | -4 |
| | PFs | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | -50 | 40 | -5 |
| | GOV | -3 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 7 | -9 | -66 | -73 |
| | NFCs | 1 | -6 | 1 | 0 | -4 | -26 | 0 | -1 | -7 | 0 | -5 | -85 | -132 |
| | HHs | 0 | -4 | 5 | 0 | 0 | -22 | 34 | 50 | 9 | 5 | 0 | -1 | 77 |
| | ROW | 15 | -12 | -9 | -1 | 49 | 5 | -17 | -40 | 66 | 85 | 1 | 0 | 145 |
| | Total | 10 | -27 | -8 | 15 | 27 | -8 | 4 | 5 | 73 | 132 | -77 | -145 | |

Sources: CBI calculations; and IMF staff calculation.

**12. Exclusion of the ROW shows that the banking sector, NFCs, and OFIs are the three main sectors in the domestic financial network (Figure 6 and Table 4).[13]** The banking sector was the largest financial sector (financial assets at 169 percent of GDP), followed by other financial institutions (117 percent of GDP), and non-financial corporations (107 percent of GDP) in June 2015. As shown in Box 1, they are ones with more connections (high in- and out-degree) than any other sectors, excluding the ROW. Table 5 and 6 show that many domestic sectors had large financial claims on and obligations to these three sectors relative to their balance sheets. As such, shocks to these sectors can affect other sectors via these direct and indirect financial interlinkages.[14]

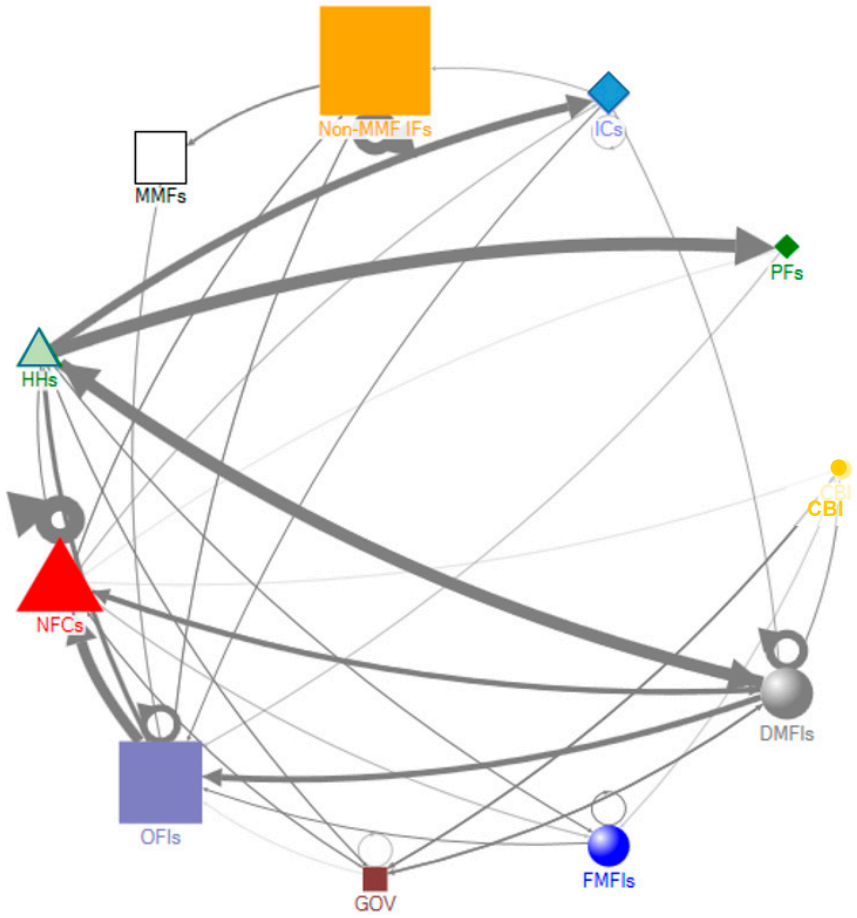
[12] See Technical Note on Banking Sector Stress Tests for detailed assessment.

[13] See Technical Note on Asset Management and Financial Stability in Ireland.

[14] When sector A has a large claim (obligation) relative to its assets (liabilities) vis-à-vis sector B, which in turn has a large relative claim (obligation) vis-à-vis sector C, then sector C can be identified as a systemically important funding destination (source). Thus, a funding shock in sector A can have a large impact on sector C. Conversely, an income/profit or valuation shock in sector C can have significant repercussions for sector A.

**Figure 6. Ireland: Domestic Financial Network Map** [1/]

(As of 2015Q2)




Sources: CBI calculation; NodeXL; and IMF staff calculation.

1/ The size of each vertex shows the size of total financial assets. The thickness of arrows depicts the volume of bilateral gross exposures from a creditor to a debtor; loops represent gross intra-sectoral claims.

## Table 4. Ireland: Domestic Financial Network (Gross Bilateral Position)

(Percent of GDP, as of 2015Q2)

| Unit: Percent of GDP | | Liabilities | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CBI | DMFIs | FMFIs | MMFs | NMIFs | OFIs | ICs | PFs | GOV | NFCs | HHs | Total |
| Assets | CBI | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 20 |
| | DMFIs | 2 | 35 | 0 | 0 | 0 | 27 | 0 | 0 | 13 | 25 | 47 | 150 |
| | FMFIs | 1 | 0 | 6 | 0 | 1 | 6 | 0 | 0 | 0 | 1 | 2 | 18 |
| | MMFs | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| | NMIFs | 0 | 0 | 1 | 15 | 48 | 12 | 0 | 0 | 0 | 7 | 0 | 83 |
| | OFIs | 0 | 14 | 0 | 4 | 3 | 30 | 1 | 0 | 1 | 42 | 22 | 116 |
| | ICs | 0 | 4 | 1 | 0 | 3 | 6 | 3 | 0 | 1 | 2 | 1 | 21 |
| | PFs | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 6 |
| | GOV | 11 | 14 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 9 | 2 | 40 |
| | NFCs | 1 | 19 | 3 | 0 | 3 | 15 | 2 | 0 | 2 | 60 | 1 | 106 |
| | HHs | 0 | 43 | 7 | 0 | 0 | 0 | 35 | 50 | 11 | 6 | 0 | 153 |
| | Total | 15 | 135 | 19 | 19 | 60 | 103 | 41 | 50 | 46 | 153 | 76 | 717 |

Sources: CBI calculations; and IMF staff calculation.

## Table 5. Ireland: Domestic Financial Network (Relative Claim Matrix)

(Percent of total assets of each sector, as of 2015Q2)

| Unit: Percent of total assets in each sector | | Liabilities | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CBI | DMFIs | FMFIs | MMFs | NMIFs | OFIs | ICs | PFs | GOV | NFCs | HHs | Total |
| Assets | CBI | 0 | 23 | 8 | 0 | 0 | 0 | 0 | 0 | 69 | 0 | 0 | 100 |
| | DMFIs | 1 | 23 | 0 | 0 | 0 | 18 | 0 | 0 | 9 | 17 | 31 | 100 |
| | FMFIs | 6 | 0 | 35 | 0 | 5 | 34 | 2 | 1 | 0 | 8 | 9 | 100 |
| | MMFs | 0 | 6 | 0 | 1 | 0 | 93 | 0 | 0 | 0 | 0 | 0 | 100 |
| | NMIFs | 0 | 0 | 1 | 18 | 58 | 14 | 0 | 0 | 0 | 8 | 0 | 100 |
| | OFIs | 0 | 12 | 0 | 3 | 3 | 26 | 1 | 0 | 1 | 36 | 19 | 100 |
| | ICs | 0 | 19 | 4 | 0 | 16 | 27 | 14 | 0 | 2 | 10 | 7 | 100 |
| | PFs | 0 | 14 | 0 | 0 | 16 | 47 | 0 | 0 | 6 | 17 | 0 | 100 |
| | GOV | 27 | 35 | 0 | 0 | 0 | 3 | 0 | 0 | 7 | 22 | 6 | 100 |
| | NFCs | 1 | 18 | 2 | 0 | 3 | 14 | 2 | 0 | 2 | 56 | 1 | 100 |
| | HHs | 0 | 28 | 4 | 0 | 0 | 0 | 23 | 33 | 7 | 4 | 0 | 100 |

Sources: CBI calculation; and IMF staff calculation.

## Table 6. Ireland: Domestic Financial Network (Relative Obligation Matrix)

(Percent of total liabilities of each sector, as of 2015Q2)

| Unit: Percent of total liabilities in each sector | | Liabilities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CBI | DMFIs | FMFIs | MMFs | NMIFs | OFIs | ICs | PFs | GOV | NFCs | HHs |
| Assets | CBI | 0 | 3 | 9 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 |
| | DMFIs | 12 | 26 | 0 | 2 | 0 | 27 | 0 | 0 | 29 | 16 | 62 |
| | FMFIs | 8 | 0 | 33 | 0 | 1 | 6 | 1 | 0 | 0 | 1 | 2 |
| | MMFs | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| | NMIFs | 0 | 0 | 5 | 77 | 80 | 11 | 0 | 0 | 0 | 5 | 0 |
| | OFIs | 0 | 10 | 0 | 21 | 5 | 29 | 2 | 0 | 2 | 27 | 30 |
| | ICs | 0 | 3 | 4 | 0 | 6 | 6 | 7 | 0 | 1 | 1 | 2 |
| | PFs | 0 | 1 | 0 | 0 | 2 | 3 | 0 | 0 | 1 | 1 | 0 |
| | GOV | 73 | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 6 | 3 |
| | NFCs | 8 | 14 | 14 | 0 | 6 | 15 | 5 | 0 | 5 | 39 | 2 |
| | HHs | 0 | 32 | 35 | 0 | 0 | 0 | 85 | 100 | 25 | 4 | 0 |
| | Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Sources: CBI calculation; and IMF staff calculation.

**13. The Irish banking sector is tightly connected with the real sectors of the Irish economy, but not with many of the other financial sectors.** Sources of banks' obligations were well diversified, with households playing the largest role (over 30 percent of bank liabilities and household assets), and destinations of banks' claims were mainly the real sectors, including households and NFCs (Table 5 and 6). There is a tight bank-sovereign financial linkage in Ireland through banks' government bond holdings and the government's holdings of bank equities. Interestingly, the Irish funds industry and the banking system did not depend on each other for funding and asset allocation. Insurance companies and pension funds had a small exposure to banks (4 percent and 1 percent of GDP, respectively), and banks had no meaningful exposure to insurance companies and pension funds, as shown in Table 4. Meanwhile, inter-bank linkages amounted to 41 percent of GDP (red box in Table 4), and the bilateral exposures between the banking sector and OFIs amounted to be 34 percent and 14 percent of GDP (blue boxes in Table 4).

**14. The link between other financial intermediaries and the domestic real sector reflects group financing transactions and as such is not a potential source of contagion.** In Table 5, OFIs held 36 percent of their total assets in the form of NFC equity or debt and NFCs invested 14 percent of assets into OFIs. The connection between the two sectors, however, mainly reflects intra-company transactions between treasury companies and their parent multinational companies. OFIs had some exposures to households (19 percent of their total assets). They do not provide loans directly to households to any significant degree, but are largely connected through purchases of mortgage loan securitizations and loan sales from banks.

**15. Non-financial corporate sector is a net borrower and the most indebted sector in Ireland.** In 2015Q2, NFCs' liabilities to domestic sectors were 153 percent of GDP (Table 4). Most of the claims were held by the non-financial corporate sector itself, OFIs, and banks (60 percent, 42 percent, and 25 percent of GDP, respectively).[15] As mentioned in the previous paragraphs, the role of treasury companies within the group of multinational companies should be noted.

**16. The household sector is the largest net lender in Ireland, holding a large amount of claims on insurance companies and pension funds.** Households held sizable retirement savings in pension funds (33 percent of household financial assets) and banks' deposits or debentures (32 percent of household financial assets). The claim on the insurance companies constituted 23 percent of household financial assets. Conversely, the largest claim on households was held by banks in the form of mortgages (47 percent of GDP and 62 percent of household liabilities), amounting to 31 percent of bank assets.

[15] The National Asset Management Agency (NAMA) is included in the OFI sector. Its assets amounted to €11 billion mainly in the form of loans and other receivables, as of 2015Q3.

**17. Irish domestic inter-sectoral financial linkages are less dense than those in Denmark at end-2013.**[16] The 2014 Denmark FSAP found that, with the data at end-2013, the interbank claims were the largest connection among domestic financial institutions (110 percent of GDP), and those between institutional investors (insurance companies and pension funds) and OFIs (including non-money market investment funds) were the second largest linkage (55 percent of GDP).[17] Relative to these numbers, the interbank claims in Ireland amounted to 47 percent of GDP, and the bilateral exposures between institutional investors and OFIs and NMIFs in Ireland were only 14 percent of GDP. The bilateral linkages between domestic financial sectors and real sectors were also tighter in Denmark with banks' loans to households (129 percent of GDP) and to NFCs (64 percent of GDP) at end-2013, while those in Ireland were 49 percent and 26 percent of GDP, respectively, in 2015Q2.

**Table 7. Denmark: Domestic Financial Network Matrix**
(Gross Bilateral Position, as of 2013Q4)

| Gross Claims (as % of GDP) | Liabilities of | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Asset of | CB | FA | GG | HH | IC | NFC | OFI | OMFI | ROW | |
| Danmarks Nationalbank | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 24 | 29 |
| Financial auxiliaries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| General government | 12 | 0 | 9 | 8 | 1 | 18 | 2 | 6 | 1 | 58 |
| Households and NPISH | 2 | 0 | 2 | 0 | 144 | 56 | 24 | 51 | 6 | 286 |
| Insurance corporations and pension funds | 0 | 0 | 20 | 0 | 3 | 6 | 52 | 42 | 47 | 170 |
| Non-financial corporations | 1 | 1 | 2 | 5 | 5 | 187 | 19 | 27 | 77 | 323 |
| Other financial intermediaries | 0 | 0 | 4 | 0 | 3 | 21 | 32 | 37 | 63 | 161 |
| Other monetary financial institutions | 13 | 0 | 9 | 129 | 6 | 64 | 12 | 110 | 80 | 422 |
| Rest of the world | 2 | 0 | 18 | 0 | 7 | 89 | 5 | 140 | 0 | 261 |
| | 30 | 1 | 65 | 142 | 168 | 442 | 146 | 417 | 299 | |

Source: IMF (2014) "Technical Note on Macroprudential Policy Framework in Denmark" prepared by Prachi Mishra.

**18. Calculating steady-state Markov chain probabilities with the relative claim matrix (Table 6) as a transition matrix, NFCs, domestic banks, and OFIs are identified as important destinations of funding in Ireland (Figure 7).**[18] The steady-state probabilities indicate that, if one euro circulates through the domestic financial network, 29 cents will flow through NFCs no matter which sector the

[16] Denmark and Ireland are both small open economies and are comparable in terms of the size of population and GDP per capita. In addition, among the recent FSAP in European countries, the 2014 Denmark FSAP is the only one that discussed the inter-sectoral financial linkages with flow of funds data.

[17] In the Denmark FSAP, other financial intermediaries included non-money market investment funds, different from the Ireland FSAP.

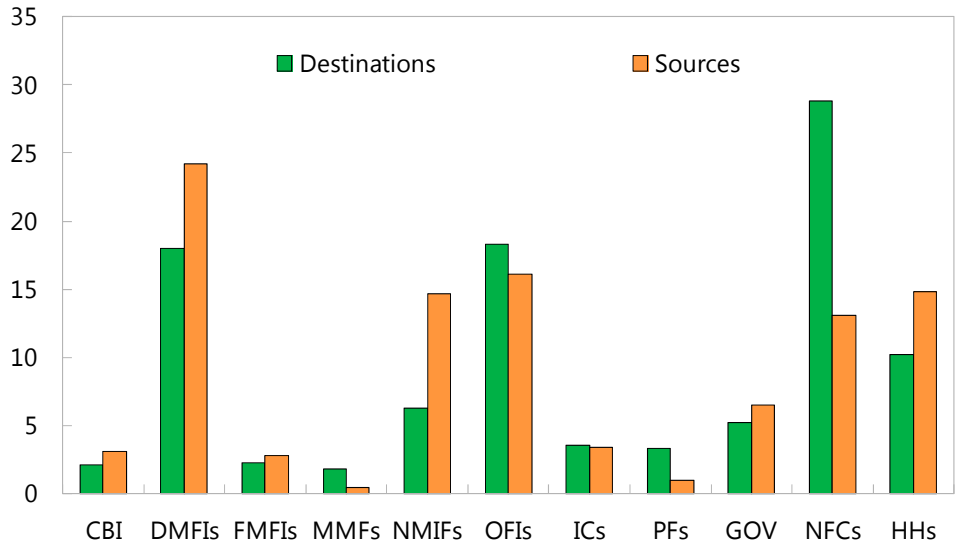
[18] The mechanics of the method are described in Feyen (2011) as follows: Assume that €1 of funding is distributed throughout the domestic financial network of relative claims. If sector A has claims on sectors B and C representing 30 and 70 percent of sector A's assets respectively, then sector A will forward 30 cents to sector B and 70 cents to sector C. In a similar fashion, B and C propagate the funding that they receive to their downstream counterparties, and so forth. As a result, a larger fraction of the one euro will flow through sectors that are systemically important funding destinations. It can be shown that (under a mild condition) a unique steady-state distribution over sectors exists and is unique. This distribution can also be interpreted as the probability that funding will travel through a particular sector—a larger probability suggests a more important role for the sector as a funding destination. See Appendix I for the detailed mathematical process to calculate the Markov chain steady state vector.

circulation starts from, making it the primary systemic funding destination. The analysis also shows that 18 cents will flow through domestic banks and other financial institutions, making these sectors the second largest funding destinations. Thus, income and profit shocks to NFCs and domestic banks can affect upstream funding sources.

**19. The same analysis with the relative obligation matrix (Table 7) as a transition matrix finds that domestic banks are the most important source of funding in the Irish economy, followed by OFIs and households (Figure 7).** The steady-state probability vector suggests that if 1 euro of funding is traced back through the relative obligation matrix, 24 cents flows from domestic banks, 16 cents from OFIs, and 15 cents from households. Non-money market investment funds are an important source of funding internationally, but mainly affect the domestic economy through economic channels, such as employment and investments, rather than through financial links. As a result, liquidity shocks to domestic banks can significantly affect the funding positions of downstream destinations.

**Figure 7. Ireland: Steady-State Destination and Source of Domestic Financial Flows**

(Percent of funding, 2015Q2)




Sources: CBI; and IMF staff calculation.

**20. Recognizing the importance of monitoring interconnections among and with sectors in the Irish financial system, the Central Bank of Ireland has been making efforts to fill data gaps in the banking and non-banking sector.** The large exposures data, which is mainly on the asset side of balance sheets, is used to examine the bilateral interbank exposures of Irish banks (Hallissey, 2016). The interlinkages on the liability side of balance sheets will be monitored with a new data template that is being finalized by the EU Commission. Kenny and others (2015) study the interconnectedness between non-domestic banks and their Irish-domiciled counterparties in the credit default swap market using data on derivative markets under the European Market Infrastructure Regulation. The Central Bank

collects security level granular data quarterly from banks and non-money market investment funds and somewhat less granular data from FVCs in line with ECB regulations. The Central Bank has, on its own initiative, extended security level reporting to MMFs on a monthly basis from December 2014 and has, in an internationally unique measure, extended the FVC reporting form in full to other Special Purpose Vehicles from 2015Q3. In addition, new detailed exposure data of insurance companies will be available in 2016 under the Solvency II reporting regime.

## D. Conclusions and Policy Implications

**21. The inter-sectoral network analysis with QFA data shows that the Irish economy is highly connected across its border.** Despite the recent deleveraging, banks are still interconnected with the ROW. If banks do not have sufficient capital and liquidity buffers, they can act as shock amplifiers. Insurance companies and pension funds can propagate negative foreign shocks into Ireland because domestic households are exposed to non-residents through their savings in these financial sectors, which invest in foreign assets. In addition, the government and NFCs rely on funding from non-residents, and remain vulnerable to a reversal of sentiment in the global financial market.

**22. The banking sector, NFCs, and OFIs (largely connected to MNC activities) are important sources and destinations of funding within the domestic-domiciled financial network in Ireland.** Income/profit or liquidity shocks in these sectors can originate negative spillovers to other sectors in the economy, unless they maintain sufficient capital or liquidity buffers.

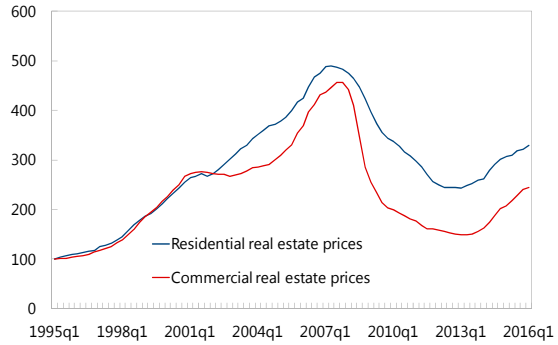
**23. Given the large volume of intra-sectoral exposures, it is important to continue to enhance the collection of granular bilateral exposure data within both the banking sector and non-bank financial institutions as well as across these sectors.** Quarterly financial accounts data show bilateral exposures at the sectoral level only. Securities data is collected for banks, investment funds, MMFs, and FVCs, with the addition of SPVs from Q3 2015 and insurers from Q1 2016. However, granular bilateral exposure data for banks are currently available for asset exposures for the most part. There are a number of data initiatives underway within the Central Bank of Ireland to fill data gaps and enhance understanding of financial interconnectedness in Ireland. These are welcome but will require sufficient resources and strong inter-departmental collaboration.

# REAL ESTATE MARKET ANALYSIS[19]

## A. Introduction

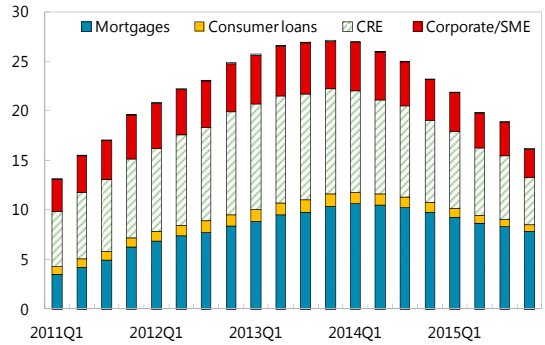
**25. Ireland has experienced a historic financial crisis with the bursting of a real estate boom during the global financial crisis (text figure).** The real estate boom in the first decade of the 21st century was fueled by fast credit growth, funded by domestic bank loans and cross-border capital flows. Prices in both the residential real estate (RRE) and commercial real estate (CRE) sectors doubled and total banking assets tripled from 2000 to 2007. Neglecting the RRE or CRE booms and the associated rapid credit growth had disastrous consequences: debt overhang and deleveraging spirals threatened financial and macroeconomic stability. GDP growth was negative for two years in a row in 2008–09, and unemployment increased to 15.1 percent by 2012. House and CRE prices fell by about 50 and 70 percent from their peak in 2007, respectively, with banks facing significant losses on their real estate exposures. The authorities had to recapitalize the banking system in the amount of €64 billion (about 40 percent of GDP).

**Property Prices**
(Index, 1995Q1=100)




Sources: CBI; IPD; and OECD.

**Non-Performing Loans**
(Percent of gross loans)




Source: Central Bank of Ireland.

**26. Ireland still faces the challenge of dealing with the stock of mortgage and CRE NPLs.** The authorities have deployed various measures to accelerate the resolution of problem loans and especially mortgages, CRE loans, and loans to small and medium-sized enterprises.[20] Nonetheless, the system still holds a large stock of NPLs, composed to a significant degree of long-overdue mortgages and CRE loans (text figure).

**27. In addition, coming out of the crisis, real estate markets bounced back from their lows, prompting concerns for possible overvaluation and a build-up of new imbalances.** RRE and CRE

[19] This Chapter of the Technical Note was prepared by Heedon Kang, Monetary and Capital Markets Department, with inputs from Christopher Wilson (MCM) and Vizhdan Boranova (EUR), in the context of the 2016 Ireland Financial Sector Assessment Program.

[20] This issue has been extensively studied (e.g., in IMF SDN/15/19, "A Strategy for Resolving Europe's Bad Loans"). A lot of SME NPLs are linked to property debt overhang. Note also that a large part of NPLs were transferred to NAMA, and thus the NPLs in the banking system underestimate the true problem of distressed loans.

prices in 2015Q4 are now about 35 and 60 percent higher than the trough in 2013Q1, but still remain 33 and 48 percent below the peak levels, respectively.

**28. Thus, developments in the real estate sector remain of central importance to macroeconomic and financial stability.** Both CRE and REE have shown a proclivity towards price booms and busts. Construction activity is likewise highly cyclical. The funding of real estate purchases and construction has been a major part of banks' business but also a source of major vulnerabilities.

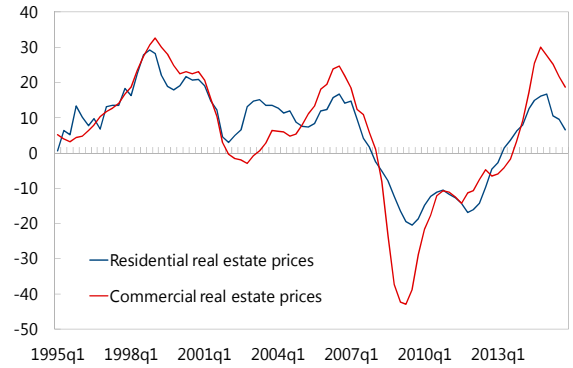
**29. Therefore, this note reviews recent developments in the two property markets, assesses certain systemic risk, and considers preemptive policy options to contain a potential build-up of imbalances.** First, it summarizes price dynamics and transaction activities in each market, and discusses demand and supply factors driving the markets. It also looks at sources of funding and the extent to which banks are exposed to the two sectors. Second, it estimates the level of misalignment between actual and fundamental prices in both RRE and CRE markets, using a variety of non-parametric and parametric approaches. Third, it examines existing and potential policy options to address detected risk.

## B. Recent Developments in Real Estate Markets

### Residential Real Estate Market

**30. National house prices have rebounded strongly since 2013.** Based on the CSO data, nominal prices recorded the first increase in June 2013 (1.2 percent y-o-y) since February 2008, and growth rates have remained positive since then. In 2014, nominal house prices rose as fast as in the pre-crisis boom period (16 percent y-o-y) and continued to increase by 7 percent in 2015 (text figure). House price growth reached 16.3 percent at end-2014 (y-o-y, 3 month moving average), accompanied by a growth in housing transactions.

**Property Price Growth Rate**
(Percent, year-on-year change)

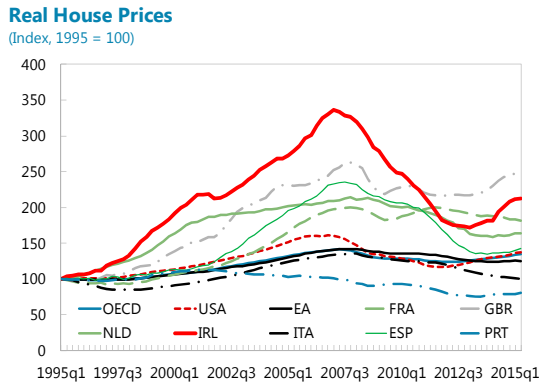



Sources: CBI; IPD; and OECD.

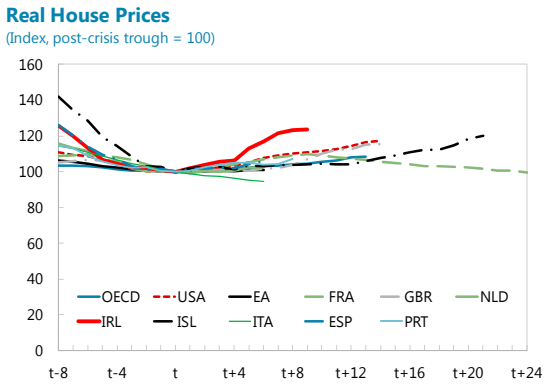
**31. The rebound in the Irish RRE market is more vigorous than in other OECD countries (Figure 8).** An international comparison reveals that Ireland has the most volatile RRE market: it had the largest boom and was also hit hardest during the crisis. Irish house prices are now returning from the post-crisis trough faster than in other OECD countries.[21]

[21] Note that house prices in Italy and Greece are still falling.

**Figure 8. OECD Countries: International Comparison of Real House Prices**



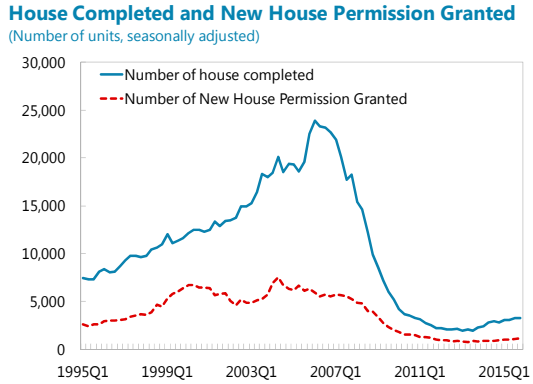

Sources: OECD; and IMF staff calculation.



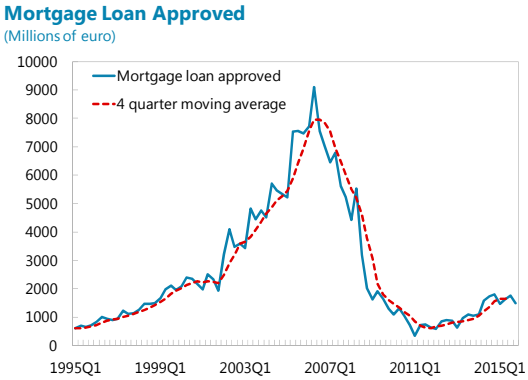

Sources: OECD; and IMF staff calculation.

**32. This price growth appears to be driven by factors such as supply shortages.** Housing construction is currently subdued, resulting in supply shortages, while it increased during the boom (Figure 9). The number of houses completed in 2015 was 12,666, well below the estimated 25,000 units required to meet household formation (CBI, 2015a; Duffy and others, 2014). Correlation between the annual house price growth and private credit growth was 0.67 before the crisis (1990–2007Q3), while the correlation after the crisis (2007Q4–2015Q3) dropped and reversed to -0.04. Mortgage loan approval has started to increase again since 2012H2, but its nominal amount is still below the pre-2000 level (Figure 9). Moreover, non-mortgage buyers play a significant role in the recent recovery, with about half of the transactions in cash (CBI, 2015b).

**Figure 9. Ireland: House Completion and Permission, and Mortgage Loan Approval**




Sources: Department of the Environment, Community and Local Government; and CSO

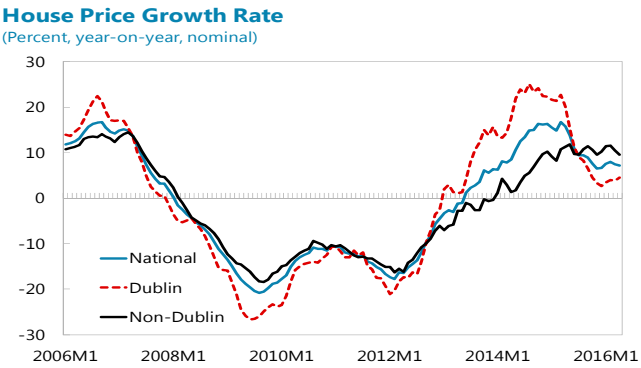



Sources: Department of the Environment, Community and Local Government; CEIC; and IMF staff.

**33. In the post-crisis period, there was a significant divergence in prices and market conditions across different regions in Ireland.** House prices in Dublin recovered earlier and about three times faster than in the rest of the country (Figure 10). The annual house price growth rate in Dublin reached 25 percent in August 2014, supported by strong rental growth in the face of limited new supply and weak construction activity. Expectations of further appreciation might also defer sales, contributing to housing shortages in Dublin.

**34. House price growth slowed to 6.6 percent (y-o-y) at end-2015, from 16 percent at end-2014.** The slowdown in the Dublin market has been more noticeable, with the growth rate falling back to 2.6 percent at end-2015. Market expectations for further increases have also moderated. In the 2015Q3 Central Bank of Ireland survey of residential property price expectations, the percentage of respondents expecting prices to rise across 1 quarter, 1 year, and 3 year-time horizons were 46, 82, 93 percent, respectively, down from 90, 97, and 98 percent, respectively, in 2014Q3 (CBI, 2015b).

**Figure 10. Ireland: House Price Growth Rate by Regions**

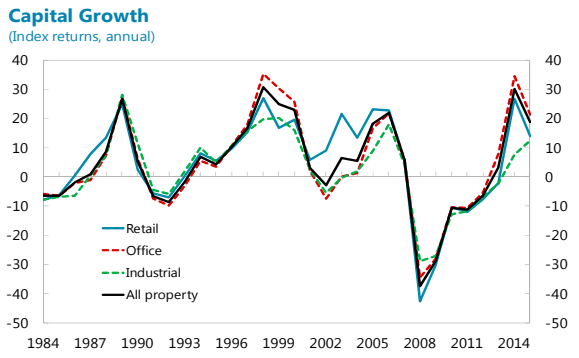



Sources: CSO; and CEIC.

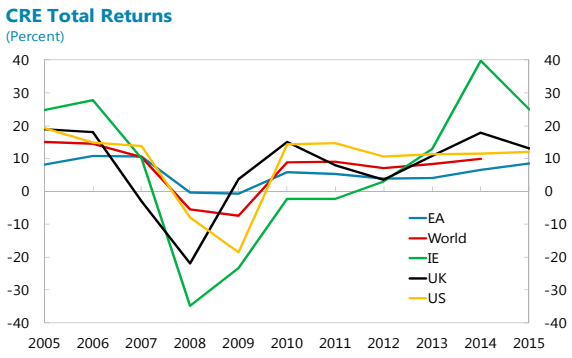
## Commercial Real Estate Market

**35. The CRE market has also been picking up strongly after plummeting from the pre-crisis boom.** Based on the MSCI Investment Property Databank (IPD), capital values grew by 30 and 19 percent (y-o-y) at end-2014 and 2015Q4, respectively (Figure 11). Rental values have also been increasing rapidly at above 14 percent (y-o-y) for the last four quarters, and are 41 percent higher than the trough in 2013. Performance in the Dublin office sector has been the most robust, and is now spreading beyond the capital. Capital values in the CRE sector have increased by 25 percent y-o-y since 2014Q2, the fastest growth since 1999.

**Figure 11. Ireland: Developments in the CRE Market[1]**




Source: IPD.




Sources: Central Bank of Ireland; and MSCI/IPD.

Note: 1/ Note that the data are a mix of annual and quarterly based on data availability. The last observation for Ireland, the U.K. and the U.S. are quarterly.

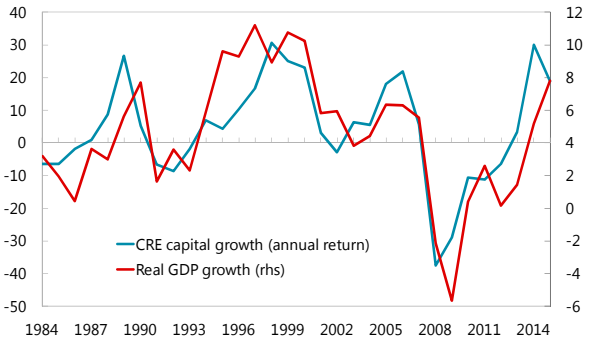
**36. Strong returns have attracted investors in the search for yield as interest rates remain low**. The Irish CRE market has been one of the best performing asset classes in Europe since 2014. Total returns for Irish CRE have outperformed other countries (Figure 11). Returns on 10-year Irish sovereign debt have trended to a twenty-year low and the spread between total returns for CRE and the long-term sovereign bonds reached approximately 8.5 percentage points.

**37. The favorable economic outlook has provided a boost to the CRE market recovery.** Investors have been encouraged by the broad-based improvement in domestic economic performance, which drove the rental growth in the office sector (text figure).

**38. The lack of new construction activity has contributed to the supply shortages (text figure).** While activities are slowly picking up, the level of CRE stock under construction fell dramatically between 2008 and 2014, reflecting the low profitability margins in an environment of depressed prices (early in the period); construction firms' stretched balance sheets and tighter lending standards by banks; and possibly other factors, such as the limited availability of suitable sites.

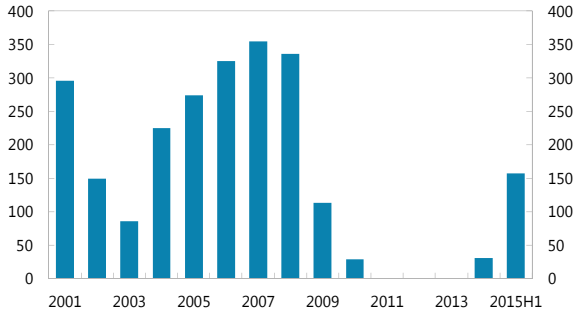
**39. The investor base has changed considerably since the crisis.** Unlike the pre-crisis period, the majority of investment activity is now being funded through foreign investors and equity funds, such as real estate investment trusts (REITs) (text figure).[22] Large foreign pension and insurance funds from the U.S., the U.K., and Germany have invested in the Irish CRE market, in part for balance sheet management, matching long-term liabilities with long-term assets. The attractiveness of Ireland as a leading destination for FDI has also increased demand for the CRE properties from multinational

**CRE Capital Growth vs Real GDP Growth**
(Percentage change y/y)



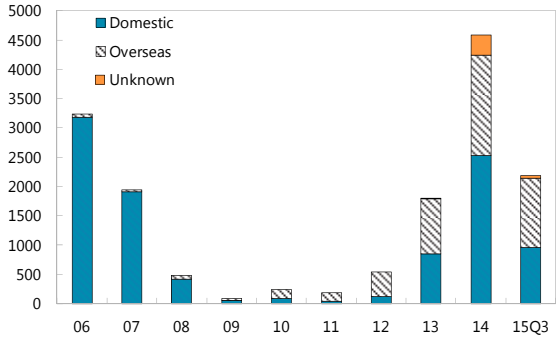

Sources: MSCI/IPD; and Central Statistics Office.

**Dublin Office Stock under Construction**
(Millions of square meters)




Sources: JLL.
Note: It is originally sourced from Figure 4 of Duffy, David and H. Dwyer (2015). In the paper, data are presented as square feet but converted to square meters here for consistency.

**CRE Investment Turnover by Type of Investors**
(Millions of euros)



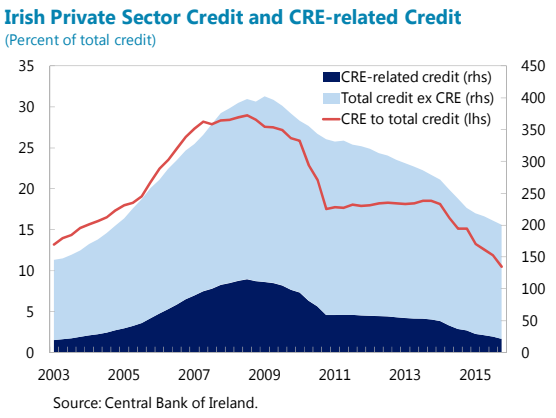

Sources: Central Bank of Ireland.

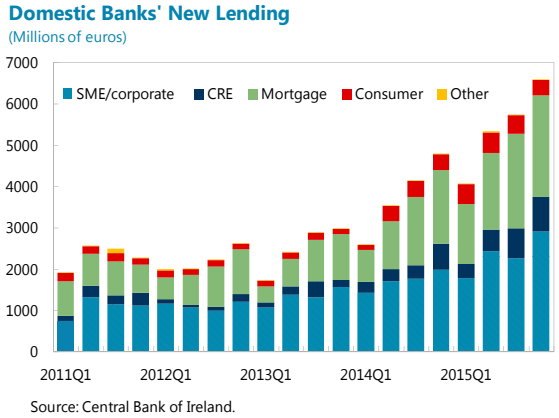
[22] Property funds such as REITs allow smaller investors access to the market and additional liquidity with listed funds offering equity securities that can be bought and sold during market hours and some unlisted funds willing to return investments at a month's notice.

companies. CBI (2015a) notes that while only 2 percent of the value of CRE transactions was from foreign investors in 2006, this figure was over 40 percent in 2014.

**40. Total outstanding balance of CRE loans has been decreasing, while the flow of new lending to CRE has slowly picked up.** Banks have reduced their exposure in the CRE market through the deleveraging process that occurred from 2009 to 2014. New bank financing to the CRE sector is slowly increasing, but new lending to CRE has been a minor component of total new lending volumes (Figure 12).

**Figure 12. Ireland: Outstanding Balance of Private Credit and New Loan Composition**




## C. Empirical Analysis of Price Misalignment in Real Estate Markets

**41. RRE and CRE prices in Ireland have been rising rapidly as shown in the previous sections due to various demand and supply factors, causing concerns about possible overvaluation and a build-up of new imbalances.** We employ several non-parametric and parametric methods in order to estimate a long-term trend or equilibrium price level and compare it with actual prices to test whether the two sectors are overvalued.

### Residential Real Estate Market

***Non-parametric approach: price-to-income and price-to-rent ratios***

**42. In view of the recent recovery, common measures of RRE valuation based on deviation from long-run historical trends, such as price-to-income and price-to-rent ratios, suggest that the market is neither undervalued nor overvalued in 2015Q2.** The two metrics show that there was an apparent overshooting in house prices before the crisis and a correction afterwards (text

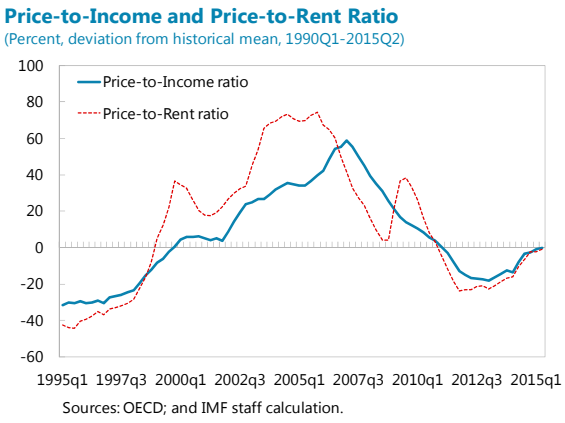
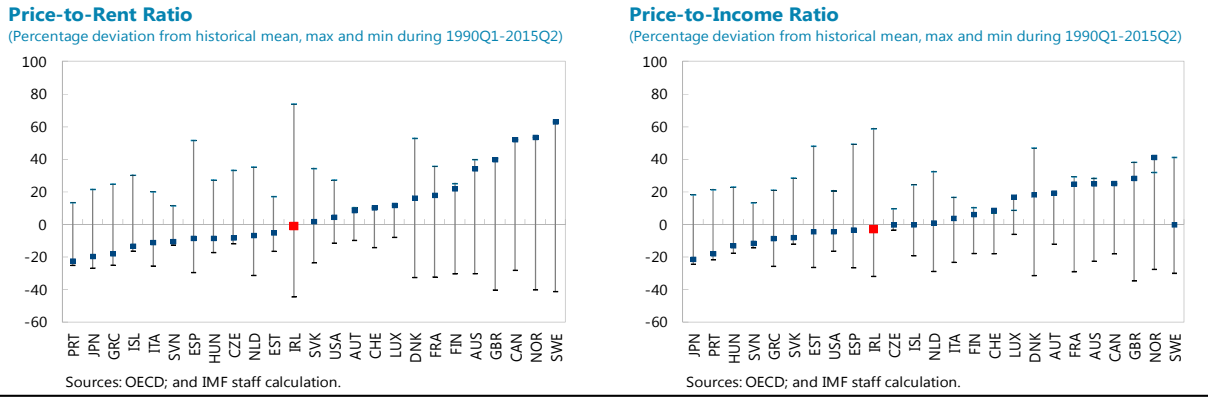


figure).[23] However, caution should be taken before confirming this result with more sophisticated methods, because absolute level of valuation depends on the length of the period for which the historical mean is calculated.

**43. An international comparison of the two metrics demonstrates that the deviation of Irish house prices from a long-term average is in the middle of the sample.** Both ratios in Ireland have been historically more volatile than ones in comparator countries. However, when compared with 25 OECD countries, using the price-to-rent ratio, Ireland does not stand out as an over- or underpriced market as of 2015Q2, and, in fact, is close to the middle of the distribution (Figure 13). Similarly, based on the price-to-income ratio, the Irish RRE market does not appear to be overvalued.

**Figure 13. OECD Countries: Price-to-Income and Price-to-Rent Ratios**




**44. It is worth focusing on RRE price developments since the introduction of macroprudential measures.** The Central Bank of Ireland imposed the proportionate limits on loan-to-value (LTV) and loan-to-income (LTI) ratios in February 2015. The aims were: (i) to strengthen the resilience of lenders and borrowers to financial shocks; and (ii) to reduce the risk of future credit and RRE price spirals.[24] It is still too early to properly evaluate the effectiveness of the measures. There is some evidence that these tools have had an effect in reducing price pressures, following very strong growth in 2013 and 2014. Moreover, market expectations for future house price increases have also moderated (expectation channel).[25]The 2015Q3 survey of RRE price expectations shows that the percentage of respondents

[23] These measures have proved useful in predicting financial stress (IMF, 2014b). The rationale is that house prices should rise in line with households' income, because a typical household will want to spend a constant portion of their income on housing; and that rents should be in line with house prices based on simple asset pricing models. A rise in these ratios above their long-run average can indicate that house prices may be exuberant.

[24] IMF (2014b) explains transmission mechanisms of two instruments in detail, such as credit demand channel, expectation channel, and resilience channel. The paper also shows how effective the two measures have been in other countries.

[25] For detailed description of the transmission channels of limits on LTV and LTI ratios, see IMF (2014b), "Staff Guidance Note on Macroprudential Policy-Detailed Guidance on Instruments" and Coates, Lydon, and McCarthy (2015)[26] See Appendix II for detailed information on the estimation results.

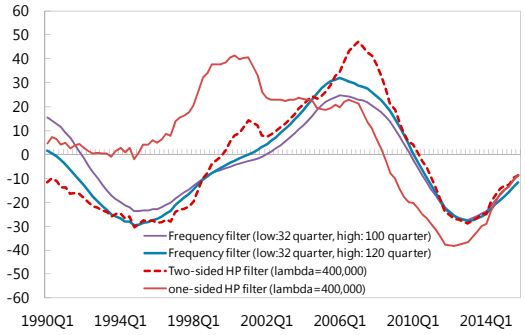
expecting prices to rise across 1 quarter, 1 year, and 3 year-time horizons were 46, 82, 93 percent, respectively, down from 90, 97, and 98 percent, respectively, in 2014Q3 (CBI, 2015a). House price growth rate had moderated to 6.6 percent (y-o-y) at end-2015, from 16 percent at end-2014.

***Parametric methods: statistical filters, error correction models, and Markov regime switching model[26]***

**45. A more analytical way of looking at the RRE valuation is to calculate the gap between the actual house prices and their predicted fundamental (equilibrium) level based on econometric models.** For this purpose, a broad range of models are used: (i) statistical filters; (ii) time-series approaches using economic fundamentals as explanatory variables (e.g., a vector error correction model (VECM) and an OLS regression with a pseudo error correction term); and (iii) a Markov regime switching model. It should be emphasized, however, that estimating equilibrium levels of house prices is still challenging and can be imprecise. Therefore, results should be interpreted with caution.

**46. Results with statistical filters suggest that house prices are somewhat undervalued by 9–10 percent (text figure).** One can assess where house prices are in a cycle without taking a view on whether the trend is driven by macro-financial factors. Using either one-sided or two-sided HP filter, Irish house prices are estimated to be about 9 percent below the trend.[27] Isolating a component of house prices that lies within an 8–30 year interval, longer than a business cycle, a band-pass filer suggests an undervaluation of about 10 percent.[28]

**House Price Valuation with Statistical Filters**
(Percent, deviation of actual prices from a trend)




Sources: OECD; and IMF staff calculation.

**47. Econometric models indicate that, as of 2015Q2, house prices were around the equilibrium level (Box 2).** Specifically, using quarterly data between 1990Q1 and 2015Q2:

[26] See Appendix II for detailed information on the estimation results.

[27] To estimate the gap between actual house prices and their trend, both one-sided and two-sided HP filters are applied with a high smoothing parameter (lambda=400,000). This is justified by the fact that financial cycles tend to be longer than business cycles.

[28] A full sample asymmetric band-filter is used, where the weights on leads and lags are allowed to differ. Because the house price index is non-stationary, it is assumed an I(1) unit root process with no detrending.

## Box 2. Summary of Econometric Model Specification

Several versions of vector or single error-correction models are used to estimate equilibrium levels of house prices on the period 1970Q1–2015Q2 (RRE market evaluation) and 1990Q1–2015Q3 (CRE market evaluation). Markov regime switching models with two or three states are estimated to identify boom-bust cycles in the two markets and find out where the current period stands in a new cycle. The data are compiled from various sources, such as the CBI, CSO, OECD, BIS, CEIC, and other sources, which are described in greater details in Appendix I. The data are deflated with GDP deflator or CPI index, and transformed into a long term.

- Vector error correction model:

$$Y_t = \sum_p A * Y_{t-p} + E_t$$
$$\text{and } \Delta Y_t = \Pi * E_{t-1} + \sum_i^{p-1} \Gamma_i * Y_{t-i} + \omega_t,$$

where $Y_t$ is a k-vector of endogenous non-stationary I(1) variables and $E_t$ and $\omega_t$ are vectors of white-noise innovations. $Y_t$ includes the log of the following variables: real house prices, real GDP per capita, real private credit, long-term interest rate (government bond yield), and real construction cost.

- Regression model with a pseudo error correcting term:

Following the approach in Igan and Loungani (2012), we set up

$$\Delta \ln hp_t = \alpha + \gamma * \ln PIR_{t-1} + \beta_1 * \Delta \ln gdp_t + \beta_2 * \Delta \ln cred_t + \beta_3 * Int_t + \beta_4 * \Delta \ln cost_t + \omega_t,$$

Where hp, PIR, gdp, cred, Int, cost denote real house prices, price-to-income ratio, real GDP per capita, real private credit, long-term interest rate (government bond yield), and real construction cost, respectively. $\omega_t$ are white-noises. Besides real GDP, other real-term variables are deflated with CPI index.

- Markov regime switching model (MRSM):

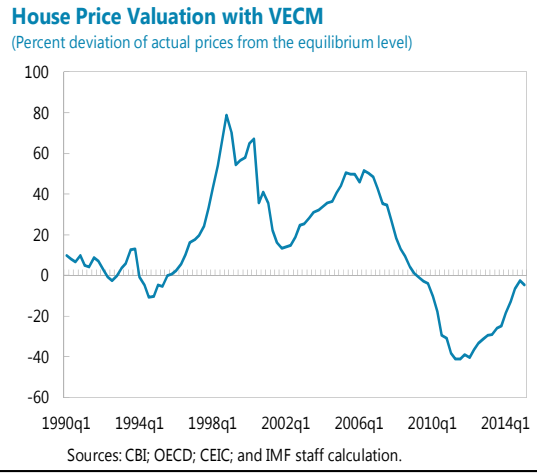
$$\Delta \ln hp_t = \alpha_{S_t} + \gamma_{S_t} * \ln PIR_{t-1} + \beta_1 * \Delta \ln gdp_t + \beta_2 * \Delta \ln cred_t + \beta_3 * Int_t + \beta_4 * \Delta \ln cost_t + \omega_{S_t},$$
$$\varepsilon_{S_t} \sim N(0, \sigma_{S_t}^2), \qquad S_t = 1, 2, \dots, k$$
$$P = \begin{bmatrix} p_{11} & \cdots & p_{1k} \\ \vdots & \ddots & \vdots \\ p_{k1} & \cdots & p_{kk} \end{bmatrix}$$

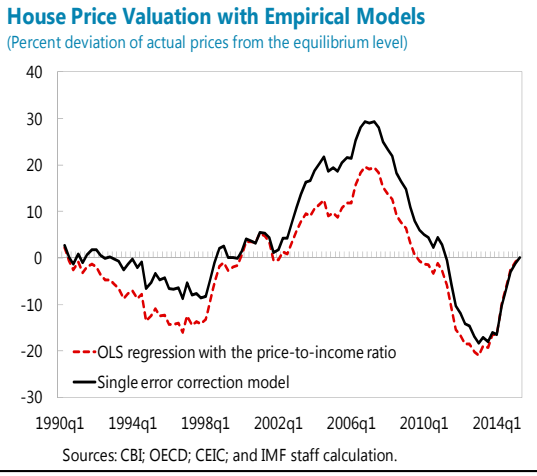
where k = 2 or 3 in the model specification and $p_{ij}$ controls the probability of a switch from state j to state i. For example, for a model with two regimes, a parameter vector $\theta = (\alpha_1, .\, \alpha_2, .\, \gamma_1, \gamma_2, \sigma_1^2, \sigma_2^2, p_{11}, p_{22})$ is estimated by maximum likelihood methods with Hamilton's filter. Two parameters, a constant term $\alpha_{S_t}$ and the coefficient of price-to-rent ratio $\gamma_{S_t}$, are allowed to change across two regimes ($S_1$ = high or $S_2$ = low) or three regimes ($S_1$ = high, $S_2$ = normal, or $S_3$ = low). Variance of the white noise term $\sigma_t^2$ is allowed to change over states only for residential real estate prices to let the maximum likelihood estimation converge. Perlin (2015) provides further information of the MRSM algorithm used in this note.

- Results from a VECM suggest that a negative house price gap opened up after the crisis but reduced to around -5 percent in 2015 (Figure 14). In the VAR and corresponding VECM, we use five endogenous variables: real house prices, real GDP per capita, real private credit, long-term interest rates (10-year government bond yield), and real construction costs. Because lag criteria and Johansen cointegration test support different model specifications, two specifications of the model are estimated and their results are averaged: one with three lags and two cointegration vectors and the other with two lags and three cointegration vectors. The estimated results show that Irish house prices have been volatile, moving away from the equilibrium level during the recent boom-bust cycle. Focusing on the recent period, the large negative house price gap that opened up right after the crisis has been closing quite rapidly to -5 percent; and

- Second, an OLS regression with the price-to-income ratio as a pseudo error correction term shows no over- or undervaluation in house prices (Figure 14). In the model, similar to the one in Igan and Loungani (2012), house prices depend on household affordability (price-to-income ratio), GDP per capita, private credit, long-term interest rates, and construction costs. The choice of these variables stems from the desire to capture both demand and supply factors.[29] The price-to-income ratio acts as a pseudo error correction term for an unsustainable deviation from the equilibrium level of house prices to normally stabilize by itself over the long run. This model specification yields R-squared of 36 percent and shows that the deviation from the equilibrium level is closed by 2015Q2. We also ran the model replacing the price-to-income ratio with an estimated error correction term from the long-run equation, yielding a very similar result and confirming the findings with the affordability indicator.

**Figure 14. Ireland: Evaluation of RRE Prices with Econometric Models**



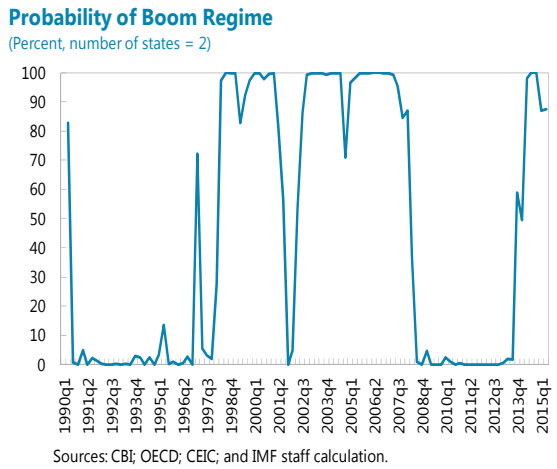



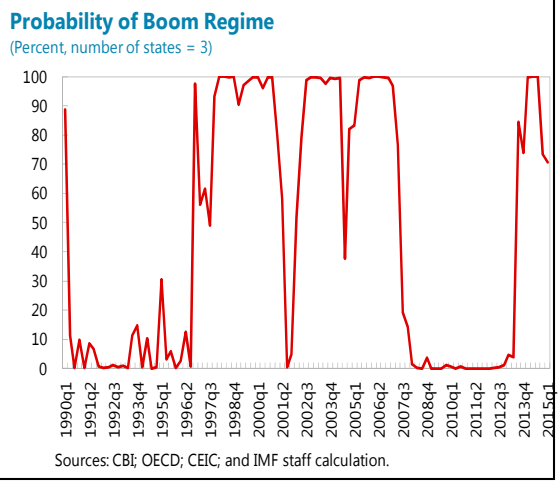

[29] All variables are in real term. As a supply factor, we include house construction costs. The number of houses completed is also considered as a variable, but its movement appears to be led by demand factors and house price dynamics during the recent boom-bust cycle, as shown in a Granger causality test, not the other way around. Hence, we do not include it as one of the explanatory variables in the model specification.

**48. Markov regime switching model (MRSM) analysis suggests that the probability of being in a high growth regime (boom) increased in 2013–14, but dropped at the beginning of 2015 (Figure 15).** The Markov regime switching model allows three parameters of the OLS regression with the price-to-income ratio as a pseudo error correction term to change between two regimes (high or low), considering that economic agents would behave differently along the boom-bust cycle. In this MRSM, three parameters (the constant term, the coefficient of the error correction term, and the variance of the white noise) can switch between two regimes.

**49. Results suggest that the MRSM specification appears to capture the dynamics of house prices well.** Most parameters are statistically significant and with the expected sign and size. Especially, the error correction speed is slower in the "high" regime than in the "low" regime, as expected. The high regime has occurred for half of the sample period, and its expected duration is estimated to be four years (16 quarters). Two booms in 1998–2001 and 2002–07 stand out markedly, and one reappeared in 2014. The MRSM with three regimes (high, normal, or low) confirms the findings with two regimes as shown in the following figure. The probability of a high regime in both specifications started to decrease in 2015 (Figure 15).

**Figure 15. Ireland: Evaluation of House Prices with Markov Regime Switching Models**




***Summary***

**50. Non-parametric and parametric analyses suggest that Irish REE prices are currently around equilibrium levels.** Prices rebounded during 2013–14, but the pace started to slow at the beginning of 2015. Recent data show that the newly introduced macroprudential measures on mortgage loans may have started to have some impact via the expectation channel.[30]

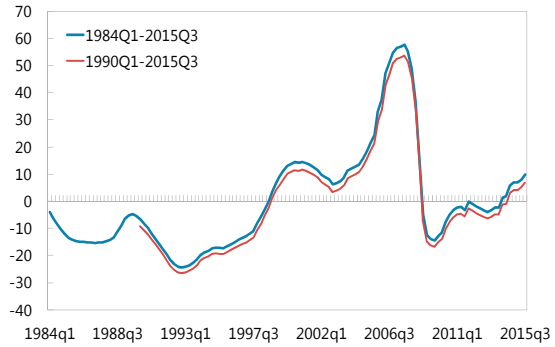
[30] As shown in IMF (2014a) and Hallissey and others (2014), the two tools will complement each other in reducing probability of defaults for borrowers and loss given defaults for lenders. LTI limits reduce the probability of defaults and LTV limits without a complementary role of LTI limits could leave borrowers' capacity to service their mortgages vulnerable to income shocks. LTV caps bolster borrowers' resilience to house price shocks by increasing the equity in the

## Commercial Real Estate Market

### *Non-parametric method: price-to-rent ratio*

**51. The deviation from a long-term trend of the price-to-rent ratio suggests that the CRE sector was moderately overvalued as of 2015Q3 (text figure).**[31] The metric show that the CRE prices were also exuberant before the crisis, growing significantly above the rental yield. The adjustment after the crisis was higher than that in the RRE market. From 2014, the ratio breached the historical average again. As mentioned above, the absolute level of overvaluation depends on the choice of the period over which the historical average is calculated.

**CRE Price-to-Rent Ratio**
(Percent, deviation from historical mean)

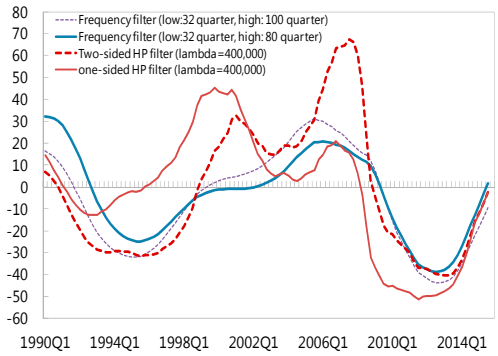



Sources: CBI; and IMF staff calculation.

### *Parametric methods: statistical filters, error correction models, and Markov regime switching model* [32]

**52. Results from HP and Band-pass filtering show that CRE prices are near the long-run statistical trends (text figure).** Using either one-sided or two-sided HP filter, Irish CRE prices are estimated to be close to the trend. Isolating a component of house prices that lies within an 8–20 year interval, longer than a business cycle, a band-pass filer show that, as of 2015Q3, CRE prices were close to the equilibrium level in the range of +2 percent, while a frequency filter, which extracts components within an 8–25 years interval, indicates 8 percent of undervaluation.[33]

**CRE Price Valuation with Statistical Filters**
(Percent, deviation of actual prices from a trend)




Sources: CBI; and IMF staff calculation.

residential property and LTI caps without LTV measures could leave lenders highly exposed to severe house price shocks, as occurred in Ireland after 2008.

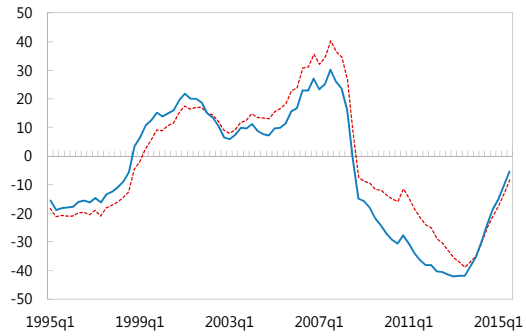
[31] Price-to-income ratio in the CRE sector is not available. The latest price-to-rent ratio is only slightly higher (19.6) than one at 2015Q3 (19.4), and thus results would be similar to those shown in this subsection.

[32] See Appendix II for the estimation results.

[33] Similar to the estimation of statistical trends of house prices, a full sample asymmetric band-filter is used, where the weights on leads and lags are allowed to differ. Because the CRE price index is non-stationary, it is assumed an I(1) unit root process with no detrending. Because the length of the latest boom-bust cycle of CRE prices was shorter than one of RRE prices, we use 8–20 or 8–25 years as the interval, instead of 8–30 years.

**53. Econometric models indicate that CRE prices are marginally undervalued in the range of 5–8 percent (text figure).**[34] In the error correction models, similar to the one used in the previous section and O'Brien and Woods (2015), CRE prices depend on economic activity (GDP), credit availability, and long-term interest rates in the long-run equation, and the CRE price growth rate is explained by an estimated residual from the long-run equation (or the price-to-rent ratio), a change in interest rates, and the growth rate of GDP and credit.[35] Using quarterly data between 1990Q1 and 2015Q3, the long-run equation yields a good R-squared of 74 percent, while R-squared for the short-run equation is 30 percent. A few other variables were tested as part of independent variables. For example, FDI inflows were included among the explanatory variables, but turned out to be unimportant (statistically insignificant). It is not surprising if one considers that foreign investors were mostly not major direct players in Irish CRE markets before the crisis, and FDI includes mainly investment outside the CRE sector.

**CRE Price Valuation with Error Correction Model**
(Percent deviation of actual prices from the equilibrium level)




Sources: CBI; CEIC; and IMF staff calculation.

**54. Similar results were obtained using an alternative specification.** In addition to an estimated residual from the long-run equation, the price-to-rent ratio is also used as a pseudo error-correction term in a model specification, because any exuberant growth of CRE prices beyond the rental value cannot be sustainable and would stabilize by itself over the long run. Results from the two specifications show that there was a large boom-bust cycle before and after the crisis, but the post-crisis "negative" deviation has been rapidly closing from 40 to 5–8 percent in a two-year horizon by 2015Q3.

**55. Analyses with Markov regime switching models (MRSM) suggest that CRE markets entered into a high regime probability in the second half of 2013, which can be an early warning signal of another prolonged boom as shown in the last cycle.**

- Two regimes (high or low): The latest boom-bust cycle in the CRE market lasted for 20 years, which is longer than a normal business cycle (Figure 16).[36] The cycle started around 1993 and ended at 2013. The boom period almost coincided with one in the RRE market. The estimated transition matrix shows that there is a long swing in the CRE market. That is, once the CRE market enters into a high regime, it tends to stay in the regime for a while: the expected duration of the high regime is

[34] The model specification is similar to the one in house price valuation models. The house construction cost is removed from the list of independent variables. We also estimate vector error correction models with different lags and a number of cointegration vectors, but find that they do not capture the dynamics of CRE prices well.

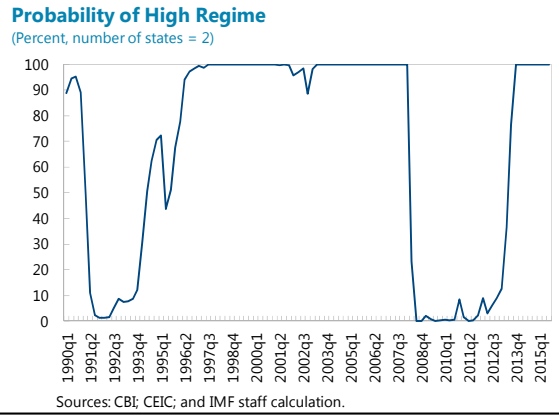
[35] Unfortunately, a long time-series of CRE supply factors is unavailable.

[36] The maximum likelihood estimates show that the two regimes differ not only in the constant term, but the error adjustment speed as well.

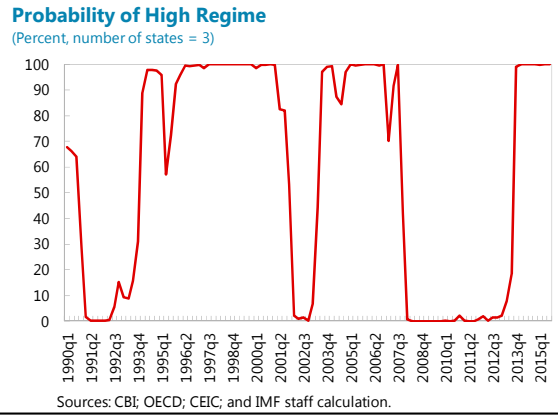
estimated to be over nine years (33 quarters). The boom regime has occurred about 65 percent of the sample period 1990–2015, longer than the bust regime.

- Three regimes (high, normal, or low): The MRSM with three regimes appears to capture dynamics of the CRE market better than one with two regimes. It detects a temporary slow-down period between two high growth periods during 1993–2007. It also hints a recent "pick-up" of CRE prices in recent years, which was an early warning signal of a prolonged boom in the last cycle (Figure 16).

**Figure 16. Ireland: Evaluation of CRE Prices with Markov Regime Switching Models**




Sources: CBI; CEIC; and IMF staff calculation.




Sources: CBI; OECD; CEIC; and IMF staff calculation.

***Summary***

**56. The mixed signals on the valuation of current CRE prices obtained from the non-parametric and parametric analyses point to the need for vigilance.** While error correction models suggest a marginal undervaluation, the price-to-rent ratio and the MRSMs indicate an early warning of an incipient new boom period. Such mixed results are common but do point to the possibility of an emerging risk. Therefore, it is necessary to monitor the market and assess the need for action, close data gaps, review the available toolkit, and be ready for immediate policy actions.

## D. Conclusion and Policy Implications

**57. It would be important to rigorously evaluate the effectiveness and examine policy leakages of the two instruments with the new wave of loan-level data.** We welcome the Central Bank of Ireland's analytical framework to assess the effectiveness of the instruments in achieving their stated objectives. The new mortgage loan data will allow the Central Bank to test the framework and produce a comprehensive evaluation report. The authorities will also need to investigate if there has been any policy leakage or violation, for example where the provision of credit migrates from mortgage loans to unsecured consumer loans.

**58. Close surveillance is needed to evaluate the early signals of a build-up of new imbalances in the commercial real estate markets.** Even if different approaches send mixed signals regarding the overvaluation of CRE prices, it is undeniable that the recent CRE price growth rate has been high. Higher CRE asset valuations may help banks improve their balance sheets with higher recovery rates on the

previously defaulted CRE loans. Yet, FDI inflows or equity funding like REITs can easily reverse if market sentiment changes, which could lead to a sharp drop in CRE values. Lenders with remaining exposures could face another hit from a collapse of collateral values via financial "decelerator" mechanisms, as observed in the post-crisis period. In addition, even if the flow of new CRE loans is a minor component of total new lending, it can continue to pick up. The ongoing intensive monitoring of CRE lending by the Central Bank of Ireland is hence welcome.

**59. The authorities should enhance data collection and continue to allocate sufficient resources for CRE market analyses.** The Central Bank of Ireland staff has made efforts to improve analyses on CRE market developments, which will need to continue with a support of sufficient resource allocation. In this regard, the mission welcomes the latest announcement that the Central Bank of Ireland and NAMA will co-fund the development of a CRE statistical system by 2018, which will be maintained by the CSO and give detailed information on sales and lease transactions, and construction activities, such as permissions, commencements, and completions.

# HOUSEHOLD SECTOR ANALYSIS[37]

## A. Introduction

**60. The legacy of the financial crisis left behind household debt overhang in Ireland, but the process of balance sheet repair has begun.** As the real economy experiences recovery and employment improves, the level of household debt has decreased in recent years. Due to the improving economy and ongoing resolution efforts, the overall number and volume of mortgage arrears have maintained a downward trend since 2013Q4.

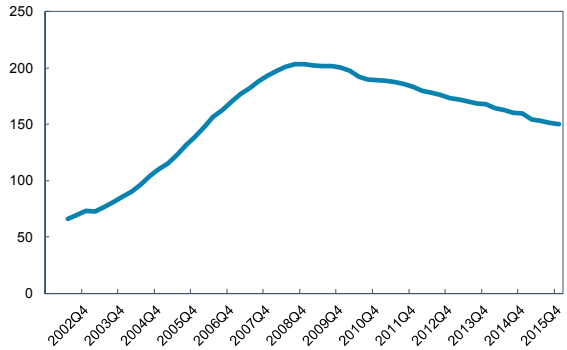
**61. Despite progress on arrears resolution, some segments are still vulnerable to domestic and external shocks.** As of December 2015, fifteen percent of Primary Dwelling House (PDH) and 23 percent of Buy to Let (BTL) mortgages remained in negative equity, notwithstanding a recent recovery of house prices (Central Bank of Ireland, 2015a). A majority of mortgage loans is on either tracker rates or standard variable rates.[38] External macro-financial risks are broadly on the downside with weak euro area growth and a possible reversal of the global search for yield. Stresses—triggered by a rapid increase in interest rates, a halt of recovery in the real economy and labor market, a sharp decline in real estate prices, or a combination thereof—can have a significant impact on the financial sector via intricate inter-sectoral financial interlinkages. Understanding how fragile the household sector would be against shocks is key to securing a robust recovery and financial stability in Ireland.

**62. The rest of the paper is outlined as follows.** Section II reviews the current state of household balance sheets using aggregate data. Section III assesses the vulnerability of the Irish household sector and its financial resilience to the FSAP stress test scenario, using loan-level data and the loan-loss forecasting model developed by the Central Bank of Ireland. Section IV concludes and considers policy options to address current and potential vulnerabilities.

## B. Recent Developments in Household Indebtedness and Vulnerabilities

**63. Households have deleveraged and debt sustainability improved (text figure).** During 2008Q3–2015Q4, household financial assets increased by 20 percent from €294 billion to €355 billion, and household debt fell by 27 percent from €204 billion (the previous peak) to €150 billion. Unlike the pre-crisis period, the household sector became a net lender in 2009 and has kept this status since then (text figure).[39]

**Ireland: Household Debt**
(Billions of euro)




Source: Central Bank of Ireland.

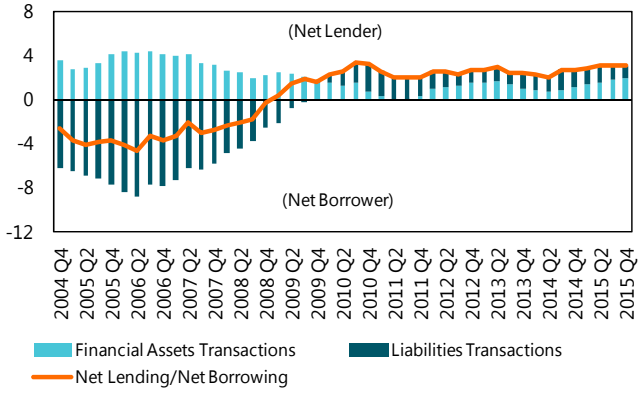
[37] This Chapter of the Technical Note was prepared by Heedon Kang, Monetary and Capital Markets Department, and Fergal McCann (Central Bank of Ireland), in the context of the 2016 Ireland Financial Sector Assessment Program.

[38] A tracker mortgage is a special type of variable-rate mortgage loan that is indexed to the ECB or Euribor rate with a fixed margin.

[39] A sector is a net lender if the transaction of financial assets is larger than that of financial liabilities.

Households' debt-to-disposable income ratio decreased from 215 percent in 2011Q1 to 155 percent in 2015Q4, and debt as a proportion of total assets decreased from 28 percent in 2012Q1 to 19 percent in 2015Q4 due to the deleveraging, as well as a rise in disposable income and total assets, supported by economic recovery and employment growth (Box 3).

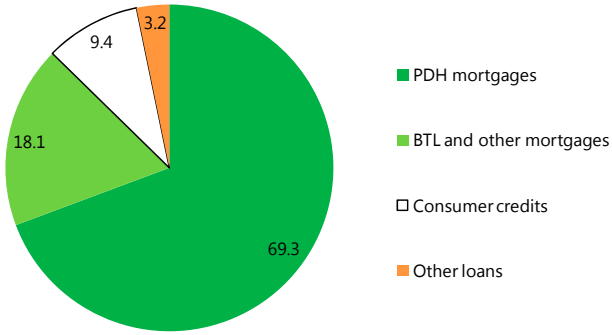
**Household Financial Assets and Liabilities Transactions**
(Billions of euros)




Source: CBI.

**64. Two main components of household debt, mortgage loans and consumer credits, have declined from their peak in 2009Q1 (text figure).** The growth rate (q-o-q) of mortgage loans, which account for almost 90 percent of total household loans, was minus 1.1 percent on average during 2009Q2–15Q3, and that of consumer loans was -3.3 percent in the same period.[40] The deleveraging happened in both of the two subcomponents of mortgage loans, PDH and BTL loans, while the pace of negative growth in the PDH market has declined in recent quarters. New mortgage loan approval has started to increase again since 2012H2, but its nominal amount is still below the pre-2000 level.

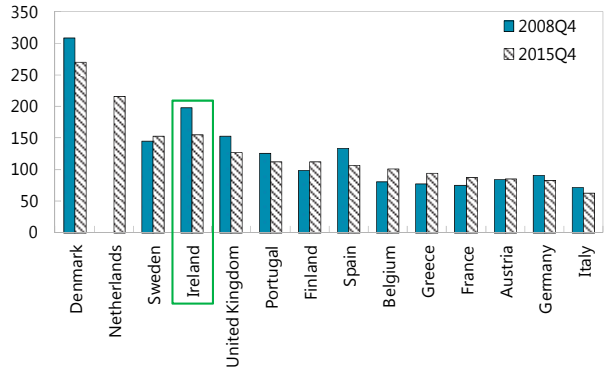
**Composition of Household Loan**
(Percent of total household loan, as of 2015Q3)




Source: CBI; and IMF staff calculation.

**65. However, households are still highly indebted.** The outstanding balance, however stood at €150 billion in 2015Q4 (155 percent of household disposable income and 70 percent of nominal GDP). As shown in a text figure, the Irish household debt-to-disposable income ratio is one of the highest in Europe (text figure). The NPL ratio has declined from the post-crisis peak (25.6 percent in 2014Q1), but remains at a high level (20.2 percent in 2015Q4).

**Household Debt-to-Disposable Income**
(Percent of gross disposable income)



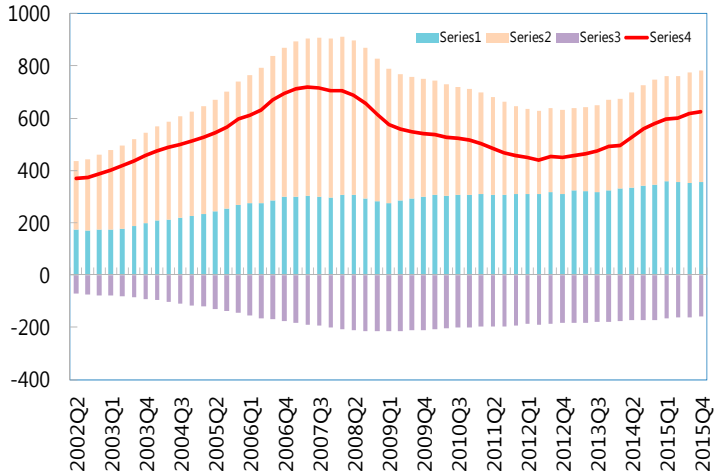

Sources: ECB; and Haver Analytics.

[40] Consumer loans include credit cards, auto loans, and unsecured personal loans.

### Box 3. Ireland: Household Net Worth

After a large swing, household net worth started to increase again in recent years (text figure). It is still 13 percent lower than the previous peak at 2007Q2, but amounted to about three times nominal GDP as of 2015Q4. It declined by 60 percent during 2008–12Q2, but has increased by about 41 percent from the lowest level (€444 billion) in 2012Q2. The recent increase reflects not only the deleveraging process in the sector, but also a strong increase of housing asset values. The housing asset values have increased by more than 36 percent since 2013, as house prices strongly rebound.

**Dynamics of Household Balance Sheet Components**
(Billions of euro)




Source: CBI.

**66. A vast majority of mortgage loans (about 91 percent) have variable interest rates, and thus most households with mortgages are vulnerable to an increase in interest rates.** As of 2015Q3, tracker loans and standard variable rate (SVR) loans accounted for 50.4 percent and 40.1 percent of total mortgage loans, respectively, while the share of loans with fixed rates over 1 year was only 7.5 percent (Table 8). Interest rates on existing tracker mortgages are current very low (about 1 percent), reflecting the ECB's accommodative monetary stance. The average interest rate on SVR loans, where banks have more flexibility to set rates in line with market conditions, was 3.96 percent at 2015Q4 (CBI, 2016). If rates rise, interest payments will increase and thus some households will have difficulty servicing their debt.

### Table 8. Ireland: Mortgage Loans by Types of Interest Rates and Associated Interest Rates

Rate Types Market Share, Percent, as of 2015Q3

| | Standard Variable Rate | Tracker | Fixed less than 1 year | Fixed over 1 year | Sum |
|---|---|---|---|---|---|
| PDH | 34.1 | 36.7 | 1.9 | 7.3 | 80.0 |
| BTL | 6.0 | 13.7 | 0.0 | 0.2 | 20.0 |

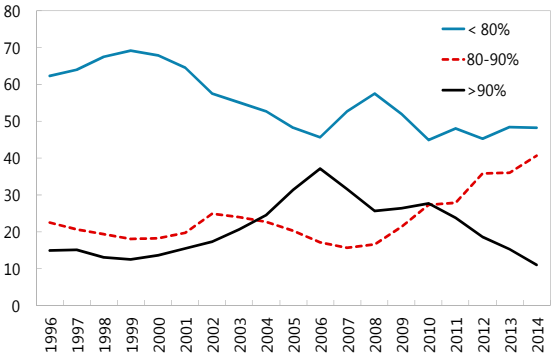
Interest Rates, as of 2015Q4

| | Standard Variable Rate | Tracker | Fixed 1 to 3 years | Fixed Over 3 year |
|---|---|---|---|---|
| PDH | 3.96 | 1.07 | 3.83 | 3.79 |
| BTL | 4.61 | 1.1 | 4.68 | 4.29 |

Source: CBI Household Credit Market Report 2016H1.

**67. A sizable share of mortgage loans remains in negative equity.**[41] 10 percent of PDH loans were in negative equity and performing and 5 percent of PDH loans were in negative equity and non-performing at end-2015. On the other hand, for BTL loans, 12 percent were in negative equity and performing and 11 percent were in negative equity and non-performing in the period. Negative equity is a well-documented cause of default (Lydon and McCarthy, 2011; Kelly and O'Malley, 2016). Even if the share of new loans with high loan-to-value (LTV) ratios decreased significantly during the post-crisis period, the large share of mortgage loans originated with high LTV ratios before the crisis continue to be a cause of concern in Ireland.[42]

**Distribution of Originating Loan-to-Value Ratio**
(Percent of new lending in each year)




Source: CBI.

**68. Arrears remain high in mortgage loans, and are increasingly prolonged despite a progress in restructuring distressed mortgages over recent years.** The number and volume of mortgage arrears has fallen by about 36 percent and 35 percent since 2013Q3, respectively. Yet, the share of arrears in the greater-than 720 days-past-due category continues to rise, accounting for about 85 percent of total arrears as of 2015Q4.

**69. The aggregate picture can mask large variations in financial soundness across households.** The CBI (2015c) shows that 43 percent of Irish households do not hold any debt, and the debt burden faced by indebted households varies substantially across different segments of households. In particular, indebtedness is a particularly heavy burden for younger cohorts (34–45 age group). One needs to know which segments of households (e.g., the young, BTL borrowers, etc.) are vulnerable to shocks. The burden of the debt overhang is unevenly distributed across different groups of households, and thus detailed loan-level information of vulnerable segments would be useful to design and select targeted policy measures.

[41] Negative equity means that current LTV ratio is greater than 100.

[42] CBI (2015b) introduced differentiated LTV limits for different categories of buyers to minimize distortions. For primary dwelling homes (PDHs), lower LTV limits (80 percent) apply to non-first-time home buyers (FTBs). For FTBs of PDHs, a 90 percent LTV limit applies to the first €220,000 of the value of the property, and a limit of 80 percent is imposed on the value of the property above this threshold. The amount of mortgage loans for PDHs above these limits should not exceed 15 percent of total PDH loans of a credit institution by the end of each year. A 70 percent LTV limit is applied to new Buy-to-Let (BTL) mortgage loans, which should be exceeded by no more than 10 percent of the total amount of BTL loans of a lender in a year. The CBI imposes an LTI limit of 3.5 times gross annual income to new PDH mortgage loans, which should not be exceeded by 20 percent of total amount of PDH loans of a lender in a year. There were exceptions: the LTV limit does not apply to switcher mortgages or loans for the restructuring of mortgage arrears, and the LTI limit is not imposed on BTL loans. The "proportionate" limits, which are also used in New Zealand, allow some flexibility (part of new lending above the limits) while maintaining prudent lending standards.

## C. Simulation Analyses of Probabilities of Default in Household Sector

***Methodology and Data***

**70. In this section, the Central Bank of Ireland's internal Loan Loss Forecasting (LLF) models with loan-level data are used to assess vulnerabilities across the Irish household sector.** These models have been in usage since 2011 both for stress tests and research purposes. The models combine an approach—jointly computing probability of default (PD), exposure at default (EAD), and loss given default (LGD)—where any set of house price, interest rate and unemployment rate scenarios can be applied to the population of mortgages at the Bank of Ireland (BOI), Allied Irish Bank (AIB), Educational Building Society (EBS, now merged with AIB but a distinct entity at the date of origination of many mortgages in the sample), and Permanent TSB (PTSB).

**71. The sample amounts to 515,210 mortgage loans in Ireland, totaling €78 billion and 68.4 percent of total mortgage loans at end-2014.**[43] Table 9 reports the composition of the sample under study. 72 percent of the loans in the sample are outside Dublin; the vast majority are PDH loans (85 percent); Previous Owner mortgages represent 60 percent of the sample, as opposed to 40 percent for First-Time Buyer (FTB) mortgages; the most common age categories are between 35–44 and 45–55; 45 percent of loans have LTV of below 60, with over twenty percent being in negative equity; most loans have variable interest rates, with 51 percent on tracker contracts and 41 percent on SVR loans.

**72. The framework and mechanics behind the LLF are outlined in detail in Gaffney and others (2013) and Kelly and O'Malley (2016).** For the purposes of the current analysis, only the PD module of the model is utilized. This module applies the coefficients of a Multi-State Model (MSM, see Jackson (2011) for methodological detail) to the following set of explanatory variables: bank, interest rate, current LTV ratio, regional unemployment, interest rate type, BTL status, and loan age (and its natural logarithm). The model then calculates a loan-level PD and Probability of Cure (PC) for each loan depending on their values as of December 2014 and the stress test scenario values for interest rates, unemployment and house prices, which affect the loan-level interest rate, regional unemployment and loan-level LTV ratio, respectively. The model calculates PD and PC over a three-year horizon from December 2014, as reported in all charts in this section.

[43] This sample relates to "primary loans" only, meaning that only one mortgage per household is considered.

**Table 9. Ireland: Sample Composition of Residential Mortgages in December 2014**

| | All Loans | PDH Only |
|---|---|---|
| Non-Dublin | 72.3 | 72.4 |
| Dublin | 27.7 | 27.6 |
| PDH | 84.6 | |
| BTL | 15.4 | |
| Previous Owner | 60.4 | 56.8 |
| FTB | 39.6 | 43.2 |
| Age Under 35 | 9.6 | 10.7 |
| Age 35-45 | 37.7 | 40.0 |
| Age 45-55 | 31.5 | 30.7 |
| Age 55-65 | 16.3 | 14.6 |
| Age 65-75 | 4.0 | 3.1 |
| Age 75+ | 1.0 | 0.9 |
| Current LTV Under 60 | 45.0 | 47.2 |
| Current LTV 60-70 | 8.3 | 8.5 |
| Current LTV 70-80 | 8.5 | 8.6 |
| Current LTV 80-90 | 8.7 | 8.6 |
| Current LTV 90-100 | 6.7 | 6.5 |
| Current LTV 100-120 | 10.9 | 10.0 |
| Current LTV 120-150 | 9.4 | 8.7 |
| Current LTV 150+ | 2.5 | 1.9 |
| Fixed | 7.3 | 8.2 |
| SVR | 51.1 | 53.7 |
| Tracker | 41.7 | 38.1 |

Sources: IMF; and CBI in collaboration with the ECB.

***Opening position: default stocks at December 2014.***

**73. There are two distinctive aspects to household financial vulnerability that can be measured with the data.** Firstly, one can observe "backward looking" vulnerability by calculating the "opening stock" of non-paying loans across segments of the market, and secondly, one can observe "forward looking" vulnerability by predicting the probability of default over a three-year horizon for those loans still fully paying at end-2014. In all cases default rates are reported on a count basis rather than the balance-weighted default rates more familiar to banking and stress testing practitioners. This is because the current analysis is focused on vulnerability across households, rather than across monetary volumes of mortgages. Table 4 focuses on the "backward looking" measure of vulnerability by showing how defaults are distributed across the Irish mortgage market at end-2014.

**74. The value in exploring the heterogeneity underlying the headline default stock in the Irish mortgage market is clear from Table 11.** Many of these patterns have previously been highlighted in regression analyses by McCarthy (2014) and Kelly and O'Malley (2016).

- Small differences in default propensity are uncovered across geography (where Dublin mortgages are less likely to default), FTB status (where previous-owners are more likely to default, in line with the findings of Kelly and others (2014)), and across the originating income distribution (where higher-income households are less likely to default, particularly when excluding BTL loans);

- A much starker default differential is shown when comparing PDH to BTL loans, with the latter loans for investment purposes having a default stock that is double that in the owner-occupier segment (26.4 percent vs. 12.4 percent);

- The age distribution also exhibits important differences, with default rates on existing loans increasing with age (excluding the 75+ category, which only accounts for 1 percent of mortgages, and where it is possible that borrowers have acted as guarantors for younger borrowers). Mortgages where the primary borrower is between 65 and 75 years of age have a default stock of 16.6 percent, while those under 35 years of age have default stock of 9.9 percent when BTL mortgages are excluded. This pattern partially reflects the relationship between borrower age and the housing and credit cycles: for those under 35, fifty percent have had their mortgage originated since 2010, by which point banks' credit standards had tightened considerably, and housing values had already begun to collapse. Of those in the 65–75 category, on the other hand, 67 percent originated between 2003 and 2008, the years in which house prices were at their most overvalued, credit standards at their most liberal in Ireland (Kelly and others, 2015) and equity release or "top up" loans at their most prevalent;

- The distribution of default across the LTV categories highlights stark differences in default propensity. In the PDH segment, loans with an LTV under 90 generally have default stocks between 7 and 11 percent. However, in the categories in negative equity, default stocks rise from 20 percent to 27 percent to 70 percent for loans between 100–120, 120–150 and 150+ LTV ratio; and

- Finally, fixed rate loans are shown to have a far lower default propensity (4.6 percent) than variable rate mortgages (14 percent among SVR and 11.9 among tracker mortgages).

**Table 10. Ireland: Default stocks by Loan Group**
(Percent, at end-2014)

| | All Loans | PDH Only |
|---|---|---|
| Total | 14.6 | 12.4 |
| Non-Dublin | 15.2 | 13.0 |
| Dublin | 13.1 | 11.0 |
| PDH | 12.4 | n/a |
| BTL | 26.4 | n/a |
| Previous Owner | 14.5 | 13.4 |
| FTB | 11.3 | 11.2 |
| Age Under 35 | 10.0 | 9.9 |
| Age 35-45 | 12.1 | 11.5 |
| Age 45-55 | 14.0 | 12.9 |
| Age 55-65 | 14.5 | 13.6 |
| Age 65-75 | 17.2 | 16.6 |
| Age 75+ | 10.6 | 8.7 |
| Current LTV Under 60 | 7.5 | 7.0 |
| Current LTV 60-70 | 10.3 | 9.3 |
| Current LTV 70-80 | 11.5 | 10.1 |
| Current LTV 80-90 | 12.9 | 10.8 |
| Current LTV 90-100 | 16.9 | 14.6 |
| Current LTV 100-120 | 22.8 | 19.6 |
| Current LTV 120-150 | 31.2 | 26.7 |
| Current LTV 150+ | 68.1 | 70.0 |
| Fixed | 5.1 | 4.6 |
| SVR | 15.8 | 14.0 |
| Tracker | 14.7 | 11.9 |

Source: CBI. All default rates are on an unweighted count basis.

***Forward-looking vulnerability analysis under FSAP macroeconomic scenarios***

**75. To assess the vulnerability of Irish households to macroeconomic shocks, the baseline and adverse scenarios agreed for the purposes of the FSAP by the Irish authorities and the Fund are used.** The stress test scenarios are reported in Table 11. These scenario inputs feed directly into the LLF's framework to affect the interest rate, LTV and regional unemployment rate *of each loan*, which then lead to an updated PD and PC distribution being calculated for three years. Given that the LLF utilizes opening Loan Level Data from December 2014, the actual or estimated values for 2015 are used, along with scenario values for 2016 and 2017 to calculate a three-year PD.

**Table 11. Ireland: Stress Test Scenarios**

| Macroeconomic indicators | | Baseline scenario | | | Adverse scenario | | |
|---|---|---|---|---|---|---|---|
| | 2015 (est) | 2016 | 2017 | 2018 | 2016 | 2017 | 2018 |
| Real GDP growth | 5.8 | 4.7 | 4.0 | 3.0 | 1.1 | 0.3 | 0.1 |
| Unemployment rate | 9.5 | 8.5 | 7.8 | 7.2 | 9.6 | 10.5 | 11.2 |
| Short-term interest rate (3 month Euribor) | 0.0 | 0.0 | 0.1 | 0.4 | 0.8 | 0.9 | 1.2 |
| Long-term interest rate (10 year Irish government bond) | 1.3 | 1.7 | 2.3 | 3.3 | 3.2 | 5.3 | 7.9 |
| HICP growth | 0.3 | 1.5 | 1.9 | 1.6 | 0.5 | 0.3 | -0.7 |
| Residential property prices | 6.5 | 7.5 | 6.7 | 5.1 | -5.0 | -5.0 | 0.0 |
| Commercial property prices | 21.8 | 10.3 | 4.2 | 1.9 | -4.6 | -16.1 | -11.2 |

Sources: IMF WEO; Haver Analytics; national sources; and IMF staff estimates.

**76. In a forward-looking vulnerability analysis, the predicted three-year PD for performing loans as of December 2014 is projected under the baseline and adverse FSAP scenarios outlined in Table 10.** Three-year PDs are calculated by taking the first year PD for all performing loans at December 2014, which gives the probabilistic component of each performing loan that will have entered default in 2015. The second year PD is then applied to the remaining performing loan at end-2015, while the second year PC is applied to the defaulted component.[44] This exercise is repeated with the third year PD and PC to calculate a three-year PD at end-2017, which accounts for all macroeconomic scenario values across the three years and allows for the possibility of loan cure throughout the scenario. In all cases, it is important to note that the PDs reported relate to forward-looking vulnerabilities among the remaining performing loans at December 2014. In most segments of the household sector, the largest source of mortgage credit risk is the "stock" of defaulted loans reported in Table 4 rather than the probabilistic default risk among performing loans highlighted in this section.

**77. The study finds that there is a strictly increasing relationship between LTV groups and the stressed PDs (the bottom left chart in Figure 17).** At an LTV ratio of over 150 percent, there are far larger increases in PD, with the adverse PD in this group climbing above 20 percent and a significant share of the loans in this category with estimated PDs closer to thirty percent (Appendix III). This pattern falls naturally from the PD model underlying the LLF framework, which estimates a positive default coefficient and a negative cure coefficient on LTV ratios.

**78. The upper left chart in Figure 17 reports average PDs over the baseline and adverse scenario, along with the difference between the two scenarios for Dublin and Non-Dublin loans.** The three-year PD is close to 6 percent under the baseline, and close to 8 percent under the adverse scenario, with loans outside Dublin being only marginally more vulnerable than loans in Dublin in both scenarios.

[44] In all cases, PC is calculated using the coefficients of the MSM model.

**79. While default risk is far higher in the BTL segment, there is a smaller difference in forward-looking vulnerabilities, as measured by unconditional average estimated PDs across performing PDH and BTL mortgages to baseline and adverse scenarios (the upper right chart in Figure 17).** This finding may seem surprising given that the opening default stocks across the two groups at end-2014 are so starkly different (12 percent in PDH versus 26 percent in BTL). However, the fact that the most vulnerable loans have already entered default before December 2014 must be taken into account when interpreting these results. Further, compositional differences play an important role in reducing the forward-looking vulnerability estimates for BTL loans, with interest rates among performing BTLs being significantly lower than among performing PDH loans due to the preponderance of tracker mortgages in the BTL segment (63 percent, as opposed to 38 percent in the PDH segment under analysis). When considering the backward and forward looking vulnerabilities in their totality, default risk remains far higher in the BTL segment.

**80. Focusing on the split between first-time home buyers (FTB) and those taking out a second or subsequent mortgage (previous owners), a more marked difference is found in the middle left chart of Figure 17.** *Performing* FTBs have an average adverse three-year PD of over 9 percent, while previous owners are closer to 7 percent. FTBs also experience a larger average increase in PD between the baseline and adverse scenario. It is noteworthy that the estimated vulnerability of FTBs to shocks is higher than that for previous-owners, whereas in the case of default stocks in Table 4, FTBs are the less risky group. This difference in vulnerability is driven in part by differences in the *current* LTV (CLTV) distribution, given that the estimation is based on all loans outstanding at end-2014, regardless of origination date. The data confirm this, with the average CLTV being 53 among previous owners and 75 among FTBs for those still performing at end-2014, while the 90$^{th}$ percentile CLTV is 103 percent among previous owners and 125 percent among FTBs. These patterns must be distinguished from the differential in the appropriate *originating* LTV (OLTV) ratio. Kelly and others (2014) have previously shown that *conditional* default rates among FTBs were lower than among previous-owners at end-2013 (consistent with the results on default stock in Table 11 of this note) and that the differential between the two groups is at its largest around OLTV values of 80–85. The vulnerabilities presented here, on the other hand, are unconditional averages across the FTB and previous-owner groups, and refer only to those loans that remained performing at end-2014.

**81. Variation in the age of the primary borrower is investigated, and forward-looking vulnerabilities appear to decrease with age (the middle right chart in Figure 17).** Those under age 35 have an adverse PD of 10 percent on average, with those 65–75 years of age at 6 percent. Again it must be noted that the forward-looking vulnerabilities are unconditional average estimates across the age groups. The current LTV distribution, which reflects a combination of many elements (first time buyer status, originating LTV, the housing cycle since origination, and location), may be a factor behind this pattern. Among those loans performing at December 2014, average and 90$^{th}$ percentile LTV ratios in the under 35 group are higher (83 percent and 128 percent) than the analogous figures in the age 65–75 group (41 percent and 106 percent), with progressive decreases in intermediate age categories. This largely reflects the higher originating LTV ratios that are prevalent among younger borrowers who are more likely to be in the FTB group. The older age group is also slightly more likely to be in Dublin than younger mortgage holders.

**82. Households with SVR rate mortgages will suffer more under the adverse scenario than those with other interest rate types (the bottom right chart in Figure 17).** Whereas tracker loans are shown to have a similar backward-looking vulnerability to SVR mortgages (Table 11), the picture is different when projecting forward using the LLF model. Due to the far lower interest rate on tracker loans relative to SVR and fixed-rate loans (and potentially other compositional differences), PDs are projected to be 6 percent on tracker loans and over 9 percent on SVRs.

***Summary***

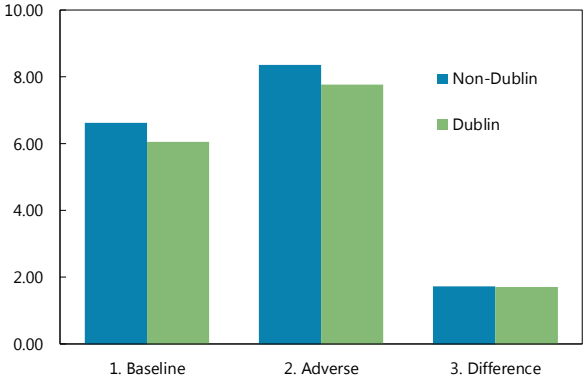
**83. This section has provided an in-depth view of the heterogeneity in default risk across the Irish mortgage market.** Backward-looking default risk (measured as the stock of mortgages in default at end-2014) is shown to be extremely high among BTL loans and loans in deep negative equity (LTVs over 120). Other noteworthy differences in default stocks in December 2014 are that variable rate mortgages (both SVR and tracker) are significantly more impaired than fixed-rate loans, while loans to older borrowers and previous-owner mortgage holders (as opposed to FTBs) are riskier.

**84. The forward-looking analysis results suggest that there is considerable heterogeneity in vulnerability to the proposed shock.** At-risk segments include first time buyers, younger borrowers, and to a lesser extent those with SVR mortgages and those outside Dublin. As opposed to a predicted rate of closer to 10 percent for SVR customers, those on tracker mortgages are estimated to have a three-year PD of 6 percent under the adverse FSAP scenario.

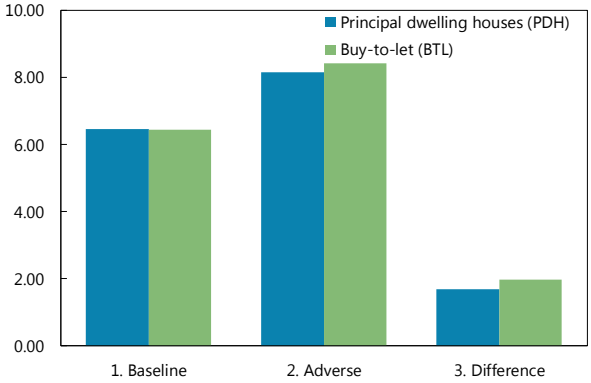
**85. The analysis points out a key differentiation between what has happened up to this point and what is likely to happen under an adverse shock.** The magnitude of predicted default probabilities suggests that key vulnerabilities remain in the Irish mortgage system, even among those not measured in the high stock of defaulted loans, such as FTBs and young households.

## Figure 17. Ireland: Probability of Default of a Group of Households against Stress Tests

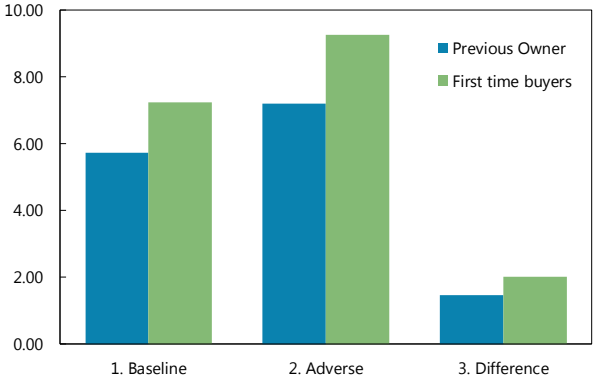
### PDs for Dublin and Non-Dublin Mortgages
(Average three year PD, 2014-17)



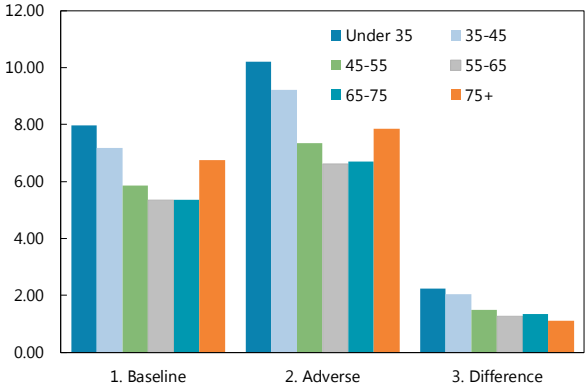

### PDs for PDH and BTL Loans
(Average three year PD, 2014-17)



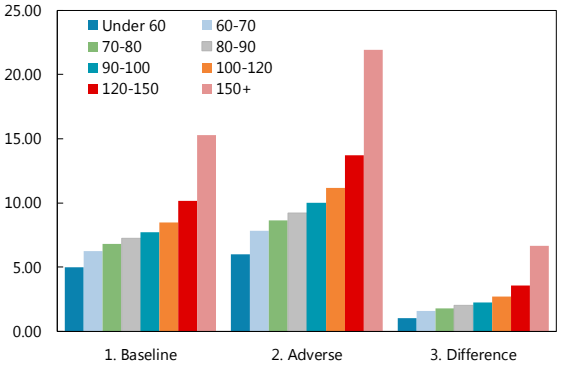

### PDs for First Time Buyers and Previous Owners
(Average three year PD, 2014-17)



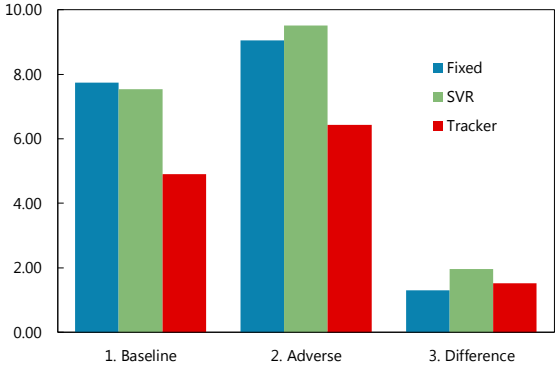

### PDs by Age Groups
(Average three year PD, 2014-17)




### PDs by LTV Groups
(Average three year PD, 2014-17)




### PDs by Interest Rate Types
(Average three year PD, 2014-17)




Sources: Central Bank of Ireland; and IMF staff calculations.

## D. Conclusion and Policy Implications

**86. Segments of households that are particularly susceptible to economic shocks have been identified using aggregate and loan-level data.** By analyzing household debt dynamics and comparing the simulated PDs across different groups, borrowers with high LTV ratios (e.g., young borrowers, FTBs, and BTL investors) and standard variable rates are found as the segments that are relatively more vulnerable to adverse shocks.

**87. This analysis supports the role of proportionate limits of LTV and LTI ratios and thus the Central Bank of Ireland should maintain the present state of the measures to build resilience of borrowers and lenders against future macro-financial shocks.** As shown in IMF (2014) and Hallissey and others (2014), the two tools will complement each other in reducing probability of defaults for borrowers and loss given defaults for lenders. LTI limits reduce the probability of defaults; LTV limits without a complementary role of LTI limits could leave borrowers' capacity to service their mortgages vulnerable to income shocks. LTV caps bolster borrowers' resilience to house price shocks by increasing the equity in the residential property; LTI caps without LTV measures could leave lenders highly exposed to severe house price shocks, as occurred in Ireland after 2008. Combining the Irish experience during the crisis with results from the previous section supports the view that it is highly advisable to keep the measures and closely monitor the risky segments.

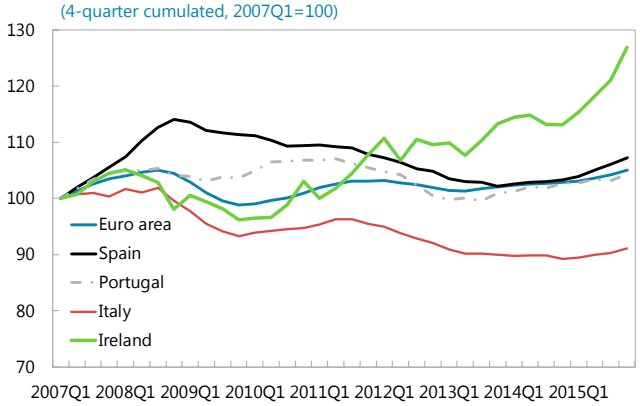
**88. It will be crucial to continue to collect loan-level data from commercial banks for systemic risk assessment and macroprudential implementation, and the Central Bank of Ireland could consider expanding it to all regulated financial institutions for monitoring purposes if the number of institutions lending in the market increases.** Macroprudential analysis and policy is highly data-dependent. The loan-level data allowed the Central Bank of Ireland to gather granular information on the Irish mortgage market, which was previously inaccessible with aggregate data. The establishment of a Central Credit Register (CCR) will further support the gains in data granularity and risk identification achieved to date.

# CORPORATE SECTOR ANALYSIS[45]

## A. Introduction

**89. The activity level of the corporate sector in Ireland has risen significantly recently**. Following a sharp downturn in 2008–09, the activity in the corporate sector has rebounded rapidly in recent years; the rate of recovery has exceeded that seen in many of its euro area peers. In 2015, the corporate sector registered a real growth rate of 12 percent while, the gross operating surplus increased by 15 percent in real terms. The profitability share (gross operating surplus divided by gross value added) up to about 65 percent—well above the pre-crisis average of 55 percent. The improvement in profitability supported the sector's strong investment activity without relying heavily on debt issuance, and accordingly—and against persistent contraction of bank lending—the sector continued to deleverage.[46]

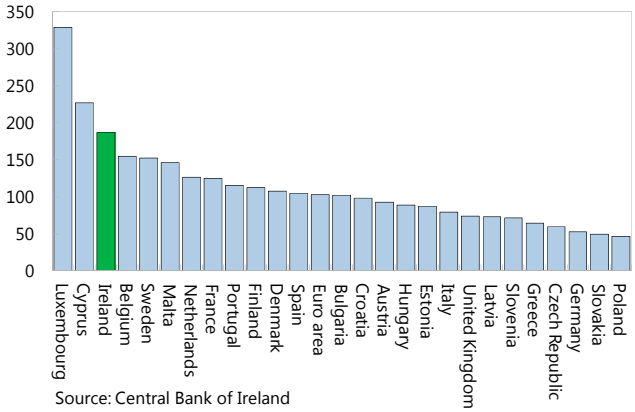
**Real Gross Value Added**
(4-quarter cumulated, 2007Q1=100)




Sources: Eurostat and IMF staff calculations.

**90. However, some indicators suggest that the corporate sector vulnerabilities remain elevated**. While partly held by foreign-owned multinationals, which have limited linkages to the domestic financial system, the non-financial corporate (NFC) sector's debt stands at 187 percent of GDP—among the highest in Europe in relative terms, leaving the sector vulnerable to a fall in revenues or increase in interest rate.[47] Also, non-performing loans (NPLs)—while declining— remain high. These two features limit firms' ability to undertake new investments. While credit conditions have somewhat eased and new lending to SMEs has picked up recently, banks' corporate loan books continue to contract reflecting both supply and demand factors. Despite

**Non-Financial Corporate Debt**
(In percent of GDP, 2015Q4)




Source: Central Bank of Ireland

[45] This Technical Note was prepared by Nir Klein, European Department, in the context of the 2016 Ireland Financial Sector Assessment Program Prepared.

[46] See Carroll and others (2016).

[47] Lawless et al. (2015) showed that, in the post-crisis period, a higher debt-to-turnover ratio has a material impact on investment and employment growth of Irish SMEs as well as being associated with higher credit constraints.

some recent relaxation in credit conditions, the financing cost for firms, particularly SMEs, remains high relative to those of their European peers.

**91. Against this background, the primary objective of this paper is to assess vulnerabilities of the Irish corporate sector and its financial resilience to shocks**. In particular, the paper aims to:

- Assess to what extent corporate sector vulnerabilities have changed since the financial crisis, examine which of the sectors and categories of firm size are the most vulnerable, and identify the portion of firms that remains at a heightened risk of default;
- Examine whether firm-level factors affect the firms' likelihood of being in distress, controlling for macroeconomic and sectoral effects; and
- Assess the sensitivity of the corporate sector to a plausible but substantial deterioration in macroeconomic conditions, and estimate how the related increase in defaults is likely to affect banks' asset quality and capital position.

**92. The paper is structured as follows**: section B describes the balance sheet developments of the corporate sector and discusses the sector's vulnerabilities from a macro-level perspective; section C uses firm-level data to assess corporate sector vulnerabilities, including by looking at indicators such as interest cover ratio and debt-at-risk across different categories of firm size, sectors, and ownership (domestic vs. foreign). This section also presents an empirical analysis of the link between firm-level factors and firms' distress. Section D provides a sensitivity analysis of the corporate sector to adverse shocks and assesses the impact on banks' asset quality and capital position. Section E concludes.

## B. Some Stylized Facts from a Macro-Level Perspective

***Debt ratios have moderated from high levels***

**93. The debt of the Irish NFC sector increased rapidly in the pre-crisis period.** With lax credit conditions in Ireland and abroad and strong investment activity, particularly in the construction sector, the Irish NFC sector sharply increased its leverage prior to the global financial crisis, mainly through borrowing from domestic monetary financial institutions. During 2005–07, the NFC sector's debt in terms of GDP climbed by 40 percentage points to 125 percent. With the contraction of GDP in 2008–9, which was accompanied by a significant decline in firms' profitability, debt to GDP increased further to 207 percent (end-2009), among the highest corporate debt levels in Europe. Since the onset of the crisis in 2008, new debt accumulation has come mainly from external and inter-company sources while domestic banks have tightened lending conditions.

**94. The NFC sector has deleveraged in recent years.** In part because credit supply has become more risk-sensitive, particularly for SMEs, the recent economic recovery has been accompanied by a significant increase in internal funding and equity issuance by larger firms as a source to finance investment and working capital. Consequently, credit to the corporate sector has continued to contract,

and the debt-to-equity ratio declined to 45 percent in 2015Q4—among the lowest in Europe (Figure 18)—from a peak of 123 percent in early 2009. Reflecting slower accumulation of nominal debt and the rapid increase in nominal GDP in 2014–5, the NFC debt-to-GDP ratio has declined since 2013; in 2015Q4 it stood at about 187 percent of GDP.

**95. Recent years have shown a significant increase in the share of multinational enterprises' debt (Figure 18)**. The increased activity of multinationals in Ireland has also been reflected in their rising share in the overall NFC sector's debt. On a consolidated basis, the multinationals' debt stood at 94½ percent of GDP in 2014 compared to 36 percent of GDP in 2007, while the debt of Irish firms modestly increased to 85 percent of GDP in 2014 from at about 65 percent of GDP in 2007. As multinationals rely mostly on external financing sources, including inter-group loans, the share of non-euro denominated debt in total debt increased to more than half in 2015, from about one-quarter in 2006. Similarly, the growing reliance on external financing sources, along with the deleveraging of the Irish banking system, led to an increase in the share of loans from non-Irish entities to 55 percent of total loans in 2015Q4 compared with 34 percent in end-2012.

***Rising profitability has supported the NFC sector's deleveraging***

**96. The increase in profitability across all categories of firm size has helped firms to sustain investment without relying on external funding.** The gross operating surplus of the NFC sector—although declining as a share of total assets—has increased significantly and, as a share of the firms' value added, reached 63 percent, which is significantly above the European average (39 percent) and above Ireland's historical average (Figure 19). Although more pronounced among large and medium-sized firms, profitability improved across all categories of firm size, and thus supported their investment activity (Carroll and others, 2016).

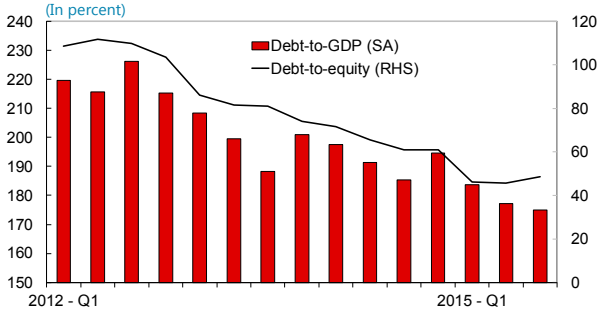
***The level of corporate distress has somewhat eased recently***

**97. The share of non-performing loans in the corporate sector has moderated, but has remained elevated (Figure 20).** The share of overdue corporate loans has eased to about 17 percent in 2015Q3 from a peak of nearly 27 percent at end-2013 thanks to improved economic conditions, write-offs, and restructuring activity. The moderation of the NPL ratio took place in all sectors, though in an uneven pace, with the NPL ratio in the manufacturing sector declining to a single digit level while the NPL ratio in the construction sector—although moderating—stayed above 50 percent.

## Figure 18. Ireland: Non-Financial Corporate Sector Debt

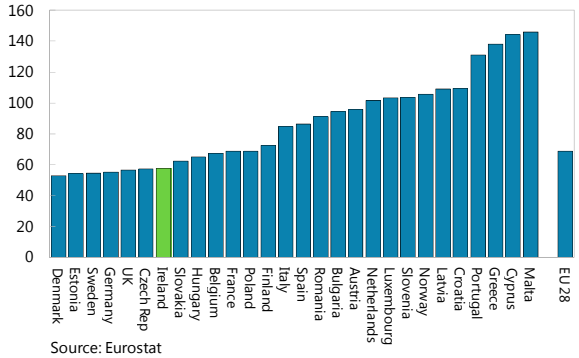
### Debt of Non-Financial Corporations /1

(In percent)




1/ Debt is equal to securities other than shares, loans, and financial derivatives and employee stock options.
Sources: Central Bank of Ireland and IMF staff's calculations.

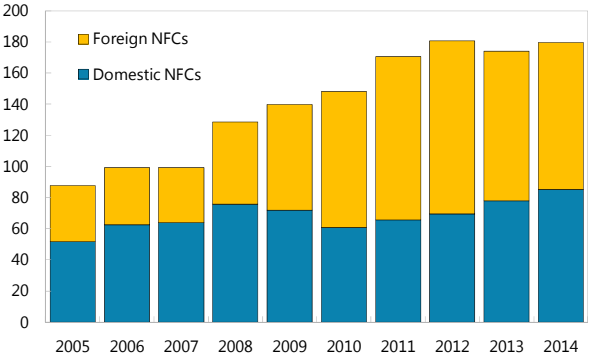
### Debt-to-Equity ratio of the Non-Financial Corporate Sector, 2014




Source: Eurostat

### Ireland: Non-Financial Corporate Debt

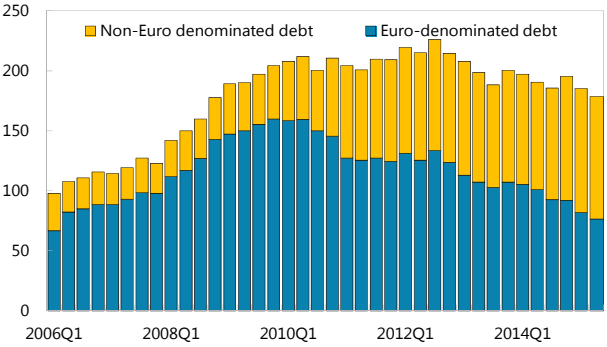
(In percent of GDP, consolidated)




Source: Central Statistic Office

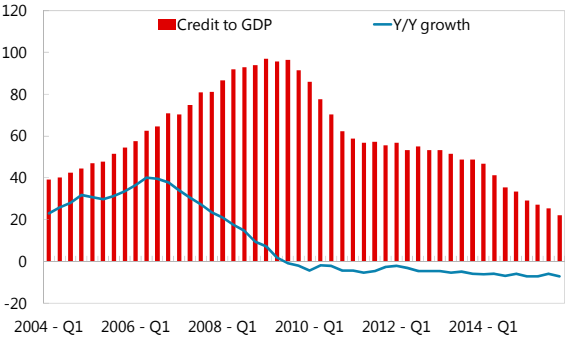
### Debt of the Non-Financial Corporate Sector, by currency[1]

(In percent of GDP)



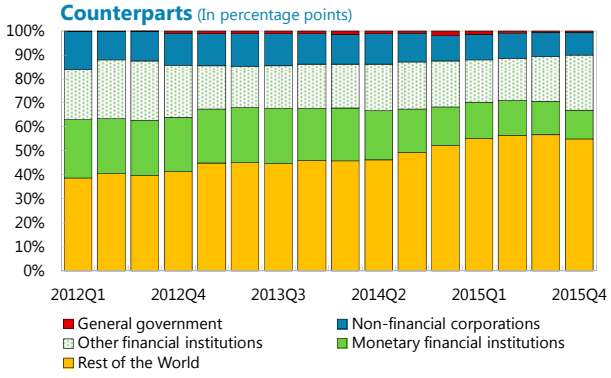

Sources: Central Bank of Ireland and IMF staff's calculations.

### Credit to Irish Resident Private Sector Enterprises, Excluding Financial Intermediation




Source: Haver.

### Loans of Non-Financial Corporate Sector, by Counterparts (In percentage points)



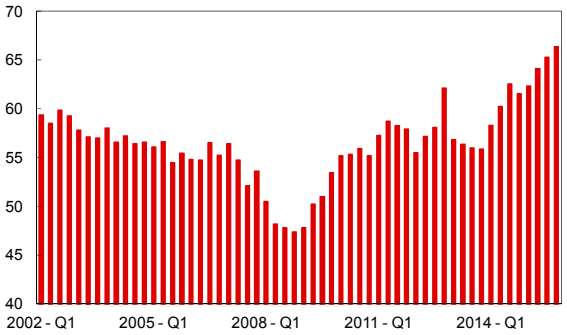

Source: Central Bank of Ireland.

## Figure 19. Ireland: Non-Financial Corporate Sector Profitability

(percent)

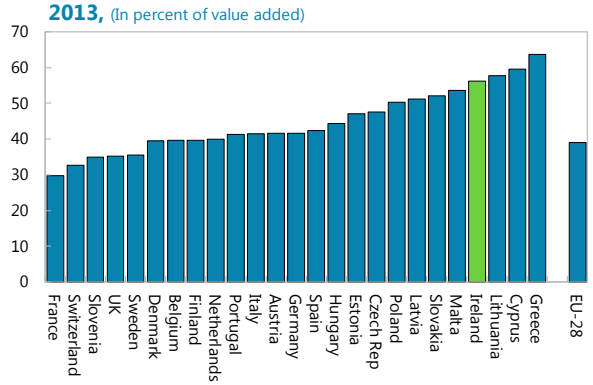
### Profitability of the Non-Financial Corporate Sector

(Gross operating surplus as a share of value added, in percent)



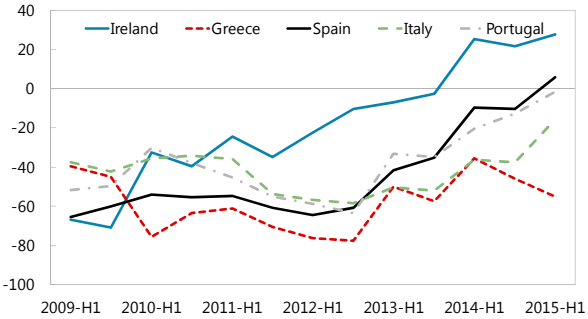

Sources: Haver and IMF's staff calculations.

### Profitability of the Non-Financial Corporate Sector, 2013, (In percent of value added)



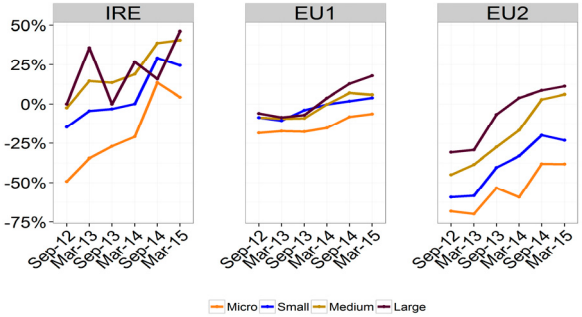

Source: Eurostat.

### Net Change in Profitability 1/




1/ Net change indicates the net balnce of firms that reported an increase in profitability compared with firms that reported a decline in profitability.
Source: ECB SAFE data.

### Net change in Profitability by Firm Size 1/

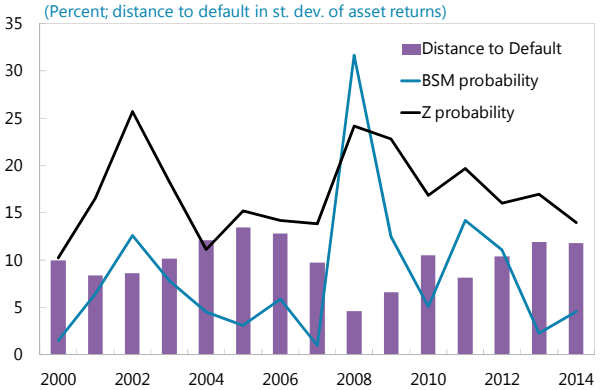



1/ Net change indicates the net balance of firms that reported an increase in profitability compared with firms that reported a decline in profitability.
EU1: Austria, Belgium, Germany, Finland, The Netherlands, France
EU2: Portugal, Italy, Spain, Greece
Source: ECB SAFE data.

**98. The number of corporate bankruptcy cases has declined significantly, yet remains above the pre-crisis level (Figure 20).** Corporate bankruptcies registered more than a threefold increase in 2009–2012, reaching a quarterly average of 300 compared with 84 during 2005–07. Bankruptcies in construction, trade, and utilities sectors accounted for more than half of the cases in the former period. More recently, the quarterly average number of bankruptcies has moderated to about 225 cases (2014–15) reflecting an improvement in most of the sectors, although it still remains well above the pre-crisis levels.

### Ireland: Corporate Default Probability

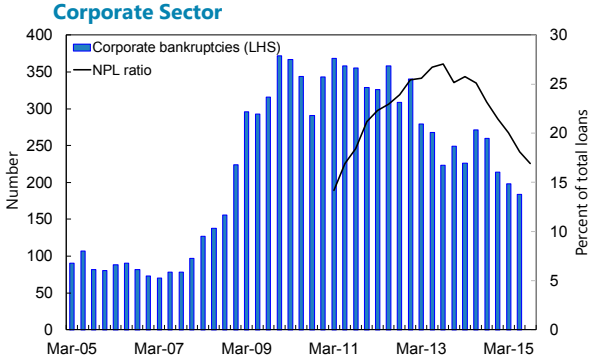
(Percent; distance to default in st. dev. of asset returns)




Source: IMF Corporate Vulnerability Utility.

# Figure 20. Ireland: Selected Corporate Distress Indicators

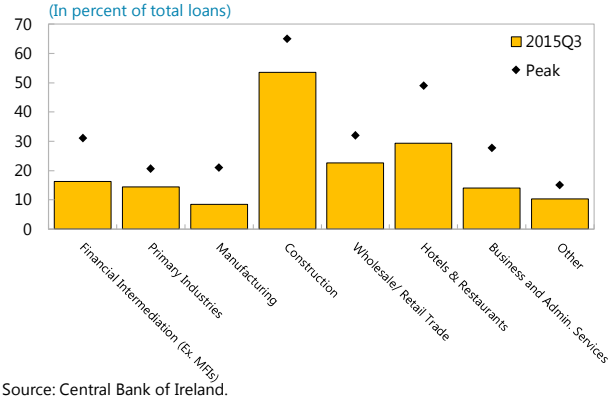
## Non-Performing Loans and Bankruptcies in the Corporate Sector




Source: Central Bank of Ireland and Department of Jobs, Enterprise and Innovation.

## Non-Performing Loans

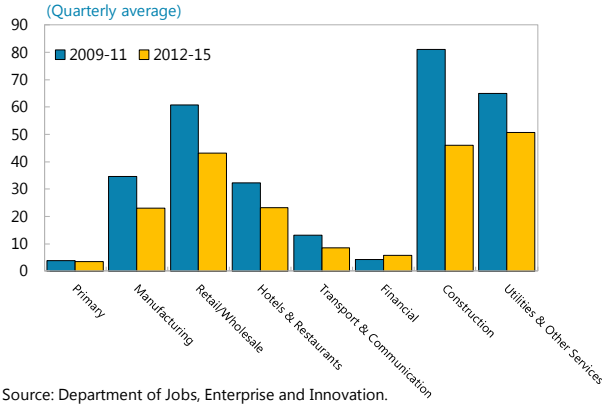
(In percent of total loans)




Source: Central Bank of Ireland.

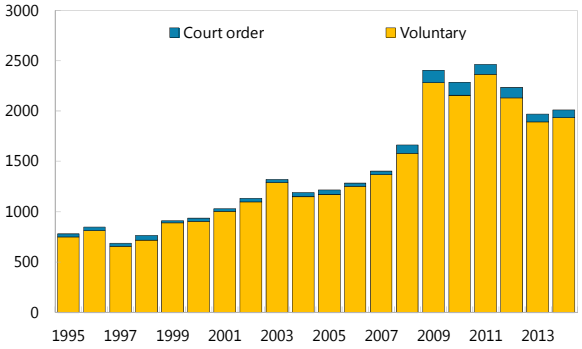
## Bankruptcies by Sectors

(Quarterly average)




Source: Department of Jobs, Enterprise and Innovation.

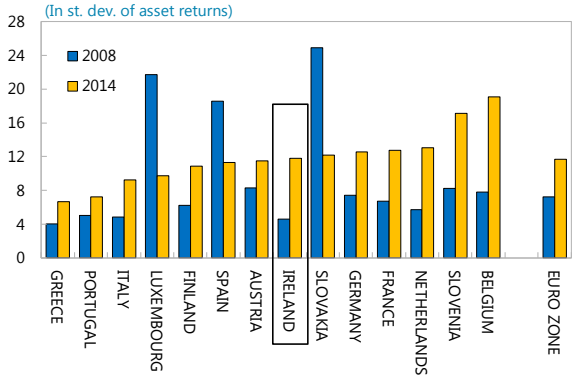
## Corporate Liquidations




Source: Companies Registration Office.

## Distance to Default

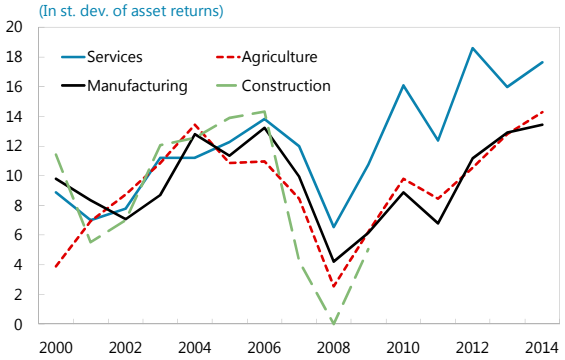
(In st. dev. of asset returns)




Source: IMF's Corporate Vulnerability Utility

## Distance to Default by Sectors

(In st. dev. of asset returns)




Source: IMF's Corporate Vulnerability Utility

**99. Default probabilities have normalized.** The Black-Scholes-Merton (BSM) and Altman Z-probability consistently show a decline in the default probability in recent years:[48] in 2014, the BSM and the Z-probability stood at 4½ percent and 14 percent, respectively, compared with 24 percent and 32 percent in 2008, respectively. Accordingly, the distance-to-default (DTD), which measures how much asset values must fall during the year for a firm to default based on the current balance sheet position, improved significantly across the main sectors. Compared to peers, the DTD of the Irish corporate sector was slightly better than the 2014 euro zone's average, while in 2008 it was the second lowest after Greece (Figure 20).[49]

## C. Evidence from Firm-Level Data

**100. This section assesses corporate vulnerabilities in Ireland using firm-level data.** More specifically, the analysis in this section looks at the firms' interest cover ratio (ICR), i.e. the ratio between the firms' earnings before interest, taxes, depreciation and amortization (EBITDA), and the firms' interest expenses, to assess to what extent the firms' debt-servicing capacity has changed in recent years, and how it could be affected by future shocks. Firms whose EBITDA is less than interest payment due, i.e. ICRs of less than one, are sometimes referred as being in "technical default". In such situations, many of these firms can survive for some time by selling assets to meet their debt obligations, but if their ICRs remain below one for a sustained period, they eventually will run out of assets and actual default will ensue. A firm with an ICR between 1 and 2 is generally regarded as being at heightened risk.

***Data and sample coverage***

**101. The analysis uses the ORBIS database of Bureau Van Dijck (BvD), which contains world-wide information on private and public firms**. For Ireland, we include all private enterprises that have a complete record of debt, EBITDA, and interest expenses.[50] The analysis distinguishes between domestic firms and subsidiaries of foreign corporations ("foreign firms" thereafter) as the financial resilience of the latter may not be primarily dependent on the Irish economy, but on their parent company's financial health. Additionally, the links of foreign firms to the Irish financial system are likely to be limited as many of these subsidiaries rely on their parent firms for funding (Stuart, 2006).

[48] The BSM probability provides the one-year-ahead probability of default, based on a theoretical asset-pricing model. The Z probability converts the Altman Z-score (a statistic that combines five accounting ratios) into a forward-looking probability of default.

[49] The distance-to-default calculation is based on a narrow sample of firms, both domestic and foreign-owned, across different categories of firm size.

[50] The sample includes all firms that have a non-missing value for Debt and interest cover ratio, including firms that have a marginal level of debt.

**102. The sample provides a wide coverage of firm size, sectors, and ownership.** Overall, the sample contains an unbalanced panel dataset of 7,663 observations of 3,040 domestic firms and 1,904 observations of 727 foreign firms, most of which are of small size (text table).[51] The sample covers the period 1995–2014, though the vast majority of observations is concentrated in the period 2006–2013. The sectoral composition indicates that the majority of the observations (77 percent) relate to services. Manufacturing, construction, and primary sectors account for 14 percent, 7½ percent, and 1½ percent of the observations, respectively (text table).

**Sample Coverage by Firm Size**

| Firm size | Number of observations | Number of firms |
|---|---|---|
| **Domestic** | **7663** | **3040** |
| Small (1-49 employees) | 4409 | 1882 |
| Medium (50-249 employees) | 2266 | 833 |
| Large (>249 employees) | 988 | 325 |
| **Foreign** | **1904** | **727** |
| Small (1-49 employees) | 1131 | 475 |
| Medium (50-249 employees) | 543 | 188 |
| Large (>249 employees) | 230 | 64 |
| **Total** | **9567** | **3767** |

**103. The dataset, however, has several shortcomings, suggesting that the results should be treated with some caution.** First, the composition and number of firms is not fixed over time, thus complicating inter-temporal comparisons. Second, the sample may involve a selection bias problem because distressed firms may not be fully represented in the sample. Third, certain sectors may be under-or over-represented. Last, the composition of the sample suggests that small firms are under-represented compared to their share in the Irish economy. To mitigate this problem, we present the vulnerability indicators and results of the sensitivity analysis also by categories of firm size. We also report the findings on the impact of the shocks on banks' asset quality and capital position based on a sample that is adjusted for the "right" composition of firms.

**Sample Coverage by Sectors**
(Number of observations)

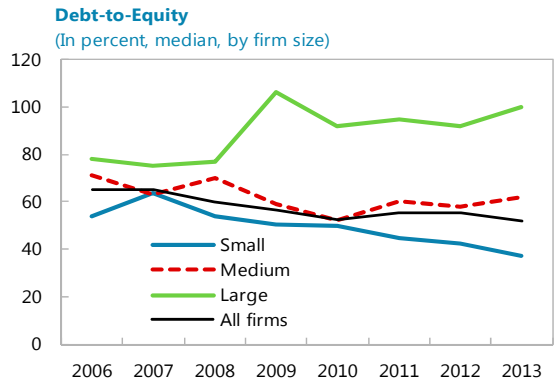
| Sector | Domestic | Foreign | Total |
|---|---|---|---|
| Primary | 121 | 35 | 156 |
| Manufacturing | 999 | 295 | 1294 |
| Construction | 603 | 131 | 734 |
| Services | 5940 | 1443 | 7383 |
| **Total** | **7663** | **1904** | **9567** |

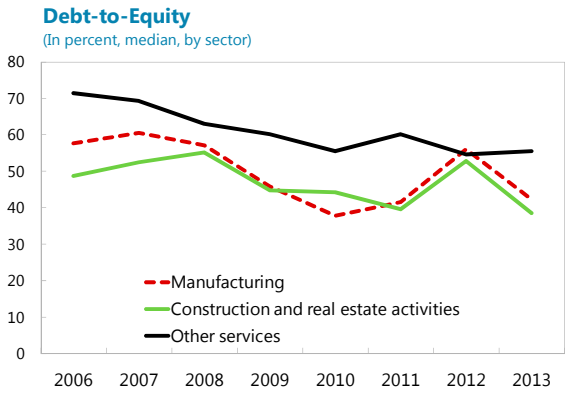
***Some stylized facts on firms' financial performance from firm-level data***

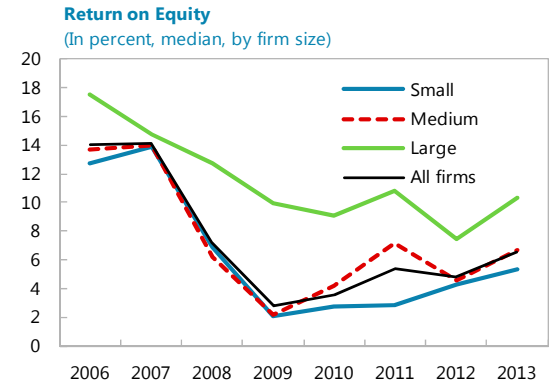
**104. Firms' profitability dropped significantly across all firms in 2009, and only recently it has shown a modest recovery.** The return on equity (RoE) of the median firm fell to just below 3 percent in 2009 from 14 percent in 2007, reflecting mainly a decline in profitability across small and medium-sized firms, particularly in the construction sector. The profitability among large firms declined, but more modestly. In 2010–13, the profitability recovered somewhat across all categories of firm size and sectors, though RoE of large firms remained significantly above that of smaller firms.

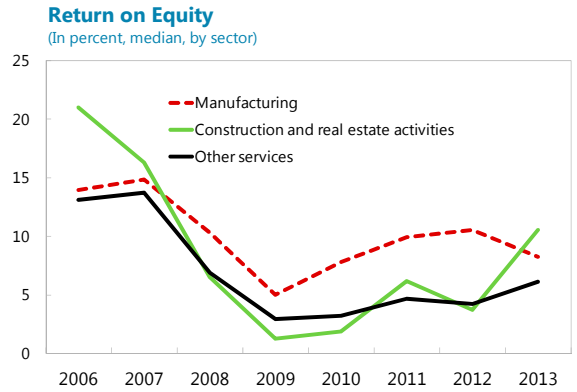
[51] See Table A1 in Appendix IV for a more detailed breakdown of the sample's coverage.

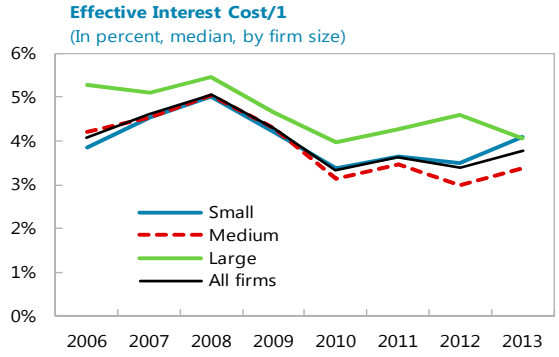
## Figure 21. Ireland: Return on Equity, Debt-to-Equity, Effective Interest, and Composition of Debt

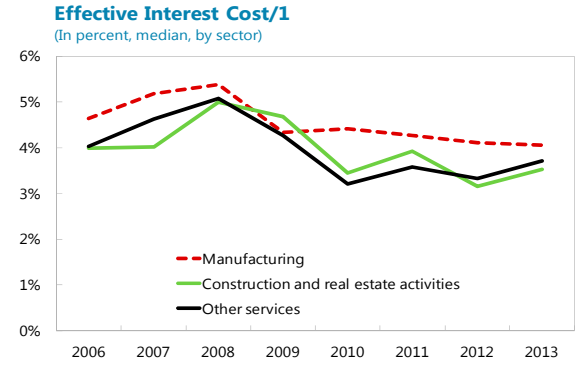


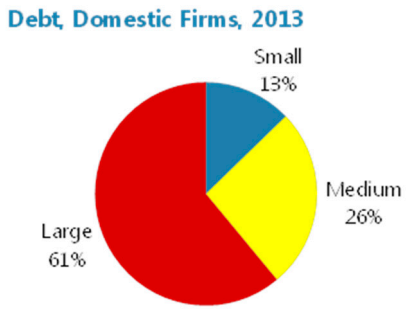




1/ Annual interest paid by the firm divided by the overall debt.



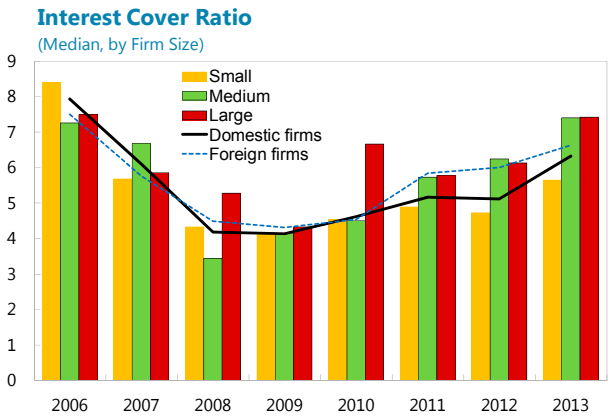


Source: BvD and IMF's staff calculations.

**105. The debt-to-equity ratio has declined since the pre-crisis period, though deleveraging was concentrated in small and medium-sized firms.** The debt-to-equity ratio of the median firm in the sample declined to 52 percent in 2013 from 65 percent in 2007, driven largely by a rapid deleveraging of small firms. In contrast, large firms, which on average maintain a higher debt ratio, accumulated higher debt, and as a result, the debt-to-equity ratio of the median large firm increased to 100 percent in 2013 from 75 percent in 2007. Deleveraging was evident across all sectors, though at a slower pace among firms in the services sector.

**106. Borrowing costs have declined modestly**. The median firm's effective interest cost, as measured by total interest expenses divided by total debt, slightly increased in 2008 to 5 percent from 4.6 percent in the previous year, possibly reflecting tighter financial conditions at the outset of the global financial crisis. In the following years, the effective interest rate cost eased to around 3.5 percent. Interestingly, the effective interest rate cost of large firms was higher than that of smaller firms, perhaps due to longer maturities and higher term premia.

**107. The ICR increased steadily in recent years following a considerable decline in 2008-09.** As profitability declined significantly in 2008–09, the ICR fell across all categories of firm size. The ICR of the median firm declined to about 4 from just above 6 in 2007. This brought the share of vulnerable domestic firms (i.e., firms with ICR lower than two) to 37.2 percent in 2009 from 24.4 percent in 2007, mainly reflecting a sharp increase in the ICR among small and medium-sized enterprises (Table 12).[52] The share of domestic firms where profits were below debt service payments (i.e. ICR below one) also increased significantly.[53]



Source: BvD and IMF staff's estimates.

**108. A similar pattern was observed among foreign firms.** In recent years, their ICR exhibited a healthy recovery as profitability somewhat improved and deleveraging continued. This brought the ICR of the median domestic and foreign firms in 2013 to 6.3 and 6.6, respectively, though in both types of ownership the ICR of small firms remained below that of medium-sized and large firms, suggesting that, on average, small firms have become more vulnerable. Reflecting recent improvements, the share of vulnerable firms across all categories of firm size has declined, and apart from medium-sized domestic firms, it has even fallen below the pre-crisis levels.

[52] The data suggests that low ICR was persistent. About 22 percent and 29 percent of the firms that had ICR of less than 2 in 2008 and 2009, respectively, had it for more than two years consecutively.

[53] The number of firms that remain in the sample in each year during 2007–13 is limited (few hundreds) and they are mostly of large and medium size. Nevertheless, their ICR exhibits a similar U-shape pattern over the period.

**Table 12. Ireland: Share of Vulnerable and Distressed Firms /1**
(Share of firms per year, percent)

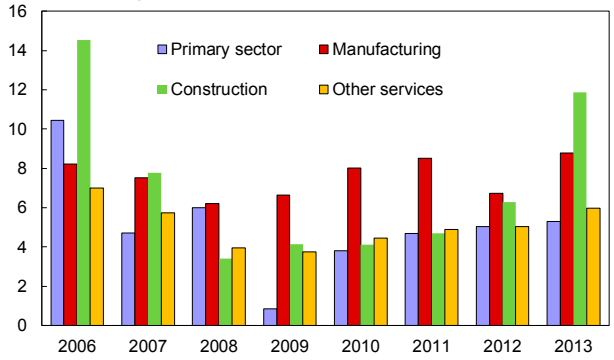
| | 2007 | | 2009 | | 2013 | |
|---|---|---|---|---|---|---|
| | ICR<2 | ICR<1 | ICR<2 | ICR<1 | ICR<2 | ICR<1 |
| **Domestic firms** | 24.4 | 16.6 | 37.2 | 27.7 | 24.3 | 18.0 |
| *Of which:* | | | | | | |
| Small | 15.2 | 10.7 | 23.1 | 17.7 | 14.2 | 10.1 |
| Medium | 6.4 | 4.0 | 10.5 | 7.8 | 8.1 | 6.5 |
| Large | 2.8 | 1.9 | 3.5 | 2.1 | 2.0 | 1.4 |
| **Foreign Firms** | 28.4 | 20.4 | 35.2 | 27.7 | 19.1 | 12.7 |
| *Of which:* | | | | | | |
| Small | 18.3 | 12.2 | 22.4 | 16.7 | 10.0 | 7.3 |
| Medium | 7.0 | 5.8 | 9.2 | 7.4 | 6.4 | 3.6 |
| Large | 3.1 | 2.4 | 3.6 | 3.6 | 2.7 | 1.8 |

Source: BvD and IMF staff estimates.
1/ The number of firms changes over time.

**109. The U-shape pattern of the ICR is evident also across sectors.** The ICR of the median firm registered a decline in all of the main sectors in 2008–09. The sharpest decline in the median ICR took place in the primary sector, where the ICR of the median firm fell to below 1 in 2009 from above 10 in 2006, with half of the firms in "technical default". A similar decline was evident in the construction sector, though the financial health of the median firm was still solid. In recent years all the sectors recorded an improvement in their ICR, and, in 2013, the ICR of the median firm was above the 2007 level across all sectors.

**110. The share of "debt-at-risk" has moderated in recent years following a significant increase in 2009.** The analysis suggests the share of debt that is owned by domestic firms with an ICR of less than one increased to above 15 percent in 2009 from 10½ percent in 2007, mainly reflecting deterioration in the financial health of small and medium-sized enterprises (Table 13). Interestingly, the share of debt-at-risk among large companies declined. Also, the share of debt that is owned by foreign firms with an ICR of less than one increased rapidly at the onset of the financial crisis, mainly due to a decline in profitability of large companies; in 2009 it reached 20 percent compared with 11.2 percent in 2007. In recent years, the share of risky debt moderated across both domestic and foreign firms. Among domestic firms, the share of risky debt in 2013 reverted to just below the pre-crisis level, though with a different composition:

**Interest Cover Ratio**
(Median, by Sector)




Sources: BvD and IMF's staff estimates.

small firms accounted for about two-thirds of the risky debt compared with one-third in 2007; the share of risky debt owned by large firms declined significantly to about 15 percent, from nearly 50 percent in 2007. Among foreign firms, the decline in risky debt was largely driven by large companies, though the improvement was evident across all categories of firm size.

**Table 13. Debt-at-Risk, Based on ICR<1**
(Debt of firms with ICR < 1 Relative to Total Debt, Percent)

| | 2007 | 2009 | 2013 |
|---|---|---|---|
| **Domestic firms** | 10.5 | 15.3 | 9.9 |
| | | | *of which:* |
| Small | 3.1 | 6.5 | 6.3 |
| Medium | 2.3 | 4.2 | 2.3 |
| Large | 5.1 | 4.6 | 1.3 |
| **Foreign firms** | 11.2 | 20.0 | 4.1 |
| | | | *of which:* |
| Small | 5.2 | 4.9 | 3.0 |
| Medium | 2.4 | 3.6 | 0.8 |
| Large | 3.6 | 11.5 | 0.3 |

## D. Econometric analysis

**111. This sub-section explores whether there is a significant relationship between a low ICR (below 2) and a situation of "distress".** The results could indicate whether a situation of distress is directly linked to the firm's financial health or whether it is related to a broader set of factors, including macroeconomic and sectoral effects.

**112. To examine this question, we apply a binary Logit model where the dependent variable is the probability of being in a "distress" situation (i.e. in insolvency proceedings, liquidation, default of payment, or temporary inactivity).**[54] The model uses a logistic distribution that limits the predicted probabilities to between zero and one as follows:

$$y_{i,t} = f(X'\beta) = \frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}}$$

where $y_{i,t}$ is the probability of being in distress and X is a vector of the explanatory variables, which includes both firm-specific factors as well as sectoral, and time dummies. The effect of a low ICR is explored by including two alternative dummies: one for firms with an ICR lower than two (*vulnerable*), and one for firms with ICR lower than one (*highly vulnerable*). The analysis controls for firm level factors, such as the firm's current ratio, age, size (as measured by the number of employees), ownership

[54] For simplicity, the analysis does not differentiate between different levels of distress. The level of distress may vary over time.

(domestic vs. foreign) and the share of fixed assets to total assets, which captures the firm's collateral and thus may indicate the firm's ability to obtain bank financing.

**113. The sample available for estimation purposes covers the period 1995-2014, and includes about 9,500 observations.** Overall, there are 706 observations of distress, accounting for about 7½ percent of the total observations in the sample, with more than half of them in the 2007–09 period. Figure 25 in Appendix IV presents the distribution of distressed firms by sectors and firm size.

**114. The estimation results presented in Table 14 corroborate the hypothesis that the ICR is an important indicator of corporate financial soundness.** While the explanatory power is relatively low, the results remain robust to various specifications and confirm that, other things being equal, firms are more likely to be in distress if they have a low ICR.[55,56] The marginal effects at mean, which are presented in Table A4 in Appendix IV, indicates that the effect of the *vulnerable* dummy is slightly higher than that of *highly vulnerable*, possibly reflecting the higher mean of the latter as it covers a larger number of firms in the sample. Moreover, the results suggest that firms in the construction sector are more likely to be in distress compared with companies in other sectors, though two specifications show that also firms in the manufacturing sector are more prone to distress. More liquid companies (i.e. with a higher current ratio) are less likely to be in distress, suggesting that they can use their liquid assets to meet their debt service payments, even if their profitability declines sharply and their interest cover ratio is below the indicated thresholds. Finally, larger companies are less likely to be in a distress, perhaps indicating their strong bargaining power with the creditors. Interestingly, the results do not indicate that ownership has a significant effect.

[55] The results remain robust for a dummy that obtains a value of one if ICR remained below two/one consecutively for two years or more, and for inclusion of real GDP (excluding the activity of multinationals) growth instead of time dummies.

[56] The estimates coefficients on the control variables have the predicted signs.

**Table 14. Ireland: Determinants of Firms' Distress**

| | Logit model, coefficients | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Highly vulnerable | 0.806* | 0.804* | 0.795* | | | |
| Vulnerable | | | | 0.948* | 0.956* | 0.945* |
| Current ratio | -0.024** | -0.032** | -0.032** | -0.022* | -0.031* | -0.031** |
| Fixed assets/total assets | | -0.004* | -0.004* | | -0.005* | -0.004* |
| Number of employees | | | -0.000** | | | -0.000** |
| Foreign | | | 0.100 | | | 0.101 |
| Primary sector | -0.262 | -0.230 | -0.274 | 0.230 | -0.195 | -0.236 |
| Manufacturing | 0.189 | 0.144 | 0.168 | 0.224*** | 0.174 | 0.196*** |
| Construction | 0.815* | 0.731* | 0.740* | 0.824* | 0.730* | 0.738* |
| Time dummies | yes | yes | yes | yes | yes | yes |
| # of obs. | 9,522 | 9,522 | 9,522 | 9,522 | 9,522 | 9,522 |
| Pseudo $R^2$ | 0.086 | 0.088 | 0.097 | 0.0957 | 0.098 | 0.100 |

Source: IMF staff estimates.

* Indicates significance at 1 percent **indicates significance at 5 percent *** indicates significance at 10 percent.

## E. Sensitivity Analysis

***Calibration of shocks***

**115. This section assesses the vulnerability of the corporate sector to adverse changes in the macroeconomic environment and evaluates the impact on banks' asset quality and capital positions.** For this exercise, we exclude the subsidiaries of foreign firms as their linkages to the Irish economy and the domestic banking system are limited. We consider three types of shocks: (i) an interest rate shock; (ii) a profit shock; and (iii) an interest rate-profit combined shock. In this static exercise, we define all three shocks on the basis of end-2013 balance sheets.[57]

- **Interest rate shock.** We use the calculated effective interest rate of each firm at end-2013 ($i_{eff,t-1}$), and we apply a 450bp shock, which is consistent with the adverse scenario of the banking sector's stress test.[58] In addition, and in line with CBI data on corporate lending, we assume that half of the 2013 debt stock ($Debt_{t-1}$) will be rolled-over with a higher interest rate:[59]

$$Interest\ expense_{i\_shock,t} = \frac{i_{eff,t} + 4.5}{100} \cdot \frac{1}{2} \cdot Debt_{t-1} + \frac{i_{eff,t}}{100} \cdot \frac{1}{2} \cdot Debt_{t-1}$$

[57] Parameters of the shocks are in line with the FSAP's adverse scenarios.

[58] This shock is consistent with the deviation from the baseline of the yield on 10-year Irish sovereign bond at the end of the stress horizon.

[59] CBI data suggests that 45 percent of large firms' debt and 69 percent of SMEs' debt are at variable rates. The rollover assumption of 50 percent takes into account the higher weight of large firms (60 percent) in total debt.

An increase in the interest rate would also increase the return on financial assets. Hence, we add the expected increase in the return on these assets to EBITDA, assuming that the 2-percentage points spread between lending rates and deposit rates that was observed during 2008–9 will prevail also in this scenario. This effect is captured by the assumption that the yield on financial assets will increase by 250bp as follows:[60]

$$EBITDA_{i\_shock,t} = EBITDA_t + (financial\ assets_{t-1}) \cdot 2.5/100$$

The ICR in the interest rate shock scenario is then given as:

$$ICR_{i\_shock,t} = \frac{EBITDA_{i\_shock,t}}{Interest\ expense_{i\_shock,t}}$$

- **Profit shock**. This scenario simulates a downturn of economic activity, leading to lower profitability. Lower profits are derived by shocking the firms' added value by 15 percent, while holding the costs of employees constant at their baseline level.[61] The rigidity in the costs reflects firms' tendency to hoard labor in the short run at least until the magnitude and length of the shock become clearer. The calculation of this shock suggests that average profit in the sample declines by about 20 percent compared with the baseline. The ICR in this scenario is then given by:

$$\begin{aligned} EBITDA_{profit\_shock,t} &= Added\ value_t - Costs\ of\ employees_t \\ &= Added\ value_{t-1} * 0.85 - Costs\ of\ employees_{t-1} \end{aligned}$$

$$ICR_{profit\_shock,t} = \frac{EBITDA_{profit\_shock,t}}{Interest\ expense_t}$$

- **Combined interest rate and profit shock.** This shock combines the two shocks that are discussed above to affect the numerator and the denominator. The ICR in this shock is given by:

$$ICR_{combined\_shock,t} = \frac{EBITDA_{profit\_shock,t} + financial\ assets_{t-1} \cdot 2.5/100}{Interest\ expense_{i\_shock,t}}$$

[60] Consistent with the financial quarterly accounts of the non-financial corporate sector, we assumed that the firms' financial assets amount to 10 percent of the firms' total assets.

[61] The firm's added value can be proxied by the sum of cost of employees and EBITDA (the share of income that goes to capital).

***Stress test results***

**116. The sensitivity analysis suggests that Irish corporations, particularly SMEs, are vulnerable to adverse macroeconomic changes (Table 15).** In particular:

- A 450bp interest rate shock would push the median ICR from 6.8 in the baseline to 4.0—similar to the median ICR during 2008–09—while increasing the share of vulnerable firms to nearly one-third from 22 percent in the baseline. In addition, the share of risky debt (debt owned by firms with ICR of less than 2) would increase to more than half of the total, pointing to a potential of sharp increase in new defaults.[62] The most vulnerable group appears to be the large and medium-sized firms, reflecting their high leverage and debt service payments.

- A profit shock would bring the ICR of the median firm down to 2, and would make more firms vulnerable compared with the impact of the interest rate shock (i.e. result in a higher share of firms with ICR of less than 2). However, the impact of this shock on the share of debt that is owed by firms with ICR lower than 2 would be significantly smaller than under the interest rate shock. This may suggest that the shocks affect firms differently: An interest rate shock would mostly affect firms that are heavily leveraged (mostly medium-sized and large firms), resulting in a sharp increase in the share of risky debt. By contrast, a profit shock would affect the entire distribution of firms, but, as the results indicate, the impact of this shock on firms that are heavily leveraged would be weaker than that of the interest rate shock, and thus the share of risky debt would increase only moderately. A close look at the sample's characteristics indeed corroborates this hypothesis: firms with ICR below two under a profit shock had an average debt-to-equity ratio of 140 percent in the baseline, while firms with ICR below two under an interest rate shock had an average debt-to-equity ratio of 197 percent in the baseline.

- Finally, a combined shock of tighter financial conditions and lower profitability would have a sizable impact on firms' balance sheets, and thus likely to push many firms into a vulnerable situation. In particular, the share of firms with ICR less than 2 would increase to nearly 60 percent from 22 percent in the baseline. A similar increase is expected to take place in the share of risky debt, indicating a sharp increase in new defaults. Table 3 in Appendix IV shows that, in a combined shock, the shares of risky debt (i.e. owned by firms with ICR at less than 2) are at 50 percent or above in all categories of firm size.

[62] As discussed in Section IV, the probability of default also for firms with ICR higher than 1 is significant.

**Table 15. Ireland: Corporate Sector Sensitivity Analysis Results[1]**
(Percent except where indicated)

| | | ICR of the median firm | Share of Firms ICR<1 | Share of Firms ICR<2 | Share of Debt ICR<1 | Share of Debt ICR<2 |
|---|---|---|---|---|---|---|
| **Baseline** | All firms | 6.8 | 16.5 | 22.3 | 9.4 | 22.7 |
| | *of which:* | | | | | |
| | Small | 6.0 | 8.0 | 11.5 | 5.8 | 6.1 |
| | Medium | 7.4 | 6.9 | 8.8 | 2.3 | 9.6 |
| | Large | 7.4 | 1.5 | 2.2 | 1.3 | 7.0 |
| **Interest rate shock** | All firms | 4.0 | 17.3 | 31.0 | 9.8 | 56.6 |
| | *of which:* | | | | | |
| | Small | 3.6 | 8.6 | 17.2 | 6.1 | 7.0 |
| | Medium | 4.3 | 7.4 | 10.8 | 2.4 | 21.6 |
| | Large | 4.7 | 1.3 | 3.0 | 1.3 | 27.0 |
| **Profit shock** | All firms | 2.0 | 42.9 | 50.2 | 11.3 | 25.9 |
| | *of which:* | | | | | |
| | Small | 1.9 | 24.7 | 27.7 | 6.4 | 7.1 |
| | Medium | 2.1 | 14.5 | 17.5 | 2.6 | 10.1 |
| | Large | 2.3 | 3.7 | 5.0 | 2.3 | 8.7 |
| **Combined shock** | All firms | 1.2 | 47.4 | 58.6 | 14.7 | 59.9 |
| | *of which:* | | | | | |
| | Small | 1.2 | 26.4 | 31.4 | 6.7 | 7.6 |
| | Medium | 1.2 | 16.5 | 21.6 | 3.2 | 22.5 |
| | Large | 1.3 | 4.5 | 5.6 | 4.8 | 29.8 |

Source: BvD and IMF staff's calculations.

[1] To ensure consistency in the number of observations between the baseline and the adverse scenarios, the baseline figures were re-calculated and thus slightly differ from those presented in Section III.

***Implications for banks' asset quality and capital position***

**117. This section estimates the banks' potential losses that may arise due to corporate exposures, and compare them with the banks' buffers**. We follow the GFSR's (IMF 2013) methodology and assess the corporate exposures of the banking system as follows:[63]

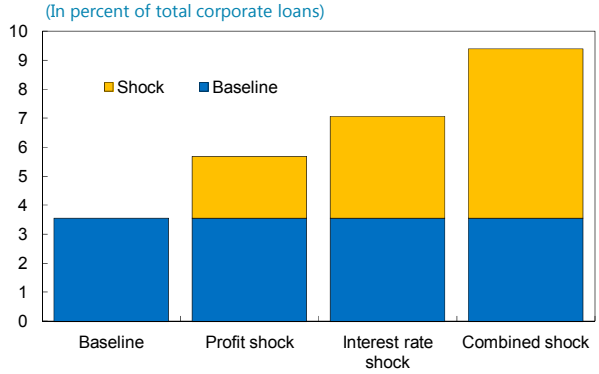
[63] See Global Financial Stability Report, 2013 October, Annex 1.2, for further details.

- Firm-level ICRs are mapped into probability of defaults (PDs) by using GFSR calculations, which matched ICR levels to historical default rates of companies rated by rating agencies (Table A5 in Appendix IV).
- Loss rates are obtained by multiplying the PDs by loss given default (LGDs) ratios. For this, we apply the Basel's standard LGDs of 45 percent.
- We assume that 50 percent of the large firms' debt and 75 percent of the SMEs' debt are owned by the banks.[64, 65]

**118. The results show that the applied shocks would lead to a significant increase in new corporate defaults (text figure).**[66] The analysis indicates that a profit shock would increase the new corporate defaults to 5.7 percent of the overall bank corporate loan book from 3.6 percent in the baseline (cumulative, two-year horizon).[67] The impact of an interest rate shock and a combined profit-interest rate shock would have a greater effect as it estimated to increase new defaults to 7.1 percent and 9.4 percent of total corporate loans, respectively. While the magnitude of shocks differs, these estimates appear comparable to the 11 percentage point increase in corporate NPL ratio realized in 2011–13, when corporate distress was generally high.

**New Corporate Defaults**[1]

(In percent of total corporate loans)




1/ Cumulative new defaults over a period of two years.
Sources: BvD and IMF staff's calculations.

**119. These estimations are moderately sensitive to the assumptions regarding the shares of SMEs' and large enterprises' debt that is owned by the banks.** For example, assuming that the share of SMEs' debt that is owned by banks is the same as that of large firms (50 percent), a profit shock, interest rate shock, and a combined shock would increase the share of new defaults to 5.0 percent, 6.6 percent, and 8.9 percent of total corporate loans, respectively, from a level of 3.2 percent in the baseline (cumulative, two-year horizon). The results assuming a LGD rate of 60 percent are not dramatically different.

[64] While recent surveys on SMEs' credit, including the Department of Finance's Red C and ECB's SAFE, suggest that the reliance on internal funding has increased significantly in recent years and now accounts for the lion share of SMEs' financing of investment and working capital, bank loans/overdrafts still account for the majority of SMEs' debt. Lawless et al (2013) suggest that nearly 80 percent of SMEs used bank overdrafts/loans in 2013.

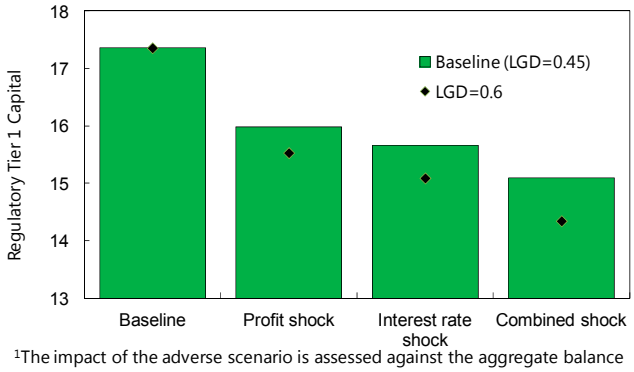
[65] CBI's data suggests that credit from monetary financial institutions accounted for 64 percent of the overall domestic NFC's debt in 2013.

[66] The presented calculations are based on Moody's PDs. The calculations based on alternative PDs are not significantly different.

[67] The banks' corporate loan book is assumed to remain constant during the shock period.

**120. Ceteris paribus, banks would still be able to absorb the shocks while keeping the regulatory Tier 1 capital well above the minimum requirement.** To calculate the impact on the banking system, we apply the calculated share of new defaults in the total corporate loan book under each scenario to the aggregate corporate loan book of the three main domestic banks in 2015Q3. Given the moderate share of corporate loans in the domestic banks' loan book (about 35 percent) and the banks' current capitalization levels, the analysis suggests that banks would be able to keep the regulatory Tier 1 capital well above the minimum requirement (text figure). More specifically, the results show that, in a combined shock scenario, where losses from defaults are expected to be the highest, the regulatory Tier 1 capital would fall to 15.1 percent of risk-weighted assets from 17.4 percent in the baseline (2015Q3). If a more conservative LGD is used, such as 60 percent, the regulatory Tier 1 capital would fall by an additional 0.8 percentage points of risk-weighted assets to 14.3 percent.

**Impact on Banks' Tier 1 Capital**[1]
(In percent of risk weighted assets)




[1]The impact of the adverse scenario is assessed against the aggregate balance sheets of the three domestic banks.
Sources: BvD and IMF staff's calculations.

***Re-weiging the composition of firms***

**121. The application of shocks to a sample with higher representation of SMEs would lead to a higher share of new defaults and a stronger effect on banks' capital.** The baseline relies on observations of 2013, where SMEs are somewhat under-represented: They account for about 90 percent of the total firms compared with a Central Statistics Office estimation of 99.7 percent. To correct for this bias, we increase the weight of SMEs in the sample while keeping the distribution of ICR the same and examine the impact on banks. The results suggest that, given the SMEs' high reliance on bank financing and their initial weaker financial health, the shocks would have a somewhat stronger effect on banks. In particular, a profit shock, interest rate shock, and a combined shock would increase the share of new defaults to 9.1 percent, 9.4 percent, and 11.9 percent of total corporate loans, respectively, from 5.2 percent in the baseline (cumulative, two-year horizon). In a combined shock scenario, where losses from defaults are expected to be the highest, the regulatory Tier 1 capital would fall to 14.5 percent of risk-weighted assets from 17.4 percent in the baseline (2015Q3).

## F. Conclusion

**122. The vulnerabilities of the Irish NFC sector have moderated in recent years.** The recent strong economic performance of the Irish economy was accompanied by increased corporate sector's profitability, sharp reduction in debt-to-equity ratio, and a decline in distress indicators, including default rates. The ICR of the median firm increased steadily in recent years, following a sharp decline in 2008–09, and the share of risky debt in total debt has declined. While NFC debt-to-GDP ratio remains

high from an international perspective, more than half of it is owned by multinationals and originates from external sources, including from inter-group loans.

**123. However, vulnerabilities remain elevated.** The levels of corporate debt and corporate NPLs remain high, therefore limiting firms' ability, particularly SMEs, to access finance and undertake new investment. While firms' financial health has improved, about one-fifth of the domestic firms—mostly of small size—were under "technical default" (with ICR of less than one) in 2013, with the share of debt owned by firms with ICR of less than one at 10 percent. Furthermore, the share of risky debt among small firms constituted nearly half of small firms' debt.[68]

**124. The sensitivity analysis suggests that adverse shocks would push many firms into a vulnerable state, yet banks' capital position would remain comfortable, at least in a first round effect.** An adverse shock might push many corporates' ICR below two, and thus result in a significant increase in the flow of new defaults. Still, given the moderate share of corporate loans in banks' loan books and banks' current capital position, they would still be able to keep the regulatory Tier 1 capital well above the minimum requirement.

**125. It is important to treat these results with some caution as the analysis in this paper is a static exercise.** Therefore, the analysis does not take into account second round effects, which may lead to higher unemployment and lower property prices and thus inflict additional losses on banks. Also, as adverse macroeconomic changes are likely to have a wider impact on the economy, including on government revenues, households, and financial institutions, the stress on banks' balance sheet is likely to be greater than measured in this exercise.

[68] It must be noted that one-in-three Irish SMEs have no debt on their balance sheet (McCann, 2014), therefore vulnerabilities are concentrated amongst a group of indebted SMEs.

# References

## Section I

Carstrén, Olli, and Llja Kristian Kavonius, 2009, "Balance Sheet Interlinkages and Macro-Financial Risk Analysis in the Euro Area," ECB Working Paper Series, No. 1124 (Frankfurt am Main; European Central Bank).

Cussen, Mary, 2015, "New Insights from the Enhancements to Quarterly Financial Accounts," Quarterly bulletin, April (Dublin: Central Bank of Ireland).

———, forthcoming, "Identifying Inter-Sectoral Exposures in Ireland using Network Analysis," Economic Letter Series (Dublin: Central Bank of Ireland).

Feyen, Erik, 2011, "Chile: Technical Note on Financial Interlinkages," IMF-WB Financial Sector Assessment Program Update, mimeo.

Financial Stability Board, 2015, "Global Shadow Banking Monitoring Report 2015," November (Basel: Financial Stability Board).

Hallissey, Niamh,2016, "Interconnectedness of the Irish banking sector with the global financial system," Quarterly bulletin, Spring (Dublin: Central Bank of Ireland).

Jones, Bradley Anthony, forthcoming, "Ireland: Technical note on Asset Management and Financial Stability in Ireland," IMF Financial Sector Assessment Program Update, mimeo.

Murphy, Gareth, 2012, "Irish Funds Regulation after the Implementation of AIFMD," *Address to the Irish Funds Industry Association, Institute of Bankers*, November 20 (Dublin: Central Bank of Ireland).

## Section II

Aiyar, Shekhar, Wolfgang Bergthaler, Jose M. Garrido, Anna Ilyina, Andreas Jobst, Kenneth Kang, Dmitriy Kovtun, Yan Liu, Dermot Monaghan, and Marina Moretti, 2015, "A Strategy for Resolving Europe's Bad Loans," SDN/15/19 (Washington: International Monetary Fund).

Central Bank of Ireland, 2015a, "Macro-Financial Review," Volume I (Dublin: Central Bank of Ireland).

———, 2015b, "Macro-Financial Review," Volume II (Dublin: Central Bank of Ireland).

Dombret, Andreas, 2013, "An overview of the CRE (Commercial Real Estate) market," Speech at the Workshop on Commercial Real Estate Underwriting (Basel: Bank of International Settlements).

Duffy, David, David Byrne, and John FitzGerald, 2014, "Alternative scenarios for new household formation in Ireland," Quarterly Economic Commentary, Autumn (Dublin: The Economic and Social Research Institute).

Duffy, David and Hannah Dwyer, 2015, "FDI and the Availability of Dublin Office Space," Quarterly Economic Commentary, Autumn (Dublin: The Economic and Social Research Institute).

Igan, Deniz, and Prakash Loungani, 2012, "Global Housing Cycles," IMF Working Paper, WP/12/217 (Washington: International Monetary Fund).

International Monetary Fund, 2014a, "Staff Guidance Note on Macroprudential Policy," Policy Paper, (Washington: International Monetary Fund).

_____, 2014b, "Staff Guidance Note on Macroprudential Policy: Detailed Guidance on Instruments," December (Washington D.C.: International Monetary Fund).

O'Brien, Eoin, and Maria Woods, 2015, "Estimating misalignment in Irish commercial property prices," mimeo (Dublin: Central Bank of Ireland).

Perlin, Marcelo, 2015, "MS_Regress – The MATLAB Package for Markov Regime Switching Model," mimeo.

## Section III

Central Bank of Ireland, 2015a, "Household Credit Market Report," Volume II (Dublin: Central Bank of Ireland).

_____, 2015b, "Information Note: Restrictions on Residential Mortgage Lending," January (Dublin: Central Bank of Ireland).

_____, 2015c, "Macro-Financial Review," Volume I (Dublin: Central Bank of Ireland).

_____, 2015d, "Macro-Financial Review," Volume II (Dublin: Central Bank of Ireland).

Gaffney, Edward, Robert Kelly, and Fergal McCann, 2014, "A transitions-based framework for estimating expected credit losses," Research Technical Papers 16/RT/14 (Dublin: Central Bank of Ireland).

Grace, Therese, Niamh Hallissey, and Maria Woods, 2015, "The Instruments of macro-prudential policy", Quarterly Bulletin 01, January (Dublin: Central Bank of Ireland).

Hallissey, Niamh, Robert Kelly, and Terence O'Malley, 2014, "Macro-prudential Tools and Credit Risk of Property Lending at Irish banks", *Economic Letter,* Vol. 2014. No. 10 (Dublin: Central Bank of Ireland).

International Monetary Fund, 2014, "Staff Guidance Note on Macroprudential Policy," Policy Paper, (Washington: International Monetary Fund).

Jackson, Christopher, 2011, "Multi-State Models for Panel Data: The MSM Package for R," *Journal of Statistical Software*, Vol. 1, 38 (8), 1–28.

Kelly, Robert, and Terence O'Malley, 2016, "The good, the bad and the impaired: A credit risk model of the Irish mortgage market," *Journal of Financial Stability*, Volume 22, February, Pages 1–9.

———, Terry O'Malley, and Conor O'Toole, 2015a, "Designing Macroprudential Policy in Mortgage Lending: Do First Time Buyers Default Less?" Research Technical Paper 02/RT/15 (Dublin: Central Bank of Ireland).

———, Paul Lyons, and Conor O'Toole, 2015b, "Mortgage Interest Rate Types in Ireland," *Economic Letter,* Vol. 2015. No. 9 (Dublin: Central Bank of Ireland).

———, Fergal McCann, and Conor O'Toole, 2015c, "Credit conditions, macroprudential policy and house prices," Research Technical Paper 06/RT/15 (Dublin: Central Bank of Ireland).

Lydon, Reamonn, and Yvonne McCarthy, 2011, "What Lies Beneath? Understanding Recent Trends in Irish Mortgage Arrears," Research Technical Paper 14/RT/11 (Dublin: Central Bank of Ireland).

McCarthy, Yvonne, 2014, "Dis-entangling the mortgage arrears crisis: The role of the labour market, income volatility and housing equity," Research Technical Papers 02/RT/14 (Dublin: Central Bank of Ireland).

## Section IV

Bastos, F.R., H. Kamil, and B. Sutton. 2015. "Corporate Financing Trends and Balance Sheet Risks in Latin America: Taking Stock of The Bon(d)anza", IMF Working Paper WP/15/10.

Carroll, J., P. Mooney, and C. O'Toole. (2016). "SME Investment in Economic Recovery", Quarterly Bulletin (April 2016), Central Bank of Ireland.

Chivakul, M., and R. Lam. 2015. "Assessing China's Corporate Sector Vulnerabilities", IMF Working Paper WP/15/72.

Chow, J.T.S., "Stress Testing Corporate Balance Sheets in Emerging Economies", IMF Working Paper WP/15/216.

Cussen, M., and B. O'Leary. 2013. Why are Irish Non-Financial Corporations So Indebted?, Quarterly Bulletin 01/2013, Central Bank of Ireland.

International Monetary Fund, May 2009. "Global Crisis: The Asian Context", Regional Economic Outlook, Asia and Pacific, Washington DC.

———, October 2013. "Making the Transition to Stability", Global Financial Stability Report, Chapter 1, Washington DC.

———, April 2014, "Could external and macroeconomic adjustments crystallize vulnerabilities in the corporate sector?", Global Financial Stability Report, Chapter 1, Washington DC.

Kang, H., and C. Saborowski. 2014. "Non-Financial Corporate Sector Vulnerability" Selected Issue paper in Brazil's 2014 Article IV Staff Report, IMF.

Lawless, M., F. McCann, and C. O'Toole. 2013. "The Importance of Banks in SME Financing: Ireland in a European Context", Economic Letter Series Vol. 2013, No 5.

———, B. O'Connell, and C. O'Toole. 2015. "SME Recovery Following a Financial Crisis: Does Debt Overhang Matter?", *Journal of Financial Stability*, 19.

McCann, F., 2014. "Profiling the Indebtedness of Irish SMEs", Economic Letter Series Vol. 2014, No 3.

Stuart, R., 2006. "Stylised Facts on Irish Corporate Balance Sheets", Financial Stability Report, Central Bank of Ireland.

# Appendix I. Mathematical Algorithm to Identify Systemic Destination and Source of Funding

[Perron-Frobenius Theorem] If $M$ is the transition matrix of a Markov process such that $M^k$ has only positive entries for some $k$, then there exists a unique probability vector $v$ such that $M \cdot v = v$. Moreover, $\lim_{k\to\infty} M^k \cdot v_0 = v$ for any initial state probability vector $v_0$. The vector $v$ is called as the steady-state Markov chain vector and its entries are steady-state Markov chain probabilities.

Let $s = (s_1, s_2, \dots, s_N)$ be the row vector of systemically important destination (source) measures of each sector in the Irish domestic financial network and let $X$ be the bilateral relative exposure matrix where $X_{AB}$ represents the relative claim (obligation) of sector A on sector B expressed as a fraction of total assets (liabilities) of sector A. Each row is a vector of probabilities and sums to 1. Because the fraction of a financial claim (obligation) flowing from a sector to another sector depends only on the current sector and not on the previous sectors, the domestic financial network is a Markov chain with a finite number of sectors with $X$ as its transition matrix.

Because the domestic financial network is dense in Ireland, the condition of the Perron-Frobenius theorem is satisfied. One can find the steady-state vector $s$ by solving

$$X \cdot s = s$$

$$s \cdot (X - I) = 0$$

where $I$ is the identify matrix and 0 is a null vector. The solution is equivalent to finding the dominant left-hand eigenvector of the matrix $X$.

# Appendix II. Estimation Results

## A. Residential Real Estate Market Estimation Results

### Table 1. Vector Error Correction Model

Identification: beta is exactly identified

Johansen normalization restrictions imposed

| beta | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _ce1 | | | | | | |
| lnhp | 1 | . | . | . | . | . |
| lnrgdp_pc | -1.67e-16 | . | . | . | . | . |
| ltir | 1.73e-18 | . | . | . | . | . |
| lnrpdebt | -.0362263 | .1319635 | -0.27 | 0.784 | -.29487 | .2224174 |
| lnconst_cost | -1.365915 | .4138951 | -3.30 | 0.001 | -2.177135 | -.5546957 |
| _cons | 2.638971 | . | . | . | . | . |
| _ce2 | | | | | | |
| lnhp | 6.94e-18 | . | . | . | . | . |
| lnrgdp_pc | 1 | . | . | . | . | . |
| ltir | 0 | (omitted) | | | | |
| lnrpdebt | -.0632705 | .0547474 | -1.16 | 0.248 | -.1705735 | .0440324 |
| lnconst_cost | -.918387 | .1717118 | -5.35 | 0.000 | -1.254936 | -.5818381 |
| _cons | -4.47799 | . | . | . | . | . |
| _ce3 | | | | | | |
| lnhp | 1.11e-16 | . | . | . | . | . |
| lnrgdp_pc | -1.78e-15 | . | . | . | . | . |
| ltir | 1 | . | . | . | . | . |
| lnrpdebt | -.6410097 | .9686346 | -0.66 | 0.508 | -2.539499 | 1.257479 |
| lnconst_cost | 8.397457 | 3.038061 | 2.76 | 0.006 | 2.442968 | 14.35195 |
| _cons | -48.72675 | . | . | . | . | . |

```
. veclmar
```

Lagrange-multiplier test

| lag | chi2 | df | Prob > chi2 |
|---|---|---|---|
| 1 | 50.0520 | 25 | 0.00210 |
| 2 | 47.8486 | 25 | 0.00389 |

H0: no autocorrelation at lag order

```
. predict ce1, ce equation(_ce1)

. label var ce1 "Long-run Relationship among variables (percent)"

. gen lnhp_long_2 = lnhp-ce1
(81 missing values generated)

. gen hp_long_2 = exp(lnhp_long_2)
(81 missing values generated)

. gen pcgap_VECM_2 = 100*(hp/hp_long_2-1)
(81 missing values generated)
```

## Table 2. Single Equation Error Correction Model

```
. reg lnhp lnrgdp_pc ltir lnrpdebt lnconst_cost, vce(robust)

Linear regression                               Number of obs     =        102
                                                F(4, 97)          =     914.95
                                                Prob > F          =     0.0000
                                                R-squared         =     0.9346
                                                Root MSE          =     .10779

------------------------------------------------------------------------------
             |               Robust
       lnhp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   lnrgdp_pc |   .5451518   .1549967     3.52   0.001     .2375262    .8527774
        ltir |   -.025022   .0058279    -4.29   0.000    -.0365888   -.0134551
    lnrpdebt |   .6624949   .0533869    12.41   0.000     .5565366    .7684532
lnconst_cost |  -1.293604   .1912341    -6.76   0.000    -1.673151   -.9140576
       _cons |   5.961584   1.337698     4.46   0.000     3.306624    8.616544
------------------------------------------------------------------------------

. predict ehat1, resid
(81 missing values generated)

. reg D.lnhp L.ehat1 D.lnrgdp_pc D.ltir D.lnrpdebt D_lnconst_cost, vce(robust)

Linear regression                               Number of obs     =        101
                                                F(5, 95)          =      14.92
                                                Prob > F          =     0.0000
                                                R-squared         =     0.3856
                                                Root MSE          =     .02288

------------------------------------------------------------------------------
             |               Robust
     D.lnhp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      ehat1 |
        L1. |  -.0486069   .0227963    -2.13   0.036    -.0938632   -.0033505
            |
   lnrgdp_pc |
        D1. |   .4475904    .120246     3.72   0.000     .2088719    .6863088
            |
        ltir |
        D1. |  -.0063101   .0047662    -1.32   0.189    -.0157723     .003152
            |
    lnrpdebt |
        D1. |   .3194734    .079729     4.01   0.000     .1611913    .4777555
            |
D_lnconst_cost |   .2380462   .0824656     2.89   0.005     .0743313    .4017611
       _cons |  -.0034872    .002908    -1.20   0.233    -.0092602    .0022858
------------------------------------------------------------------------------

. predict yhat1 if e(sample)==1
(option xb assumed; fitted values)
(82 missing values generated)
```

## Table 3. Pseudo Error Correction Model

```
. reg D.lnhp L.lnPIR D.lnrgdp_pc D.ltir D.lnrpdebt D_lnconst_cost, vce(robust)

Linear regression                               Number of obs     =        101
                                                F(5, 95)          =      13.72
                                                Prob > F          =     0.0000
                                                R-squared         =     0.3604
                                                Root MSE          =     .02334

------------------------------------------------------------------------------
             |               Robust
      D.lnhp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnPIR |
         L1. |  -.0070691   .0088194    -0.80   0.425    -.0245779    .0104397
             |
   lnrgdp_pc |
         D1. |   .4804625    .129625     3.71   0.000     .2231243    .7378008
             |
        ltir |
         D1. |   -.007368   .0050694    -1.45   0.149    -.0174321     .002696
             |
    lnrpdebt |
         D1. |   .2903431   .0827591     3.51   0.001     .1260456    .4546406
             |
D_lnconst_cost |   .2400205   .0848802     2.83   0.006     .0715119    .4085291
       _cons |   .0284892   .0400381     0.71   0.478    -.0509964    .1079748
------------------------------------------------------------------------------

. predict yhat5 if e(sample)==1
(option xb assumed; fitted values)
(82 missing values generated)
```

## Table 4. Markov Regime Switching Model

(Two states, three changing parameters: constant, error correction term, variance of the white noise)

```
***** Numerical Optimization Converged *****

Final log Likelihood: 252.7528
Number of estimated parameters: 12
Number of Observations: 101
Number of Equations: 1
Optimizer: fminsearch
Type of Switching Model: Univariate
Distribution Assumption -> Normal
Method SE calculation -> 1

***** Final Parameters for Equation #1 *****

---> Non Switching Parameters <---

Non Switching Parameter for Equation #1, Indep column 3
     Value:                -0.0010
     Std Error (p. value): 0.0037 (0.78)
Non Switching Parameter for Equation #1, Indep column 4
     Value:                0.1788
     Std Error (p. value): 0.1095 (0.11)
Non Switching Parameter for Equation #1, Indep column 5
     Value:                0.1912
     Std Error (p. value): 0.0545 (0.00)
Non Switching Parameter for Equation #1, Indep column 6
     Value:                0.0668
     Std Error (p. value): 0.1177 (0.57)

--->   Switching Parameters (Distribution Parameters)  <---

State 1
    Model's Variance:      0.000205
    Std Error (p. value):  0.0001 (0.00)
State 2
    Model's Variance:      0.000346
    Std Error (p. value):  0.0001 (0.00)

--->   Switching Parameters (Regressors)  <---

Switching Parameters for Equation #1 - Indep column 1

State 1
   Value:                 0.2507
   Std Error (p. value): 0.0749 (0.00)
State 2
   Value:                 0.2217
   Std Error (p. value): 0.0710 (0.00)

Switching Parameters for Equation #1 - Indep column 2

State 1
   Value:                -0.0501
   Std Error (p. value): 0.0160 (0.00)
State 2
   Value:                -0.0526
   Std Error (p. value): 0.0162 (0.00)

---> Transition Probabilities Matrix (std. error, p-value)

      0.94 (0.35,0.01)    0.06 (0.28,0.84)
      0.06 ( NaN, NaN)    0.94 ( NaN, NaN)

---> Expected Duration of Regimes <---

     Expected duration of Regime #1: 15.94 time periods
     Expected duration of Regime #2: 17.90 time periods


---> Covariance Matrix <---

State 1
      0.00021 (0.00006,0.00)
State 2
      0.00035 (0.00007,0.00)
```

## B. Commercial Real Estate Market Estimation Results

### Table 5. Single Equation Error Correction Model

```
. ********************************************
. * 1-1. Regression with Single Equation ECM *
. ********************************************
. reg L_capital L_credit L_gdp L_real_i, vce(robust)

Linear regression                               Number of obs     =        127
                                                F(3, 123)         =     208.79
                                                Prob > F          =     0.0000
                                                R-squared         =     0.7355
                                                Root MSE          =     .19588

------------------------------------------------------------------------------
             |               Robust
   L_capital |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    L_credit |    .299007   .046754     6.40   0.000     .2064604    .3915536
       L_gdp |  -.2892395   .0879522   -3.29   0.001    -.4633354   -.1151435
    L_real_i |  -.0919466   .0086729  -10.60   0.000    -.1091141   -.0747791
       _cons |   5.144204   .3014885   17.06   0.000     4.547426    5.740982
------------------------------------------------------------------------------

. estimate store Long_1

. predict yhat_1
(option xb assumed; fitted values)

. predict ehat_1, resid

. reg D.L_capital L.ehat_1 D.L_credit D.L_gdp D.L_real_i, vce(robust)

Linear regression                               Number of obs     =        126
                                                F(4, 121)         =      12.94
                                                Prob > F          =     0.0000
                                                R-squared         =     0.3028
                                                Root MSE          =     .03555

------------------------------------------------------------------------------
             |               Robust
D.L_capital |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      ehat_1 |
         L1. |  -.0550164   .0159082    -3.46   0.001    -.0865109   -.0235219
             |
    L_credit |
         D1. |    .32456   .0861388     3.77   0.000     .1540255    .4950946
             |
       L_gdp |
         D1. |   .4333748    .126225     3.43   0.001     .1834792    .6832705
             |
    L_real_i |
         D1. |  -.0144757   .0029362    -4.93   0.000    -.0202888   -.0086627
             |
       _cons |  -.0067351   .0039626    -1.70   0.092    -.0145801    .0011099
------------------------------------------------------------------------------

. predict yhat_1_1 if e(sample) == 1
(option xb assumed; fitted values)
(1 missing value generated)
```

## Table 6. Pseudo Error Correction Model

```
. reg D.L_capital L.PtR D.L_credit D.L_gdp D.L_real_i, vce(robust)

Linear regression                               Number of obs     =        126
                                                F(4, 121)         =      10.93
                                                Prob > F          =     0.0000
                                                R-squared         =     0.2535
                                                Root MSE          =     .03679

------------------------------------------------------------------------------
             |               Robust
D.L_capital |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        PtR  |
         L1. |   .0018002   .0245614     0.07   0.942    -.0468256    .0504259
             |
   L_credit  |
         D1. |   .2054999   .1072615     1.92   0.058    -.0068526    .4178524
             |
      L_gdp  |
         D1. |   .4723628   .1215759     3.89   0.000     .2316713    .7130543
             |
   L_real_i  |
         D1. |  -.0125777   .0031192    -4.03   0.000     -.018753   -.0064025
             |
       _cons |  -.011189    .0678611    -0.16   0.869    -.1455381     .12316
------------------------------------------------------------------------------

. predict yhat_1_2 if e(sample) == 1
(option xb assumed; fitted values)
(1 missing value generated)
```

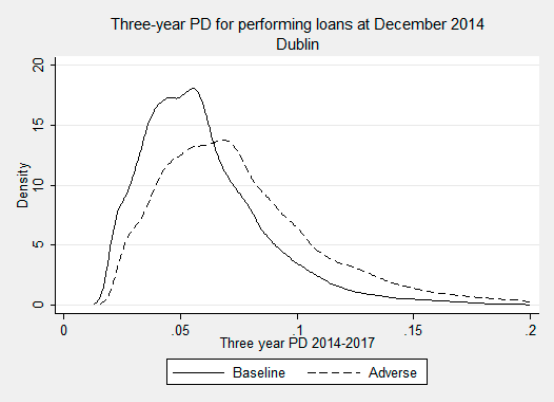
## Table 7. Markov Regime Switching Model

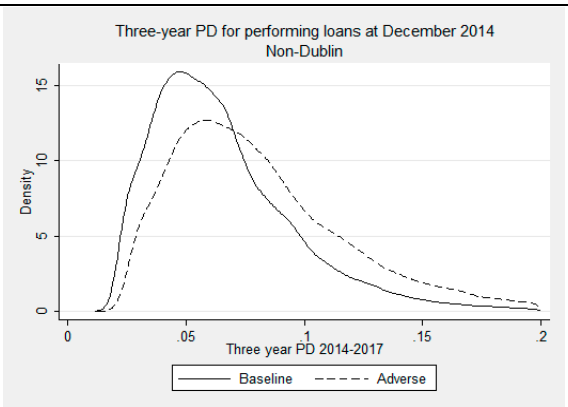
(Two states, three changing parameters: constant, error correction term, variance of the white noise)

```
***** Numerical Optimization Converged *****

Final log Likelihood: 270.8334
Number of estimated parameters: 10
Number of Observations: 126
Number of Equations: 1
Optimizer: fminsearch
Type of Switching Model: Univariate
Distribution Assumption -> Normal
Method SE calculation -> 1

***** Final Parameters for Equation #1 *****

---> Non Switching Parameters <---

Non Switching Parameter for Equation #1, Indep column 3
     Value:                  0.0678
     Std Error (p. value): 0.0585 (0.25)
Non Switching Parameter for Equation #1, Indep column 4
     Value:                  0.2022
     Std Error (p. value): 0.0620 (0.00)
Non Switching Parameter for Equation #1, Indep column 5
     Value:                 -0.0079
     Std Error (p. value): 0.0023 (0.00)

Non Switching Variance of model
     Value:                  0.000616
     Std Error (p. value): 0.0001 (0.00)

--->   Switching Parameters (Regressors)  <---

Switching Parameters for Equation #1 - Indep column 1

State 1
   Value:                0.0883
   Std Error (p. value): 0.0702 (0.21)
State 2
   Value:                0.5041
   Std Error (p. value): 0.0777 (0.00)

Switching Parameters for Equation #1 - Indep column 2

State 1
   Value:                -0.0238
   Std Error (p. value): 0.0234 (0.31)
State 2
   Value:                -0.1930
   Std Error (p. value): 0.0282 (0.00)

---> Transition Probabilities Matrix (std. error, p-value)

      0.97 (0.31,0.00)    0.06 (0.29,0.84)
      0.03 ( NaN, NaN)    0.94 ( NaN, NaN)

---> Expected Duration of Regimes <---

     Expected duration of Regime #1: 33.31 time periods
     Expected duration of Regime #2: 17.34 time periods
```

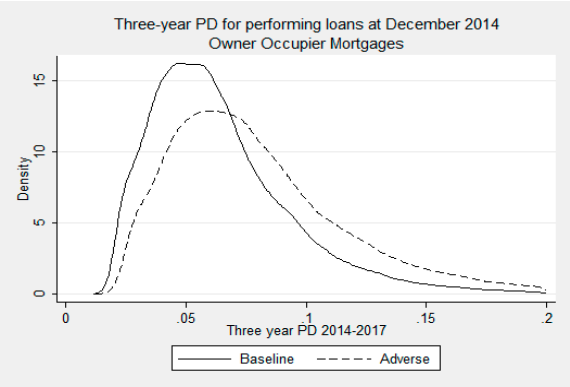
# Appendix III. Distribution of Probability of Default of a Group of Households against Stress Tests

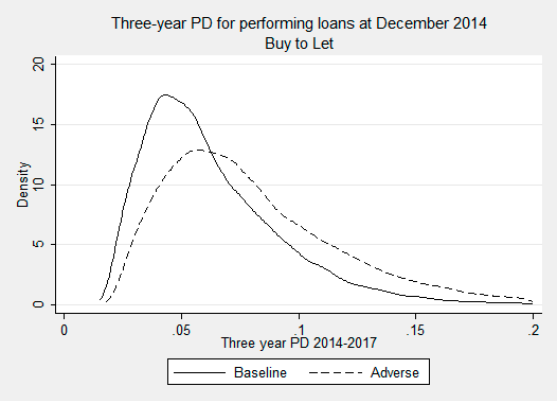
## Figure 1. PDs inside and outside Dublin



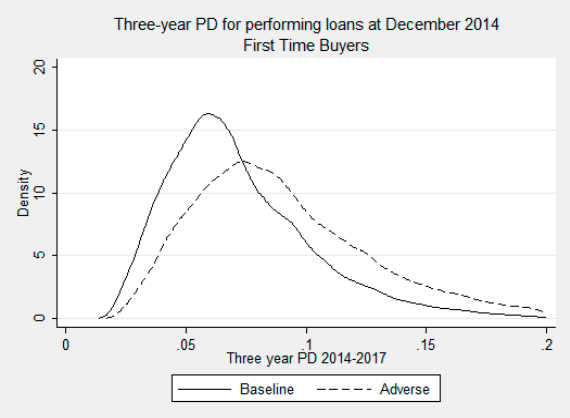



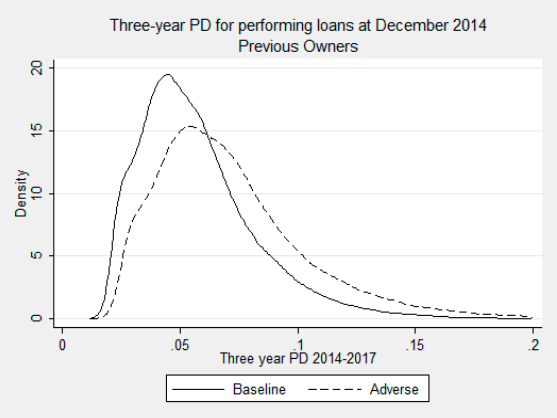

PDs by PDH and BTL Status



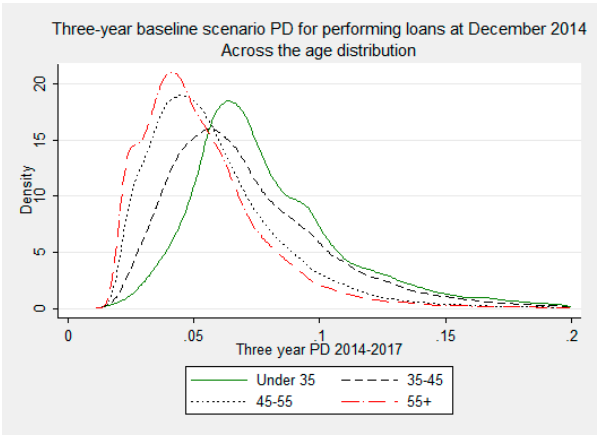



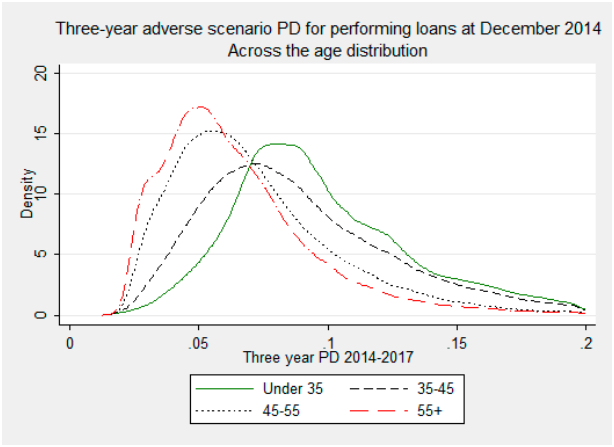

PDs by First Time Buyer Status



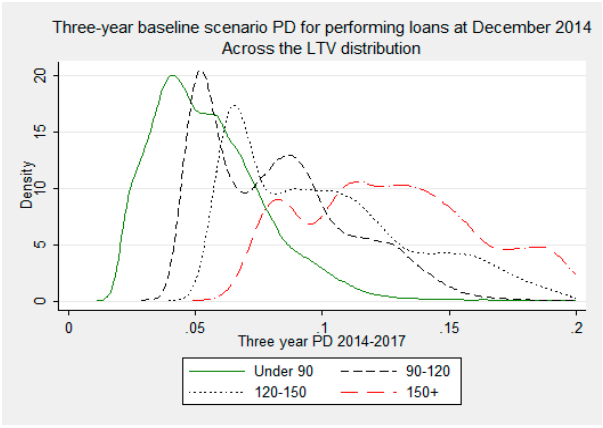



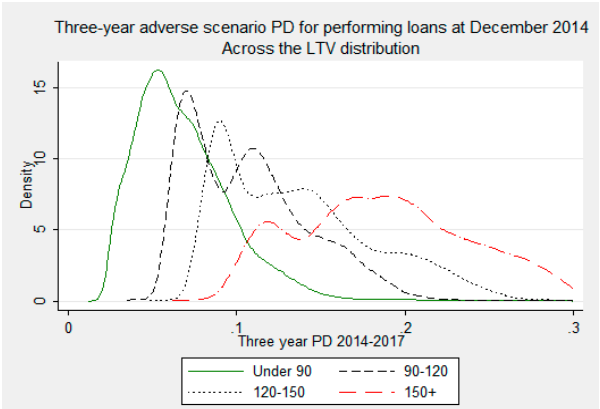
## Figure 2. PDs by Age Group



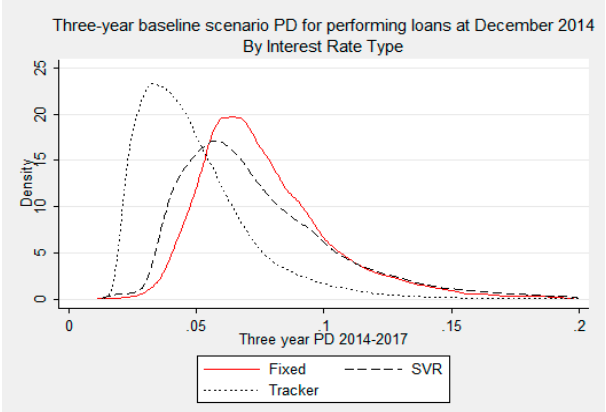



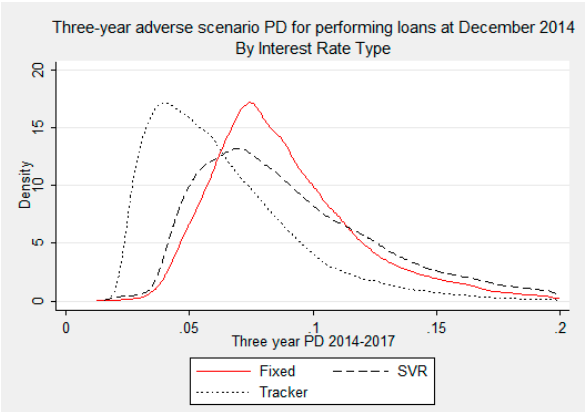

### PDs by LTV Bucket




### PDs by Interest Rate Type



# Appendix IV. Statistical Tables and Detailed Results

**Appendix Table 1. Ireland: Sample Coverage by year**

| | Domestic Firms | | | | | Subsidiaries of Foreign Firms | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | Small | Medium | Large | Sum | Cumul. | Small | Medium | Large | Sum | Cumul. |
| 1995 | 2 | 1 | 9 | 12 | 12 | 1 | | 3 | 4 | 4 |
| 1996 | 3 | 1 | 9 | 13 | 25 | 1 | | 5 | 6 | 10 |
| 1997 | 2 | 3 | 9 | 14 | 39 | 1 | | 5 | 6 | 16 |
| 1998 | 1 | 1 | 10 | 12 | 51 | | | 4 | 4 | 20 |
| 1999 | 2 | 4 | 9 | 15 | 66 | | 2 | 5 | 7 | 27 |
| 2000 | 3 | 3 | 10 | 16 | 82 | | | 7 | 7 | 34 |
| 2001 | 3 | 3 | 8 | 14 | 96 | 1 | 1 | 4 | 6 | 40 |
| 2002 | | 1 | 4 | 5 | 101 | | | 2 | 2 | 42 |
| 2003 | 4 | 2 | 4 | 10 | 111 | | 2 | 1 | 3 | 45 |
| 2004 | 3 | | 6 | 9 | 120 | | | 1 | 1 | 46 |
| 2005 | 53 | 36 | 43 | 132 | 252 | 11 | 7 | 6 | 24 | 70 |
| 2006 | 332 | 234 | 116 | 682 | 934 | 101 | 53 | 20 | 174 | 244 |
| 2007 | 700 | 381 | 153 | 1234 | 2168 | 198 | 96 | 33 | 327 | 571 |
| 2008 | 756 | 360 | 136 | 1252 | 3420 | 199 | 93 | 30 | 322 | 893 |
| 2009 | 691 | 326 | 111 | 1128 | 4548 | 177 | 78 | 26 | 281 | 1174 |
| 2010 | 616 | 280 | 106 | 1002 | 5550 | 154 | 66 | 23 | 243 | 1417 |
| 2011 | 517 | 246 | 107 | 870 | 6420 | 128 | 57 | 22 | 207 | 1624 |
| 2012 | 410 | 205 | 72 | 687 | 7107 | 85 | 52 | 17 | 154 | 1778 |
| 2013 | 281 | 164 | 49 | 494 | 7601 | 62 | 34 | 14 | 110 | 1888 |
| 2014 | 30 | 15 | 17 | 62 | 7663 | 12 | 2 | 2 | 16 | 1904 |
| **Total** | **4409** | **2266** | **988** | **7763** | | **1131** | **543** | **230** | **1904** | |

**Appendix Table 2. Ireland: Share of Vulnerable and Distressed Firms /1**

(Share of firms per year, percent)

| | 2007 | | 2009 | | 2013 | |
|---|---|---|---|---|---|---|
| | ICR<2 | ICR<1 | ICR<2 | ICR<1 | ICR<2 | ICR<1 |
| **Domestic firms** | 24.4 | 16.6 | 37.2 | 27.7 | 24.3 | 18.0 |
| Within small firms | 26.9 | 18.9 | 37.8 | 28.9 | 24.9 | 17.8 |
| Within medium firms | 20.7 | 12.9 | 36.5 | 27.0 | 24.4 | 19.5 |
| Within large firms | 22.2 | 15.7 | 36.0 | 21.6 | 20.4 | 14.3 |
| **Foreign Firms** | 28.4 | 20.4 | 35.2 | 27.7 | 19.1 | 12.7 |
| Within small firms | 30.3 | 20.2 | 35.6 | 26.6 | 17.7 | 12.9 |
| Within medium firms | 24.0 | 19.8 | 33.3 | 26.9 | 20.6 | 11.8 |
| Within large firms | 30.3 | 24.2 | 38.5 | 38.5 | 21.4 | 14.3 |

1/ The number of firms changes over time.

**Appendix Table 3. Ireland: Debt-at-Risk, based on ICR<1**

(Debt of firms with ICR < 1 relative to total debt, percent)

| | 2007 | 2009 | 2013 |
|---|---|---|---|
| **Domestic firms** | 10.5 | 15.3 | 9.9 |
| Within small firms | 22.2 | 40.4 | 49.0 |
| Within medium firms | 8.0 | 20.7 | 8.9 |
| Within large firms | 8.8 | 7.2 | 2.1 |
| **Foreign firms** | 11.2 | 20.0 | 4.1 |
| Within small firms | 28.2 | 23.2 | 38.6 |
| Within medium firms | 21.2 | 21.7 | 7.8 |
| Within large firms | 8.9 | 41.3 | 0.6 |

**Appendix Table 4. Ireland: Determinants of Firms' Distress**

| Logit model, Marginal effects at the means | | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Highly vulnerable | 0.038* | 0.038* | 0.037* | | | |
| Vulnerable | | | | 0.044* | 0.044* | 0.043* |
| Current ratio | -0.001** | -0.001** | -0.001** | -0.001* | -0.001* | -0.001** |
| Fixed assets/total Assets | | -0.000* | -0.000* | | -0.000* | -0.000* |
| Number of employees | | | -0.000** | | | -0.000** |
| Foreign | | | 0.004 | | | 0.004 |
| Primary sector | -0.012 | -0.010 | -0.012 | 0.010 | -0.009 | -0.010 |
| Manufacturing | 0.009 | 0.006 | 0.007 | 0.009*** | 0.008 | 0.009*** |
| Construction | 0.039* | 0.034* | 0.034* | 0.033* | 0.033* | 0.033* |
| Time dummies | yes | yes | yes | yes | yes | yes |
| # of Obs. | 9,522 | 9,522 | 9,522 | 9,522 | 9,522 | 9,522 |
| Pseudo $R^2$ | 0.086 | 0.088 | 0.097 | 0.0957 | 0.098 | 0.100 |

* Indicates significance at 1 percent **indicates significance at 5 percent *** indicates significance at 10 percent.

## Appendix Table 5. Ireland: Mapping of Corporate Vulnerability Indicators to Probabilities of Default

| Corporate Vulnerability Indicators[1,2] | | | | Cumulative Default Rates[3] | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Moody's | | Standard & Poor's | | Fitch | |
| ICR | Profitability | Leverage | Implied Rating | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 |
| 27.0 | 21.1 | 0.6 | Aaa/AAA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14.7 | 13.5 | 1.5 | Aa/AA | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9.3 | 12.0 | 2.0 | A/A | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 |
| 5.2 | 9.9 | 2.6 | Baa/BBB | 0.2 | 0.5 | 0.2 | 0.6 | 0.2 | 0.7 |
| 3.4 | 9.3 | 3.2 | Ba/BB | 1.1 | 3.1 | 0.9 | 3.0 | 1.1 | 2.8 |
| 1.6 | 7.3 | 4.8 | B/B | 4.1 | 9.6 | 4.5 | 10.0 | 2.0 | 4.8 |
| 0.5 | 3.2 | 7.6 | Caa-C/CCC-C | 16.4 | 27.9 | 26.8 | 36.0 | 24.9 | 31.9 |

Sources: Fitch; Moody's; Standard and Poor's; and IMF staff estimates.

[1]ICR is defined as EBIT/interest expense; profitability is defined as EBIT/average assets; leverage is defined as Debt/EBITDA.

[2]The probabilities of default are extrapolated beyond those corresponding to the implied rating C for firms with weaker vulnerability indicators.

[3]Based on 1970–2012 for Moody's, 1981–2011 for S&P, and 1990–2012 for Fitch.

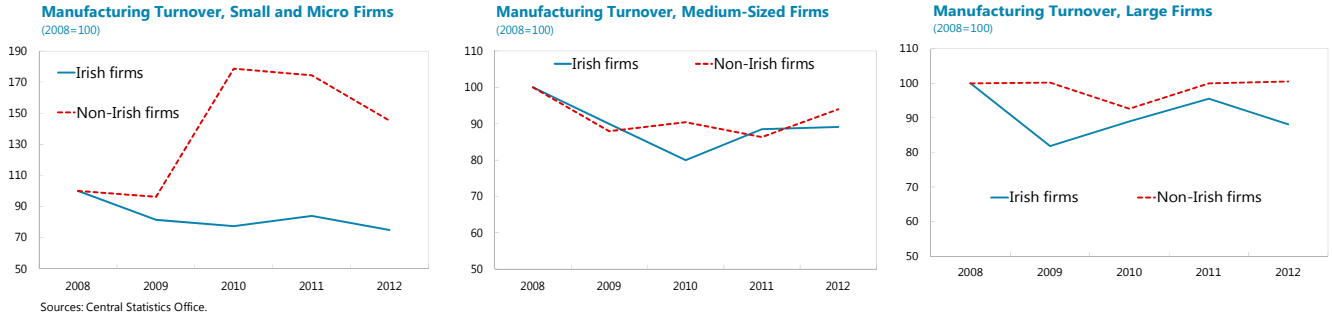
Source: IMF, GFSR, October 2013 , Chapter 1, Annex 1.2.

## Table 6. Ireland: Sensitivity Analysis Results

| | Share of Firms | | Share of Debt | |
|---|---|---|---|---|
| | ICR<1 | ICR<2 | ICR<1 | ICR<2 |
| **Baseline, 2013** | | | | |
| Shares within small firms | 14.9 | 21.2 | 47.3 | 49.9 |
| Shares within medium-sized firms | 19.5 | 24.3 | 8.9 | 36.5 |
| Shares within large firms | 14.2 | 20.4 | 2.1 | 11.4 |
| **Interest rate shock** | | | | |
| Shares within small firms | 16.1 | 31.7 | 50.3 | 57.5 |
| Shares within medium-sized firms | 20.7 | 30.5 | 9.0 | 82.9 |
| Shares within large firms | 12.2 | 28.6 | 2.1 | 44.1 |
| **Profit shock** | | | | |
| Shares within small firms | 45.8 | 51.4 | 48.7 | 51.6 |
| Shares within medium-sized firms | 40.9 | 49.4 | 9.9 | 38.5 |
| Shares within large firms | 34.7 | 46.9 | 3.8 | 14.1 |
| **Combined shock** | | | | |
| Shares within small firms | 49.0 | 58.2 | 52.2 | 59.0 |
| Shares within medium-sized firms | 46.3 | 61.0 | 12.3 | 85.7 |
| Shares within large firms | 42.9 | 53.1 | 7.9 | 48.8 |

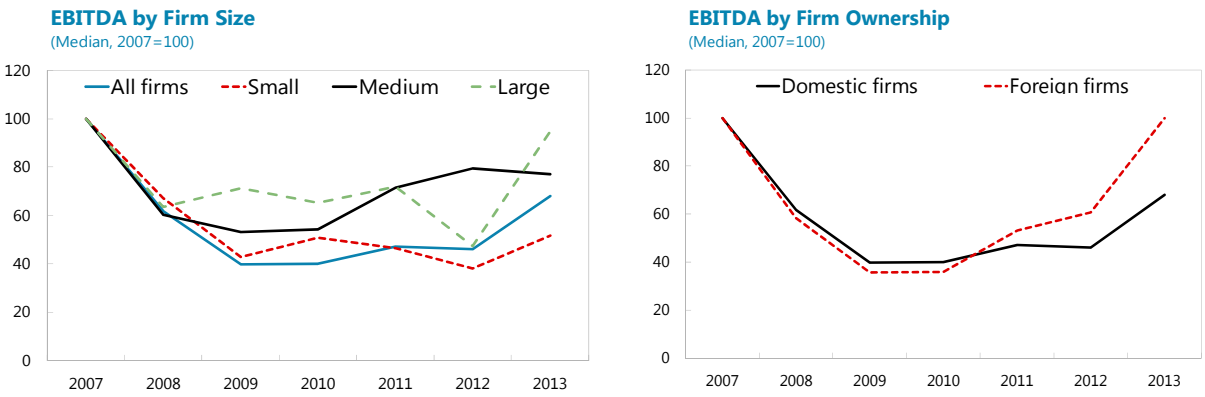
Source: BvD and IMF staff's calculations.

## Figure 1. Ireland: Manufacturing Turnover by Firm Size and Ownership




Sources: Central Statistics Office.

## Figure 2. Ireland: EBITDA by Firm Size and Ownership

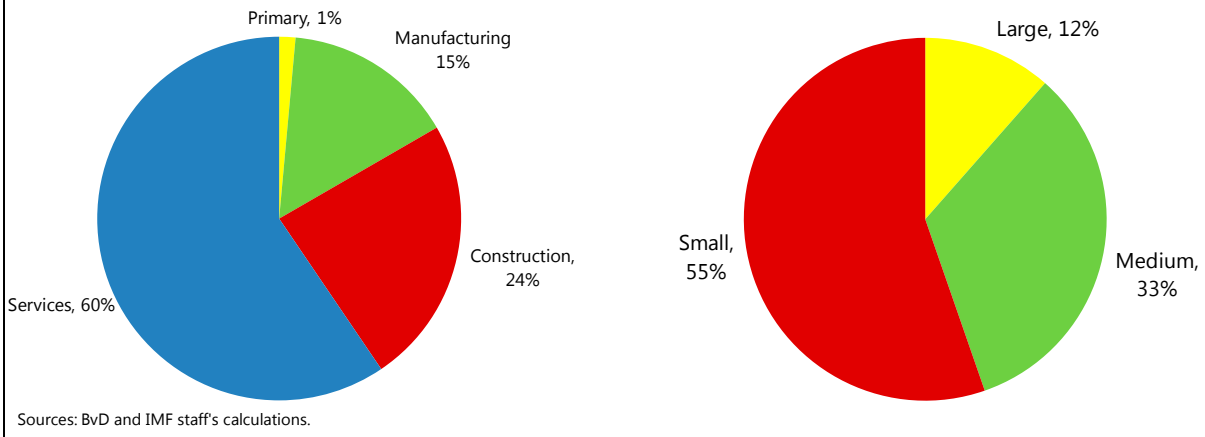



Sources: BvD and IMF staff's calculations.

**Figure 3. Ireland: Share of Vulnerable Firms**

**Figure 4. Ireland: Distribution of Distress by sectors and Firm size**

(In percent of total observations)




Sources: BvD and IMF staff's calculations.