# 4 ANNEXES

# 1. FEATURES OF FINTECH ACTIVITIES IN LUXEMBOURG: FIRST CONSIDERATIONS

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This contribution aims at providing an overview of the FinTech sector in Luxembourg. After briefly discussing the issue of defining "FinTech", we outline how the BCL's Statistics Department (hereafter "ST") collected data on FinTech entities and activities in Luxembourg and then presents the preliminary results of this data collection together with a proposal on a possible follow-up.

## DEFINITION OF FINTECH

The word "FinTech" is simply a combination of the words "financial" and "technology". Nevertheless, owing to the broad ranging activities of FinTech entities, developing a precise definition is challenging and there is no consensus on what "FinTech" means. According to Schueffel, 2016, very broadly FinTech describes the use of technology to improve financial services and products to consumers. Clearly, many companies can fall under this broad definition.

Even though FinTech entities and activities have become an increasing focus of regulatory authorities, these activities are not particularly new. Activities falling under the broad definition of FinTech were first utilized by Citigroup in the early 1990s when a project was developed aiming at facilitating technological cooperation efforts (Arner et al., 2015). However, the internet, combined with the widespread use of devices like smartphones and tablets, means the pace of FinTech innovation has accelerated greatly in recent years.

The Financial Stability Board (FSB) defines FinTech as "technologically-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial services" (FSB, 2017).

From a statistical point of view, neither the System of National Accounts 2008 (SNA2008) nor the European System of Accounts 2010 (ESA2010) provide a definition of FinTech.

Nevertheless, even if defining FinTech is not straightforward, innovations brought about by this sector could be substantial and potentially alter the financial sector. A better understanding of FinTech entities, activities and their implications for the financial system is therefore required.

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## FINTECH COMPANIES IN LUXEMBOURG

As no common statistical definition exists, the "Banque centrale du Luxembourg" has no specific Regulation related to the collection of statistics on FinTech and, therefore, any assessment of the financial stability implications of FinTech is challenging given the limited availability of official and privately disclosed data (FSB, 2017).

To compile a list of FinTech companies, ST has primarily relied on the information published by the Luxembourg House of Financial Technology (LHoFT) and the Association des Banques et Banquiers du Luxembourg (ABBL).

The LHoFT is a joint public-private sector initiative incorporated in 2017 and its purpose is to promote, encourage and support the development of innovative technologies in the financial sector. The LHoFT Board is comprised of senior executives from private sector institutions and representatives from the Luxembourg Government. In particular, some Luxembourg banks (e.g. BCEE, Société Générale, BGL BNP Paribas, etc.) are shareholders of the LHoFT as they want to closely monitor new solutions that are developed for financial services by FinTech companies brought together in the LHoFT building.

The LHoFT aims to foster the most innovative companies that could potentially improve the existing financial system by offering new products, which meet specific financial industry needs. The FinTech companies hosted in the LHoFT's working facility are selected by a Selection Committee partly made up of banks that evaluate the business models of prospective candidates to check whether they are considered as innovative and lasting. Once hosted, the FinTech companies can take advantage of the common environment offered by the LHoFT to grow. According to a LHoFT official, most of the successful FinTech companies hosted by the LHoFT are acquired by a bigger and well-established company at a certain point.

Some of the FinTech companies hosted by the LHoFT are listed on its website.[76] Nevertheless, as the FinTech environment is rather competitive some FinTech companies prefer not to be on this list in order not to disclose the solution they are working on.

The ABBL was established in 1939 and is a professional association representing the majority of credit institutions. While the range of ABBL activities is large, the ABBL created the Digital Banking and FinTech Innovation Cluster (DBFI) in 2016. This Group exchanges knowledge and ideas on how digitalization and the rise of FinTech may affect the Luxembourg financial sector. One of the outputs of the DBFI is a list of FinTech entities published on the ABBL website.[77]

76 https://www.lhoft.com/en/our-startups accessed on 14 February 2019.

77 https://www.fintechmap.lu/member-category/fintech-firms-and-software-vendors/ accessed on 14 February 2019.

Based on the two exhaustive lists published by both the LHoFT and the ABBL, ST compiled a FinTech database that contains around 200 FinTech companies. This database was enriched by information from the business register for the sectorisation of the units, the centralized balance sheets database as well the Chamber of Commerce register. The aggregated results of this database are shown in the table below:

Table 1:
**Broad population of Luxembourg FinTech companies (end of 2017)**

| ESA10 SECTOR CODE | ESA10 SECTOR DESCRIPTION | NUMBER OF COMPANIES | TOTAL ASSETS (MILLION OF EUR) | AVERAGE YEAR OF INCORPORATION |
|---|---|---|---|---|
| | Undefined | 5 | 41 | 2018 |
| 11000 | Non-financial corporations | 6 | 23 | 2003 |
| 11001 | Public non-financial corporations | 4 | 51 | 2004 |
| 11002 | National private non-financial corporations | 47 | 189 | 2011 |
| 11003 | Foreign controlled non-financial corporations | 62 | 2 612 | 2010 |
| 12203 | Foreign controlled deposit-taking corporations except the central bank | 3 | 11 827 | 2007 |
| 12400 | Non-MMF investment funds | 1 | | 2018 |
| 12600 | Financial auxiliaries | 1 | 31 | 1989 |
| 12602 | National private financial auxiliaries | 7 | 153 | 2009 |
| 12603 | Foreign controlled financial auxilaries | 19 | 1 877 | 2012 |
| 12700 | Captive financial institutions and money lenders | 6 | 42 | 2016 |
| 12703 | Foreign controlled captive financial institutions and money lenders | 14 | 3 348 | 2011 |
| 13110 | Central government | 1 | | 2012 |
| 15000 | Non-profit institutions serving households | 3 | | 2017 |
| **TOTAL** | | **179** | **20 193** | **2010** |

*Source: LHoFT, ABBL and BCL computations.*

According to the data collection performed by ST, and based on the information published by the LHoFT and the ABBL, the estimated total assets of the FinTech companies resident in Luxembourg amounts to around 20 billion euros at the end of 2017.

Out of these 20 billion euros, almost 12 billion euros can be attributed to the total assets of three FinTech entities holding a banking license including PayPal Europe, Keytrade Bank and Riverbank. PayPal (11.6 billion euros of total assets in 2017) is the largest entity out of the three banks and is considered a FinTech bank by the ABBL. In particular, PayPal offers an online money transfer service across the world. Keytrade Bank (242 million euros in total assets as of 2017) offers banking and trading services online and is considered a FinTech bank mainly because its clients are partly advised by a robot. RiverBank (more than 1 million euro in total assets at the end of 2017) helps small and medium enterprise (SME) borrowers with their credit applications and optimal financing structure and its business model sits at the intersection of FinTech and traditional banking. As these entities are actually supervised by the Commission de Surveillance du Secteur Financier (CSSF), they can be removed from the list of FinTech entities.

In addition, some companies considered as FinTech were granted a license as Electronic Money Institutions or Payment Institutions by the Ministère des Finances and, therefore, they are supervised by the CSSF. This is the case for Amazon Payments Europe, SIX Payments, MANGOPAY, Mercedes pay,

SnapSwap International and Volkswagen Payments. As these entities are also supervised by the CSSF, they can also be removed from the FinTech population.

Table 1 also shows an average year of incorporation of 2010, which seems to predate the current pattern of FinTech companies being a more recent development. The average year of incorporation of LHoFT companies is 2015 while the average year of incorporation of ABBL companies is 2009, which suggests that the ABBL tends to list more traditional and already well-established companies whose ability of really bringing innovative solutions to the financial services industry may be questioned. In particular, companies in the non-financial sector (ESA2010 sector code S.11) that were incorporated before the year 2000 should be removed from the FinTech population as they are not fully captured under the FinTech definition. The firms eliminated from the population in this step are mainly IT companies offering services to the financial sector, such as Temenos AG[78].

Once all the FinTech companies mentioned above were eliminated from the preliminary FinTech population shown in Table 1, the aggregated data of this reduced population are summarized in Table 2 below:

Table 2:
**Population of Luxembourg FinTech companies (end of 2017)**

| ESA10 SECTOR CODE | ESA10 SECTOR DESCRIPTION | NUMBER OF COMPANIES | TOTAL ASSETS (MILLION OF EUR) | AVERAGE YEAR OF INCORPORATION |
|---|---|---|---|---|
| | Undefined | 2 | 41 | 2018 |
| 11000 | Non-financial corporations | 4 | 1 | 2013 |
| 11001 | Public non-financial corporations | 3 | 48 | 2007 |
| 11002 | National private non-financial corporations | 42 | 119 | 2013 |
| 11003 | Foreign controlled non-financial corporations | 49 | 194 | 2013 |
| 12400 | Non-MMF investment funds | 1 | | 2018 |
| 12600 | Financial auxiliaries | 1 | 31 | 1989 |
| 12602 | National private financial auxiliaries | 5 | 138 | 2009 |
| 12603 | Foreign controlled financial auxilaries | 7 | 31 | 2013 |
| 12700 | Captive financial institutions and money lenders | 6 | 42 | 2016 |
| 12703 | Foreign controlled captive financial institutions and money lenders | 10 | 90 | 2011 |
| 13110 | Central government | 1 | | 2012 |
| 15000 | Non-profit institutions serving households | 3 | | 2017 |
| **TOTAL** | | **134** | **735** | **2013** |

*Source: LHoFT, ABBL and BCL computations.*

As indicated in Table 2 the population of FinTech companies in Luxembourg is currently around 130 but the aggregated total assets are now slightly above 700 million euros at the end of 2017, which is a relatively small amount compared to the total assets estimated in Table 1 and compared to the total assets of the financial sector that equaled 14 853 billion euros at the end of 2017.

Even if this amount is relatively small, ST proposes to regularly monitor the FinTech population in particular because some of these entities may have an effect on credit intermediation and, consequently, may increase financial stability risks associated with FinTech activities. For example, FinTech credit

78 Temenos AG is a company specialized in enterprise software for banks and financial services, with its headquarters in Geneva, Switzerland.

companies facilitate credit activity by offering online platforms that are not operated by commercial banks and that match borrowers with lenders. These platforms are referred to as "peer-to-peer (P2P) lenders", "loan-based crowd-funders" or "marketplace lenders". For example, Lendinvest, a UK based company with an activity in Luxembourg that is supported by the LHoFT, brings together all types of investors, and connects them with borrowers to provide property finance.

A classification of the Luxembourg FinTech companies into different clusters could also help to facilitate the monitoring of their different activities. The following clusters could be used:

- FinTech credit/lending
- FundTech and investment
- RegTech (address regulatory challenges in financial services)
- InsurTech (improve efficiency from the current insurance industry model)
- Cybersecurity and authentification
- Payments infrastructures
- Big data and Artificial Intelligence
- Cryptocurrency and blockchain
- Finance-related software vendors and IT solution providers

Statistics on the total assets, sector classification, number of companies and main activities of FinTech entities could be produced by cluster.

## CONCLUSION

FinTech innovation and activities are expected to become increasingly relevant for national authorities and it is therefore important to address data limitations at an early stage. BCL's data collection exercise has resulted in a list of FinTech firms and has provided a preliminary estimate of the total assets held by FinTech entities in Luxembourg. This data collection represents a first step towards addressing the existing data gaps and provides an initial basis for assessing FinTech activities that could be relevant for financial stability and risk assessment. As for the next steps in the project, ST plans to further enhance the database by providing statistics on FinTech firms at a more granular level using the proposed clusters, which could help to facilitate future, and more detailed, analyses and monitoring of the FinTech sector in Luxembourg.

## REFERENCES

Schueffel, P. (2016). Taming the Beast: A Scientific Definition of FinTech. Journal of Innovation Management, p 32-54.

Arner, D., Barberis, J. and Buckley, R. (2015). The Evolution of FinTech: A New Post-Crisis Paradigm? (October 1). University of Hong Kong Faculty of Law Research Paper No. 2015/047

Financial Stability Board (2017). Financial Stability Implications from FinTech, Supervisory and Regulatory Issues that Merit Authorities' Attention. June.

## 2. HOUSING SECTOR AND OPTIMAL MACROPRUDENTIAL POLICY IN LUXEMBOURG: A DGSE PERSPECTIVE

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### ABSTRACT

This study investigates the optimal macroprudential policies for Luxembourg using an estimated DSGE model. The model features a monopolistically competitive banking sector, a collateral constraint and an explicit differentiation between the flow and the stock of household mortgage debt. Based on a welfare-oriented approach and in a context of an easy monetary policy environment, we first find that the non-joint optimal loan-to-value (LTV) and risk weighted capital requirement (RW) ratios for Luxembourg seem to be 90% and 30%, respectively, while the joint optimal ratios are found to be 100% and 10% respectively.

Our results from the combination of instruments suggest that the policy scenario that provides better stabilization effects on mortgage credit isn't necessarily the one that is welfare improving. In other words, we find a complementarity between LTV and RW in terms of welfare, while their optimal combination diminishes the stabilization effects on mortgage debt and house price growth. However, the time-varying and endogenous rules for LTV and RW improve social welfare and better stabilize mortgage loans and house prices compared to their static exogenous ratios. We further find that the optimal interactions between LTV and RW ratios in our modelling framework exhibit a convex shape. It should be recalled that the results are conditional on the model's specific assumptions.


### 1 INTRODUCTION

A macroprudential policy framework was established in Luxembourg with the implementation and operationalization of the "*Comité du Risque Systémique*" (CRS) in 2015. The CRS is in charge of coordinating the implementation of macroprudential policy in Luxembourg. Macroprudential measures already implemented in Luxembourg include the 15% risk weight floor on residential real estate for IRB banks and the countercyclical capital buffer (calibrated at 0.25%). These measures have been focused on increasing the resilience of the banking sector and signalling the macroprudential stance of the national authorities. Macroprudential measures such as the loan-to-value ratio and other demand side instruments are currently not available in the national policy toolkit, although a draft law to implement these instruments was submitted to the Luxembourg Parliament in December 2017.

In September 2016, the ESRB issued a warning that the vulnerabilities in Luxembourg's residential real estate sector coupled with high household indebtedness could be a source of systemic risk to financial stability. A sustained and ongoing increase in residential real estate prices in Luxembourg has been driven by both significant excess demand for housing in combination with supply limitations. The persistent low interest rate environment in combination with high dwelling prices has fuelled the increase in household indebtedness levels.

Luxembourg households' debt is at a high level, even compared to other European countries, and amounted to 171.3% of disposable income in 2018Q4 and continues to increase. This increase in indebtedness, in combination with rising RRE prices poses risks to financial stability in the form of household debt sustainability and housing affordability. Around 70% of outstanding mortgage credit is in the form of variable rate loans exposing households to possible interest rate risk in the event of a significant and unexpected increase in the interest rate. In the absence of demand-side policy actions, these vulnerabilities could

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have adverse effects for the real economy. Borrower-based measures such as LTV limits could help to address these vulnerabilities. In addition to the existing capital based measures already implemented, the national authorities have drafted a legal framework for borrower-based measures to address risks related to household indebtedness in the residential real estate sector. Although the legal project for these instruments was transmitted to the Luxembourg Parliament in December 2017, they have not yet been formally adopted in the legislation. Nevertheless, there is a need to assess the optimal calibration of these instruments and they should be activated as soon as they are available in the national toolbox.

It is against this background that this study aims at addressing the following two interrelated questions: i) What would be the optimal loan-to-value (LTV) ratio/rule as a borrower-based macroprudential instrument for Luxembourg in a general equilibrium framework? This is an important policy issue as banks in Luxembourg currently implement various LTV ratios depending on their own assessment of household creditworthiness. ii) How important are the combinations of borrower and capital based macroprudential instruments and how can their optimal combination be determined?

To address these questions, this study proposes a framework for calibrating optimal macroprudential policies, assessing their interactions and evaluating their implications for financial stability. To this end, we build a DSGE model that features a housing sector and household debt dynamics. The model is estimated on Luxembourg data using Bayesian techniques. Unlike other studies in the literature, we distinguish between the flow and the stock of household debt in the model. We also introduce a monopolistically competitive banking sector, which features the costs of regulatory capital requirements and a feedback loop channel between the real and the financial side of the economy.

With respect to macroprudential policies, we introduce both borrower and capital based measures in order to determine their optimal ratios and interactions. We identify the optimal macroprudential ratios and rules for LTV and sectoral capital requirements while adopting a broad definition of the sectoral capital requirement that we call the risk weighted capital requirement (RW). We subsequently discuss the effectiveness of the optimal combination of instruments through their ability to stabilize the financial cycle, house prices and household indebtedness in the presence of both interest rate and LTV shocks. Finally, a welfare comparison of alternative policies is conducted in order to draw meaningful conclusions of the potential costs of these instruments to the real economy.

Our main findings can be summarized as follows[80]. First, the non-joint optimal ratios of LTV and RW leading to the maximum social welfare are respectively found to be 90% and 30% for Luxembourg in the context of an easy monetary policy environment. When solely an LTV measure is applied, it should be too tight at 20% to be realistic, leading admittedly to a welfare loss but bringing about stabilized debt relative to the use of both LTV and RW ratios. Second, we find that combining a borrower based instrument, such as the LTV cap, with a capital based one, as the RW ratio, welfare-dominates the use of LTV alone. This result suggests that these two instruments can be considered as complements in terms of welfare improvement. Notably, a single LTV measure performs better than combining the two instruments in terms of mortgage debt and house prices stabilization effects. These results suggest that the policy scenario that provides better stabilization effects on mortgage credit growth isn't necessarily the one that is welfare improving. More precisely, we find a complementarity between LTV and RW in terms of welfare improvement, while their optimal combination deteriorates the stabilization effects on mortgage debt and house prices.

80 Note that the modelling framework used to generate the results does not take into account all features of the residential real estate market in Luxembourg. In particular the constraints on the residential real estate supply, public incentives, such as the tax deductibility of mortgage interest rate, are omitted from the model.

Nevertheless, the time-varying and endogenous rules for LTV and RW improves social welfare and better stabilizes mortgage loans and the house prices compared to their static exogenous ratios. Finally, we find that the optimal interactions between LTV and RW ratios in our modelling framework have a convex shape. In other words, when LTV increases, the corresponding optimal RW ratio decreases and conversely, when the RW ratio increases, the corresponding optimal LTV ratio decreases.

## 2 LITERATURE REVIEW

The existing studies using the DSGE modelling approach for analysing the Luxembourg economy specifically are limited. Deák et al. (2011) built a DSGE model called the LSM (Luxembourg Structural Model) which captures the main structural features of the Luxembourg economy in order to undertake various policy experiments. Marchiori and Pierrard (2017) proposed a general equilibrium model calibrated on the Luxembourg economy, which features overlapping generation dynamics and labour market frictions, with the purpose of assessing how global demand for financial services promotes domestic growth in Luxembourg. These authors do not model the housing and financial sector and do not address financial regulation issues in the context of their models.

This work is related to four strands of literature. First, it is related to numerous papers that model housing sector with borrowing constraints in a dynamic stochastic general equilibrium framework (e.g. Iacoviello (2005), Iacoviello and Neri (2010), Gerali et al. (2010), Mendicino and Punzi (2014), Rubio and Carrasco-Gallego (2014), Guerrieri and Iacoviello (2017)). However, few works among the mentioned papers explicitly model the banking sector. Brzoza-Brzezina et al. (2017) use a small open economy model with a shortcut of the banking sector for studying the role of foreign currency loans under monetary and macroprudential policy, but their model does not contain any frictions in the banking sector nor a distinction between the mortgage credit flow and stock. Gerali et al. (2010) do consider frictions in the banking sector but they do not differentiate between mortgage lending flow and stock. We try to fill this gap by considering a DSGE model in which banks are explicitly modelled in a monopolistic competitive market and mortgage loan stocks and flows are explicitly differentiated in the model.

This study is also related to the growing body of literature on macroprudential policies. Several previous papers have explored the effectiveness of macroprudential policies using dynamic stochastic general equilibrium models. In particular, Lubello and Rouabah (2017) use a DSGE model with a shadow banking sector that is calibrated on euro area data to assess the role of the macroprudential policy in mitigating the effects of both real and financial shocks. However, their calibrated model does not account for the housing sector. Fève and Pierrard (2017) recently tackled issues related to macroprudential regulation using an estimated DSGE model with a shadow banking sector but without a housing sector. Overall, few studies have been interested in exploring the optimality of macroprudential policies (Rubio and Carrasco-Gallego (2014), Mendicino and Punzi (2014), Punzi and Rabitsch (2018)). However none of these studies focus on the interaction between macroprudential instruments. Most of these papers analyse optimal interactions between the monetary policy and macroprudential policy using calibrated models rather than assessing the optimal interaction of macroprudential policies.

Our work fits into the literature on combinations of macroprudential instruments. This strand of the literature is growing and most studies address the combination of borrower based instruments using regression techniques (Kelly et al. (2018) and Albacete et al. (2018) among others). Some exceptions include Chen and Columba (2016), Grodecka (2017) and Greenwald (2018) who analysed the combination of borrower based instruments using a DSGE modelling approach. Fewer works investigate the combination between borrower and capital based instruments using the DSGE modelling approach. In

particular, Benes et al. (2016) use a DSGE model for studying the effectiveness of the countercyclical capital buffer and the LTV ratio but in the absence of any optimality analysis.

Finally, the literature on the explicit distinction between credit flow and debt stock has a connection with our work. As far as we know, there exist only three papers in this case, Kydland et al. (2016), Grodecka (2017) and Alpanda and Zubairy (2017). These authors investigate household indebtedness or the effectiveness of macroprudential instruments by distinguishing mortgage credit flow from debt stock. However, they do not model the banking sector contrary to what we are doing in this study. Unlike these authors, we precisely emphasize the traditional feedback loop between the financial and real sector by incorporating the banking sector à la Gerali et al. (2010) in our modelling approach.

## 3 MODEL

In this study, we consider a closed-economy DSGE model with a housing sector, a collateral constraint and household debt. Two groups of households populate the economy: patient households and impatient households. Patient households are savers and have higher discount factors than impatient households who are borrowers ($\beta_P > \beta_I$). This heterogeneity in agents' discount factors generates positive fund flows in equilibrium; patient households make positive deposits and do not borrow, while impatient households borrow a positive amount of loans. Patient households consume, work and accumulate capital and housing. Impatient households consume, work and accumulate housing. As impatient households are considered to be borrowers, they are constrained by having to collateralize the value of their net worth (a financial friction).

We introduce a monopolistically competitive banking sector *à la* Gerali et al. (2010) in the model. Banks intermediate the funds that flow from patient households to impatient households as they have different degrees of impatience. Banks issue loans to impatient households by collecting deposits from patient households and accumulating their own capital out of reinvested profits. A second financial friction is introduced in the model by assuming that banks are subject to a risk weighted capital requirement constraint that translates into an exogenous target for the leverage ratio and implies a quadratic cost. Unlike Gerali et al. (2010), we introduce a distinction between the mortgage credit flow and stock following Kydland et al. (2016) and Alpanda and Zubairy (2017).

On the production side, monopolistically competitive intermediate-goods-producing firms produce heterogeneous intermediate goods using physical capital, bought from capital goods producers, and labour supplied by households in return for sticky wages *à la* Calvo (1983). The prices of intermediate goods are also set in a staggered fashion *à la* Calvo (1983). Final goods-producing firms, who bundle intermediate goods into final goods, capital and housing producers operate in perfectly competitive markets.

Finally, a passive government covers its expenditures and transfers to households by issuing bonds that are purchased by savers and a monetary authority follows a standard Taylor-type interest rate rule.

We present here only a brief summary of the model. All model details including the first order conditions derived from agents' optimization programmes are available under request and in Sangaré (2019).

## 3.1 HOUSEHOLDS

There are two types of households in the economy, each of unit mass and indexed by "*I*"and "*P*". Households derive utility from consumption $(c_{z,t})$, housing services $(h_{z,t})$ and hours worked, $(n_{z,t})$[81], where $\mathbf{z \in [I,P]}$.

**Patient households**

The representative patient household "*i*" maximizes their expected utility function subject to the following budget constraint (in real terms):

$$c_{P,t}(i) + q_{h,t}\left[h_{P,t}(i) - (1-\delta_h)h_{P,t-1}(i)\right] + q_{k,t}[k_t(i) - (1-\delta_k)k_{t-1}(i)] + d_t(i) + b_t(i) = w_{P,t}(i)n_{P,t}(i) + r_{k,t}k_{t-1}(i) + (1+r_{t-1})\left[\frac{d_{t-1}(i) + b_{t-1}(i)}{\Pi_t}\right] + tr_{P,t} + \Lambda_t \quad (1)$$

where $h_{P,t}$ and $k_t$ are accumulated housing and physical capital with $q_{h,t}$ and $q_{k,t}$ their respective real prices. The stock of housing and physical capital depreciate at rates $\delta_h$ and $\delta_k$, respectively. $d_t$ defines real deposits made in the period and $b_t$ is the real amount of one-period government bonds purchased by patient households, on which they earn a gross nominal interest rate of $(1+r_t)$. $\Pi_t = P_t/P_{t-1}$ defines the gross inflation rate with $P_t$ as consumption goods prices. $r_{k,t}$ denotes the rental rate of physical capital received from the intermediate goods producing firms, while $w_{P,t}$ stands for the real wage. Patient households receive lump-sum transfers from government, $tr_{P,t}$, and dividends from monopolistically competitive firms and banks, $\Lambda_t$.

**Impatient households**

The representative impatient household "*i*" also maximizes the expected utility function subject to the following budget constraint:

$$c_{I,t}(i) + q_{h,t}\left[h_{I,t}(i) - (1-\delta_h)h_{I,t-1}(i)\right] + \left(r_{M,t-1} + \kappa\right)\frac{de_{t-1}(i)}{\Pi_t} = w_{I,t}(i)n_{I,t}(i) + l_t(i) + tr_{I,t} \quad (2)$$

and the following collateral constraint

$$l_t(i) \leq m_{h,t}\left[\frac{(1-\delta_h)E_t q_{h,t+1}h_{I,t}(i)\Pi_{t+1}}{(1+r_{L,t})} - (1-\kappa)\frac{de_{t-1}(i)}{\Pi_t}\right]\mu_{m,t} \quad (3)$$

where $h_{I,t}$ is housing accumulated by impatient households. The latter don't accumulate any physical capital and borrow, $l_t$, from banks at a gross nominal interest rate of $(1+r_{L,t})$. They earn $w_{I,t}$ as wages and receive lump-sum transfers, $tr_{I,t}$, from government as for patient households.

81 The expected utility of the representative household of each type of household and the first order conditions derived from households' problem are detailed in Sangaré (2019).

$m_{h,t}$ denotes the loan-to-value (LTV) on total mortgage loans, and is set by the macroprudential authority. The collateral constraint (3) means impatient households cannot borrow more than a fraction of the expected value of their net wealth (the expected value of the housing stock minus the real value of non-amortized debt)[82]. $\mu_{m,t}$ defines an exogenous LTV shock which follows an autoregressive process AR(1).

$\left(r_{M,t-1}+\kappa\right)\frac{de_{t-1}(i)}{\Pi_t}$ represents impatient households (borrowers) mortgage payments, defined as the sum of interest and principal payments. $r_{M,t}$ denotes the effective interest rate on all mortgage outstanding and $\kappa$ is the amortization rate determining the principal payments out of the stock of debt.

Therefore, the stock of mortgage debt evolves as according to:

$$de_t(i) = (1-\kappa)\frac{de_{t-1}(i)}{\Pi_t} + l_t(i) \tag{4}$$

New and refinanced loans are both subject to the period interest rate $r_{L,t}$ set by the banks. Following Alpanda and Zubairy (2017), the effective interest rate is assumed to be:

$$r_{M,t} = (1-\zeta)\left(1-\frac{l_t}{de_t}\right)r_{M,t-1} + \left[\left(\frac{l_t}{de_t}\right) + \zeta\left(1-\frac{l_t}{de_t}\right)\right]r_{L,t} \tag{5}$$

where the fraction of existing loans that are refinanced each period is $\zeta$..

If $\zeta = 1$, all mortgage loans are refinanced and the effective rate equals the new loan rate $(r_{M,t} = r_{L,t})$, while when $\zeta = 0$ the model features no refinancing loans. Furthermore, note that if $\kappa = 1$ the model does not differentiate debt stock and loans $(l_t = de_t)$ and we have one-period debt as common in the literature and the effective interest rate would again simply equal the banking new loan rate $(r_{M,t} = r_{L,t})$.

**Wage setting**

In order to introduce wage stickiness in the model, we assume that labour services are heterogeneous across households within each group, which gives households some pricing power in setting their own wages. These differentiated labour services are aggregated into a homogeneous labour service (using a Constant Elasticity of Substitution (CES) aggregator) by perfectly competitive labour intermediaries (called unions or labour packers), who in turn rent these labour services to goods producers. Following Calvo (1983), we assume that households are not freely able to adjust their wage each period. This assumption defines wage stickiness in the model.

## 3.2 BANKING SECTOR

The banking sector is built up of a continuum of banks $j \in [0,1]$. Following Gerali et al. (2010) and Gambacorta and Signoretti (2014), we assume that each bank $(j)$ is composed of two segments: a wholesale branch and a retail branch.

The perfectly competitive wholesale segment collects deposits $(d_t(j))$ from patient households paying a net interest rate, $r_t$, set by the central bank and issues loans, $l_t(j)$, on which it earns the wholesale loan net rate. Furthermore, the bank has own funds $k_{b,t}(j)$, which are accumulated out of reinvested profits.

82 As in Iacoviello (2005), we assume that the shocks are small enough that the collateral constraint always binds.

Following Gerali et al. (2010), we assume that the bank has a target $\tau_t$ for their capital-to-assets ratio (i.e., the inverse of leverage ratio) and pays a quadratic cost whenever it deviates from that target. The target can be interpreted as an exogenous regulatory constraint that imposes the amount of own resources to hold. The existence of a cost for deviating from $\tau_t$ implies that the degree of bank leverage affects credit conditions in the economy. Wholesale bank $(j)$'s problem is therefore to maximize its profits subject to the following balance sheet constraint: $l_t(j) = d_t(j) + k_{b,t}(j)$.

The retail loan branch operates under monopolistic competition. This segment obtains loans from the wholesale segment, differentiates them at no cost and resells them to final borrowers (i.e., impatient households) at rate $r_{L,t}$. As in Gambacorta and Signoretti (2014), we assume that the retail loan rate $(r_{L,t})$ is set in the process by simply applying a constant mark-up $m_b$ on the wholesale loan rate so that:

$$r_{L,t} = r_t - \chi\left(\frac{k_{b,t}(j)}{l_t(j)} - \tau_t\right)\left(\frac{k_{b,t}(j)}{l_t(j)}\right)^2 + m_b \qquad (6)$$

### 3.3 CAPITAL AND HOUSING PRODUCERS

In each period, perfectly competitive capital investment-goods producers purchase last-period undepreciated capital from patient households and capital investment goods from final-goods firms at a relative price of one, and produce the new capital goods increasing the effective installed capital, which is then sold back to patient households. This transformation process is subject to adjustment costs in the change in investment. We assume that residential investment producers act in a way that is analogous to that of capital producers. Both capital and housing producers optimally behave by maximizing their profits.

### 3.4 GOODS PRODUCTION

Perfectly competitive final-goods producers purchase differentiated intermediate goods that are bundled into final goods via the Dixit-Stiglitz aggregator. A continuum of monopolistically competitive intermediate-goods producers $j \in [0,1]$, produce each intermediate good $(j)$ according to the following production function:

$$y_t(j) = \mu_{y,t}(k_{t-1}(j))^{\alpha}\left[\left(n^d_{I,t}(j)\right)^{\eta}\left(n^d_{P,t}(j)\right)^{1-\eta}\right]^{1-\alpha} \qquad (7)$$

where $\alpha$ is the share of capital in overall production, and $\eta$ denotes the share of impatient households in the labour input. $n^d_{P,t}(j)$ and $n^d_{I,t}(j)$ represent labour supplied by patient and impatient households. $\mu_{y,t}$ is the sector wide total factor productivity which follows an AR(1) process.

Firms solve their cost minimization problem subject to (7), which provides the real cost of production factors. Price rigidities are introduced in the model following the New Keynesian literature. Firms are subject to Calvo price-setting and the optimal price is found by solving their dynamic problem of profit maximization.

### 3.5 GOVERNMENT AND MONETARY POLICY

The government finances its exogenous consumption and transfers to households by issuing debt. The central bank sets monetary policy according to the Taylor-type rule.

### 3.6 MARKET CLEARING CONDITIONS

The model's equilibrium is defined as a set of prices and allocations such that households maximize the discounted present value of utility, banks maximize the discount present value of profits, and all firms maximize the discounted present value of profits subject to their constraints, and all markets clear.

## 4 ESTIMATION

The model was estimated using Bayesian methods and Luxembourg data. We estimate the structural parameters that mainly affect the model dynamics and calibrate the parameters that either determine the steady state so as to match key statistics in the data or are non-identifiable. In the section that follows, we first discuss the calibrated parameters, the priors and data and we then report the parameter estimates.

### 4.1 CALIBRATION AND PRIORS

Table 1 reports the values of the calibrated parameters. The parameters are set in such a way that the model matches the economic data for Luxembourg. The steady state gross inflation rate is set to 1.005, corresponding to the average long-run annual inflation rate of 2% in Luxembourg. We set the discount factor of patient households, $\beta_P$, at 0.999 in order to match the average annual Euribor rate of 2.1% in our sample (1999-2017). As for the discount factor of impatient households', $\beta_I$, we set it at 0.995 corresponding to the average annual spread between the Euribor rate and loan rates on new mortgage contracts in Luxembourg of 190 bps.

The capital share in output, α, is calibrated at 0.3, corresponding to the share of labour income over GDP of 0.7 as per Luxembourg data. The capital depreciation rates in the residential $(\delta_h)$ and non-residential $(\delta_k)$ sectors are set respectively at 0.005 and 0.01 corresponding to residential and non-residential investments over their respective stock of capital in the data. The relative weight of housing in the utility function, $\chi_h$, is calibrated such that the ratio of housing over consumption in the steady state is 0.043.

Setting the weight of labour in utility, $\chi_n$, to 7 allows us to match the share of working time of 1/3. The steady-state LTV ratio, $m_h$, is set at 0.7 consistent with the average data. The steady state value of capital-to-mortgage loan ratio $(\tau)$ is calibrated as 0.25 as provided by the Luxembourg end-period data (2017).

We calibrate the amortization rate for mortgage loans, $\kappa$, at 0.0165, which implies that the average duration of mortgage loans in the model is 20 years[83]. This value is consistent with Luxembourg data. Given this value and the ratio of debt stock to flow in the data, we infer that the share of loans that is refinanced in the model,$\zeta$, is about 0.02, by assuming that the refinancing share of the first loan applications in data is small (10%) as there are no available Luxembourg data on this parameter.

83 Following Alpanda and Zubairy (2017), we approximate the duration by 2 times the half-life of the loan.

Some steady state ratios are required for solving the models. Bank's capital-to-GDP ratio is set at 3% according to the end-period data. Public debt-to-GDP and spending-to-GDP ratios are respectively 23% and 20% as per the average data in the sample.

Parameters for which data are not available to calibrate are set following the literature. We calibrate the share of impatient households' income in labour income, $\eta$, at 0.7, following Alpanda and Zubairy (2017) and the fact that the BCL survey of Luxembourg households (HFCS, 2014) reports a small share of income of wealthier households (top deciles) over the total income declared.

All other parameters are estimated. The prior distributions are reported in Table 2. Our choices of prior distributions follow the literature and some theoretical restrictions. In particular, a Beta distribution is chosen for the parameters restricted to the interval [0, 1], Gamma and Normal distributions are chosen for the parameters which are assumed to be positive and an Inverse-Gamma distribution is used for the standard deviation of shocks. The prior means and standard errors are closely chosen from the literature.

Table 1:
**Calibrated parameters**

| | | |
|---|---|---|
| $\beta_P$ | Discount factor of patient households | 0.999 |
| $\beta_I$ | Discount factor of impatient households | 0.995 |
| $\alpha$ | Capital share in output | 0.3 |
| $\delta_h$ | Residential capital depreciation rate | 0.005 |
| $\delta_k$ | Non-residential capital depreciation rate | 0.01 |
| $\chi_h$ | Weight of housing in the utility | 0.3 |
| $\chi_n$ | Weight of labour in utility | 7 |
| $m_h$ | LTV ratio | 0.7 |
| $\tau$ | Capital-to-asset ratio | 0.25 |
| $\kappa$ | Amortization rate | 0.0165 |
| $\zeta$ | Share of refinanced loans | 0.02 |
| $k_b/Y$ | Capital-to-GDP ratio | 0.03 |
| $b/Y$ | Public debt-to-GDP ratio | 0.23 |
| $G/Y$ | Public spending-to-GDP ratio | 0.2 |
| $\eta$ | Share of Impatients in labour income | 0.7 |

*Source: Calculs BCL.*

## 4.2 DATA

We use the following 8 observable series for the estimation: real private consumption, real house price index, real residential investment, real non-residential investment, domestic households' mortgage debt stock, total hours worked, CPI inflation rate, and the Euribor interest rate (6 months). The real residential investment in data is defined by the dwellings gross fixed capital formation and the gross fixed capital formation excluding dwellings denotes the real non-residential investment. Data series are collected quarterly and the sample period is 1999Q-2017Q4. Series with seasonal patterns are seasonally adjusted by the Census X-12 procedure and those with trend are HP-filtered in order to make them stationary, while both the interest and inflation rate are demeaned.

## 4.3 POSTERIOR ESTIMATES

The posterior distributions of the parameters are obtained using the Metropolis-Hastings algorithm with 2 chains of 200 000 draws. The acceptance rate by chain was 0.25. Convergence was assessed by the convergence statistics proposed by Brooks and Gelman (1998). Table 2 reports the mean and the 5$^{th}$ and 95$^{th}$ percentiles of the posterior distributions of the estimated parameters. Clearly, it appears that data are quite informative about most of the parameters and the parameter estimates are in line with the literature.

Table 2:
**Estimated parameters**

| | | PRIOR DISTRIBUTION | | | POSTERIOR DISTRIBUTION | |
|---|---|---|---|---|---|---|
| PARAMETER | DESCRIPTION | DISTRIBUTION | MEAN | SD | MEAN | 95% INTERVAL |
| $a$ | Habit in consumption | Beta | 0.4 | 0.02 | 0.5077 | [0.4782 0.5296] |
| $\phi$ | Inverse of Frisch elasticity | Gamma | 1 | 0.15 | 1.1585 | [0.8368 1.4704] |
| $\theta$ | Calvo wage stickiness | Beta | 0.85 | 0.1 | 0.337 | [0.2426 0.4370] |
| $\psi$ | Calvo price stickiness | Beta | 0.85 | 0.1 | 0.6577 | [0.6109 0.7039] |
| $\epsilon_w$ | Labour substitution elasticity | Gamma | 6 | 1.5 | 4.1131 | [2.0805 6.2955] |
| $\epsilon$ | Goods substitution elasticity | Gamma | 6 | 1.5 | 5.6797 | [3.9188 7.6730] |
| $\xi_k$ | Capital investment adj. cost | Gamma | 2 | 1.5 | 0.2165 | [0.1531 0.2841] |
| $\xi_h$ | Housing investment adj. cost | Gamma | 2 | 1.5 | 0.287 | [0.2009 0.3831] |
| $\chi$ | Bank leverage deviation cost | Normal | 1 | 0.1 | 0.6582 | [0.4818 0.8565] |
| $\gamma_1$ | Taylor rule smoothing coeff. | Beta | 0.8 | 0.1 | 0.6758 | [0.5943 0.7496] |
| $\gamma_2$ | Taylor rule coeff. on inflation | Normal | 2.2 | 0.15 | 2.4582 | [2.2154 2.7015] |
| $\gamma_3$ | Taylor rule coeff. on output | Normal | 0.04 | 0.01 | 0.0476 | [0.0293 0.0668] |
| $\rho_c$ | AR consumption pref. shock | Beta | 0.5 | 0.15 | 0.5765 | [0.3888 0.7535] |
| $\rho_h$ | AR housing pref. shock | Beta | 0.5 | 0.15 | 0.7006 | [0.6324 0.7696] |
| $\rho_y$ | AR productivity shock | Beta | 0.5 | 0.15 | 0.2162 | [0.1054 0.3303] |
| $\rho_r$ | AR monetary policy shock | Beta | 0.5 | 0.15 | 0.1606 | [0.0612 0.2651] |
| $\rho_q$ | AR LTV shock | Beta | 0.5 | 0.15 | 0.0684 | [0.0187 0.1233] |
| $\rho_k$ | AR capital invest. shock | Beta | 0.5 | 0.15 | 0.4109 | [0.3402 0.4806] |
| $\rho_{hi}$ | AR housing invest. shock | Beta | 0.5 | 0.15 | 0.9802 | [0.9634 0.9947] |
| $\rho_g$ | AR gov. spending shock | Beta | 0.5 | 0.15 | 0.8618 | [0.8179 0.9035] |
| $\sigma_c$ | SD consumption pref. shock | Inv. gamma | 0.001 | 0.1 | 0.1277 | [0.0958 0.1635] |
| $\sigma_h$ | SD housing pref. shock | Inv. gamma | 0.001 | 0.1 | 0.9404 | [0.6940 1.2005] |
| $\sigma_y$ | SD productivity shock | Inv. gamma | 0.001 | 0.1 | 0.0855 | [0.0647 0.1075] |
| $\sigma_r$ | SD monetary policy shock | Inv. gamma | 0.001 | 0.1 | 0.0058 | [0.0045 0.0071] |
| $\sigma_q$ | SD LTV shock | Inv. gamma | 0.001 | 0.1 | 0.2952 | [0.2447 0.3475] |
| $\sigma_k$ | SD capital invest. shock | Inv. gamma | 0.001 | 0.01 | 0.5055 | [0.3880 0.6258] |
| $\sigma_{hi}$ | SD housing invest. shock | Inv. gamma | 0.001 | 0.1 | 2.0861 | [1.6924 2.5122] |
| $\sigma_g$ | SD gov. spending shock | Inv. gamma | 0.001 | 0.1 | 0.7573 | [0.5868 0.9233] |

*Source: Calculs BCL.*

## 5 MACROPRUDENTIAL INSTRUMENTS AND THE OPTIMAL POLICY FRAMEWORK

In this section, we discuss the instruments and the objectives of the macroprudential authority. We consider two macroprudential instruments: loan-to-value (LTV) and the sectoral capital requirement[84]. This includes all capital requirements that target the mortgage sector, including regulatory risk weights, countercyclical capital requirements affecting mortgage loans and other broad-based capital measures on banks, etc...[85]. For simplicity, we interpret this broad sectoral capital requirement

84 Note that the current model allows for taking into account another macroprudential tool, which is the amortization requirement. To make the analysis more tractable, we only focus on the two mentioned instruments in the current study and we plan to analyse the amortization requirement in the future work.

85 We refer to this as the shares of capital charges on banks that could weigh on mortgage lending, keeping in mind that all broad regulatory capital requirements might affect the mortgage loan sector.

as risk weights (RW) on mortgage loans with the additional assumption that all risks born by the bank stem from the mortgage sector. We choose these instruments because of their direct impacts on housing demand and prices and the policy need to assess the combinations of borrower and capital-based instruments. Therefore, our instruments capture the two key aspects of the macroprudential policy namely the demand and supply sides of mortgage loans.

In general, macroprudential policies in standard DSGE models consist of exogenously setting macroprudential instruments at fixed values, which are not time varying as they are not affected by economic conditions. In this work, we first take into account these types of static ratios and we further extend the model by introducing the macroprudential policy rules for the two aforementioned tools.

## 5.1 MACROPRUDENTIAL POLICY INSTRUMENTS

### 5.1.1 Static ratios

We start by looking at the policy case where both the instruments (LTV and RW) are exogenous and defined as fixed parameters. We then find the optimal values of these LTV and RW ratios. The optimality criteria will be defined later.

### 5.1.2 Dynamic and endogenous rules

In this section we assume that LTV and RW measures are not static but dynamic and endogenous in the sense that they depend on some endogenous variables of the model, as described below.

**LTV rule**

As in Kannan et al. (2012) and Rubio and Carrasco-Gallego (2014), we assume that a regulatory macroprudential policy for LTV (denoted as $m_{h,t}$ is time varying and a of Taylor-type rule so that it reacts inversely to the credit-to-GDP gap, in the spirit of the Basel III regulation which aims at addressing episodes of excessive credit growth:

$$m_{h,t} = m_{h,op} - \phi_l \widehat{\Delta}_t \tag{8}$$

Here $m_{h,op}$ is the optimal static level of LTV, $\widehat{\Delta}_t$ denotes the mortgage loan-to-GDP gap and $\phi_l$ measures the response of the LTV requirement to the gap. With this kind of rule, LTV would be set low in booms, restricting credit to the housing sector and therefore avoiding a mortgage boom stemming from economic upswings (and conversely for economic downturns).

**Sectoral risk weighted rule**

The risk weighted capital requirement rule (RW) is a time varying Taylor-type rule reacting to a key macroeconomic variable as in Angelini et al. (2012). We choose this variable to be the cyclical component of output. The risk weighted capital requirement (denoted by $\tau_t$) is then set according to the following rule:

$$\tau_t = \tau_{op} - \chi_\tau \hat{y}_t \tag{9}$$

where $\tau_{op}$ measures the optimal static level of the RW requirement, $\hat{y}_t$ represents the cyclical component of output (i.e., a proxy for the output gap) and $\chi_\tau$ denotes the response parameter of capital requirements to the business cycle. A positive value of $\chi_\tau$ stands for a countercyclical policy: capital

requirements increase during economic upswings (i.e. banks hold more capital for a given mortgage loan) and decrease in recessions. This capital requirement rule is in line with the countercyclical capital buffer introduced by Basel III.

## 5.2 AN OPTIMAL MACROPRUDENTIAL POLICY FRAMEWORK

An optimal policy analysis aims at identifying optimal values for the policy ratios or reaction parameters which could maximize the objective function of the macroprudential authority. Therefore, determining the optimal policy calibration requires defining the objective of the macroprudential/financial stability authority and then the optimality criteria.

It is challenging to model the objectives of macroprudential policies within a DSGE framework since vulnerabilities in the financial system can arise from different sectors in various forms. Furthermore, there is no specific proxy or widely accepted definition of such policy objectives in the majority of macro models.

Given the commonly accepted definition of the objective of the macroprudential authority, which is to safeguard financial stability, some authors such as Rubio and Carrasco-Galego (2014) and Angelini et al. (2012) assume that there exists a loss function for the macroprudential authority. This loss function is assumed to depend on a set of weighted variable volatilities that is minimized subject to the equilibrium conditions of the model. This approach is similar to the one of the optimal monetary policy in which the monetary policy authority minimizes its loss function.

However, using loss functions in a DSGE context is generally a short-cut approach to the social welfare analysis. The reason is that the loss function is derived from the second order approximation to the expected utility function of the representative household in the basic New Keynesian (NK) model in the absence of real and financial frictions (with only price stickiness)[86]. The authority's loss function therefore represents an average welfare loss and depends on the variability of some endogenous variables[87]. Moreover, the economic rationale behind the use of the welfare loss function as a policy objective function, which depends on the volatilities of variables, is that the volatility has an impact on the welfare of economic agents. For example, from a financial stability perspective, lower volatility of credit growth can help to smooth borrowers' consumption and therefore improves their welfare.

For these reasons, we use a welfare based approach in this work and the maximization of the social welfare as a proxy for the objective of the macroprudential authority. We therefore define the optimal macroprudential policy as the one that maximise the social welfare of the economy. Rather than using a weighted sum of volatilities as the macroprudential authority's loss function (like in Rubio and Carrasco-Galego (2014) and Angelini et al. (2012)), which is equivalent to the analytically derived welfare loss only in a basic NK model without real and financial frictions, we numerically compute the social welfare losses/gains since our model is far more complex than the basic NK model. We perform a grid search for values of macroprudential ratios and parameters of instruments that maximise the social welfare.

We compute the welfare loss/gain for each type of economic agent under each policy regime using optimal ratios and optimized rule parameters. This facilitates an evaluation of the benefits of implementing

86 See for instance, Gali (2008), Gali and Monacelli (2005, 2008).

87 The monetary policy authority's loss function depends for instance on the variability of both the output gap and the rate of inflation (See Gali (2008) for more details).

different macroprudential policies. We follow Schmitt-Grohe and Uribe (2007) by computing the conditional welfare of agents using the second order approximation of the model (and rules).

To make the welfare results more intuitive, we define a welfare metric in terms of consumption equivalents. This consumption equivalent welfare measure is the constant fraction of steady-state consumption that households are willing to give away in order to obtain the benefits of the macroprudential policy. A positive value means a welfare gain, which is how much the consumer would be willing to pay in terms of steady-state consumption to obtain a welfare improvement.

## 6 OPTIMAL VALUES OF LTV AND RW AND THE DYNAMIC OF THE MODEL

In this section, we first present the optimal macroprudential ratios and optimal parameters for the rules along the lines of the concepts presented in the previous section. Afterwards, we discuss the dynamics of the model.

In this sense, we address an important policy question, among other things, of what would be the optimal ratios for LTV and RW and optimal parameters for the Taylor–type macroprudential rules in Luxembourg?

The results are discussed in the context of a loose monetary policy environment and a LTV shock. A second order approximation is used for solving the model and providing the quantitative results[88].

### 6.1 OPTIMAL LTV AND RW RATIOS AND OPTIMIZED PARAMETERS OF THE POLICY RULES

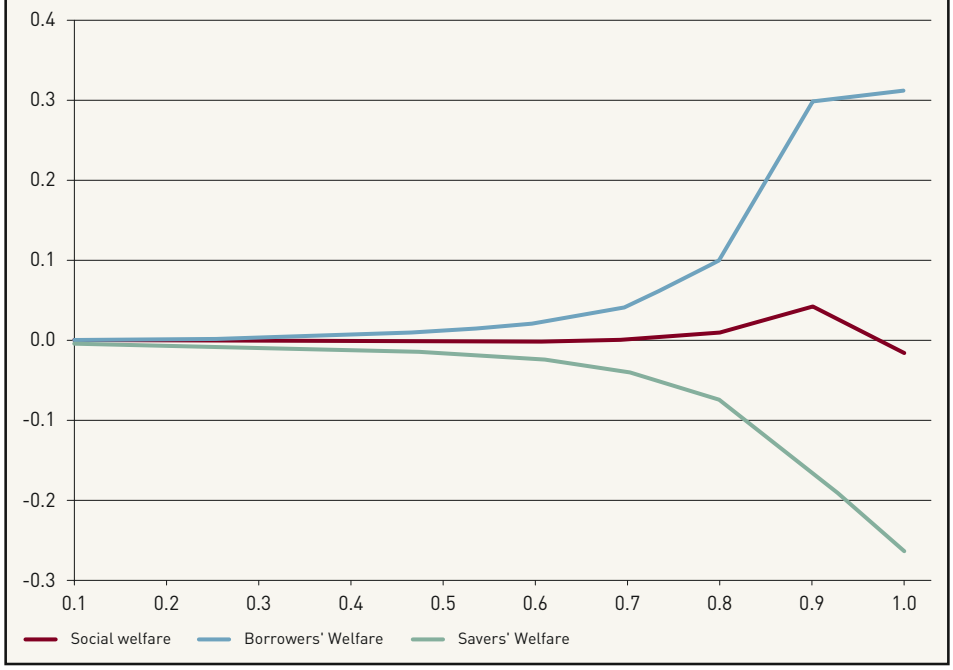
We start by computing volatilities and welfare losses/gains for the scenario in which LTV and RW are set to their average values based on the data (i.e. the benchmark case). Afterwards, we report the results for a single instrument scenario (LTV alone), a two-instrument scenario (LTV and RW) and a scenario in which the model comprises the optimal rules for instruments.

Table 3 shows the optimal ratios, optimal parameter values of policy rules, volatilities and the welfare gains/losses for different policy scenarios in a low interest rate environment. Note that when the two instruments are both used in the policy framework we assume that the set-up of the optimization exercise consists of searching for the optimal value of each ratio or rule's parameter while taking the other as given and set to its value based on the data. This is the non-joint optimization. The joint optimal values of the ratios from the joint optimization perspective are provided later.

When the two instruments are both used in the economy model (Column 3), the optimal static LTV ratio is found to be 90% while the optimal RW ratio is about 30%. These optimal levels imply a welfare gain for borrowers while savers face a welfare loss. Social welfare is therefore positive as a consequence of the welfare gain from the borrowers' side. The intuition is as follows: on one hand, increasing the LTV ratio has a direct effect on borrowers' welfare as the collateral constraint is loosened. However, up to a certain threshold, borrowers could be over-indebted as higher consumption levels imply higher interest rates (inflation being increased). This leads to higher repayments, which act to curb consumption and welfare levels.

88 Second order approximation methods have the particular advantage of accounting for effects of volatility of variables on the mean levels. See among others Schmitt-Grohe and Uribe (2004).

Figure 1
Welfare losses/gains in function of LTV ratios




*Source: Calculs BCL.*

On the other hand, higher interest rates imply higher returns on saving and, as the savers' intertemporal optimization determines their consumption pattern, they reduce their consumption. This channel is reinforced by the increase in the inflation rate following the increase in loans to borrowers (higher LTV). These results are illustrated in Figure 1.

If the RW ratio is removed from the authority's macroprudential toolkit, meaning that there are no capital requirements weighing on the banking sector, the scenario of a single LTV policy (Column 2) provides a tighter optimal value of 0.2 for the LTV ratio. This means the LTV ratio, used alone, may need to be tightened in a loose monetary policy environment, which can result in relatively low volatilities of credit and output while generating a welfare loss for the economy. Even if this scenario is less realistic in practice, it allows for assessing synergies and complementarities between LTV and RW measures in the context of the model.

Comparing the two-instrument policy scenario to the one with a single LTV policy, Table 3 (Benchmark Column and Column 3) shows that mortgage lending and output are less stabilized in the former than the latter case. However, the two-instrument policy implies a social welfare gain for the economy while the single LTV policy scenario provides a social welfare loss, suggesting that the two macroprudential instruments (LTV and RW) are complements in terms of welfare effects. The welfare gain of the combination of two instruments is around 1.2% in terms of consumption equivalents.

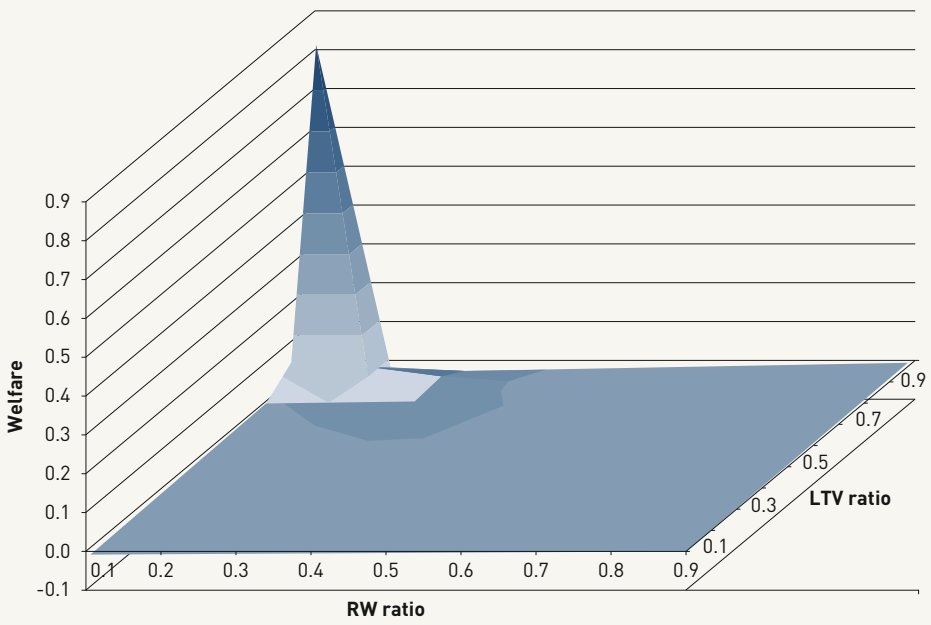
These results suggest that the policy scenario that provides a better stabilization of mortgage loans is not necessarily the one that is welfare improving. In particular, the implementation of both LTV and RW measures generates higher macro financial volatilities relative to a LTV only policy regime. This is explained by the fact that the collateral channel effects stemming from an optimal tighter LTV worsens borrowers' welfare as they are more constrained to borrow and then to consume. The LTV ratio used in a single policy scenario should optimally be tight if facing a low interest rate environment, as it restricts and stabilises credit flows to borrowers and decreases or stabilizes their consumption and wealth effects from house acquisition on consumption fall. The presence of both the borrower - and capital-based instruments in the macroprudential toolkit, i.e., one (LTV) on the credit demand side and the other (RW) on the price side (i.e. loan rates leads to a higher LTV depending on the fixation of the RW ratio. Figure 2 shows that the welfare characterisation is jointly dependent on LTV and RW with the welfare effects being somewhat convex. When the optimal RW ratio increases, the optimal ratio of LTV corresponding to the highest value of welfare is low and conversely, when the LTV

increases the corresponding optimal RW decreases. Therefore, the joint optimal value of LTV and RW are respectively 100% and 10% as illustrated by the elevated region (in blue) in Figure 2.

We finally compare the outcomes from the static LTV and RW ratios to those under time varying rules. We find that introducing the time-varying macroprudential rules is welfare improving with an associated welfare gain of 0.43% compared to the case of the static ratios. Moreover, in terms of macro financial stabilization, mortgage lending and output are more stabilized under the time-varying policy rule scenario than under the static ratio scenario. The two-instrument rule provides better outcomes in terms of volatilities and welfare suggesting the interest of introducing such rules.

The results in terms of stabilisation of output and credit flows are consistent with the impulse response functions presented below.

Figure 2
Welfare effects of interactions between LTV and RW ratios




*Sources: Calculs BCL.*

Table 3:
**Optimal LTV and RW policies**

| | BENCHMARK | OPTIMAL STATIC POLICY | | OPTIMAL POLICY RULES |
|---|---|---|---|---|
| | | SINGLE INSTRUMENT | TWO INSTRUMENTS | TWO INSTRUMENTS |
| LTV | 0.7 | 0.2 | 0.9 | 0.9 |
| RW | 0.2 | - | 0.3 | 0.3 |
| $\phi_t$ | - | - | - | 0.3 |
| $\chi_\tau$ | - | - | - | 0.1 |
| $\sigma_t$ | 17.7271 | 3.7614 | 16.4028 | 14.6057 |
| $\sigma_y$ | 3.7178 | 3.3075 | 4.8729 | 4.6760 |
| $\sigma_{(LTV+RW)}$ | - | - | - | 2.9762 |
| Social welfare (losses/gains) | 0.0002 | -0.0032 | 0.0119 | 0.0162 |
| Impatients (borrowers) | 0.0409 | -0.0005 | 0.1031 | 0.0863 |
| Patients (savers) | -0.0390 | -0.0060 | -0.0717 | -0.0494 |

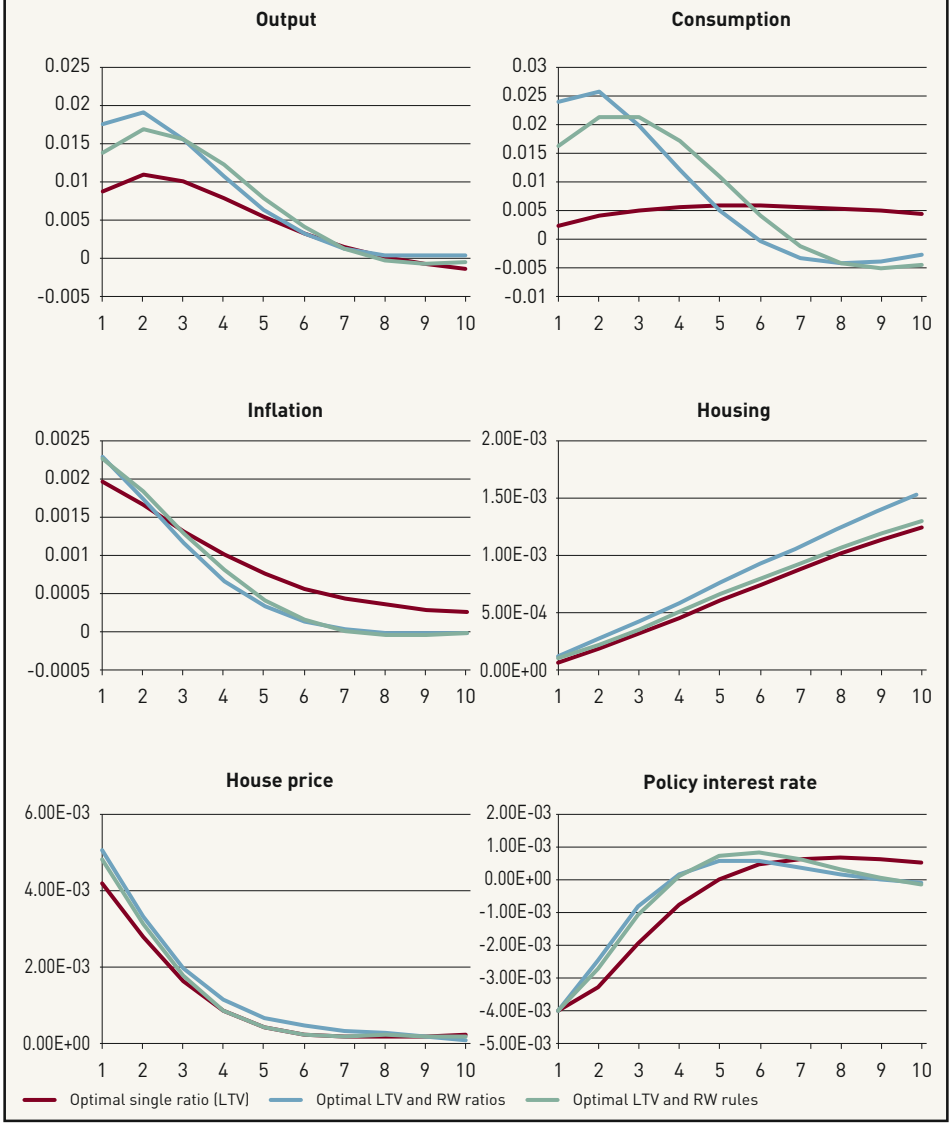
*Volatilities are expressed in %. The welfare metric used is the conditional welfare, computed conditionally on the initial state being the deterministic steady state of the model. The welfare losses/gains are expressed in terms of % of consumption equivalents. This is the same across policies. A second order approximation of the model is used for solving the model and providing those quantitative results.*
*Source: Calculs BCL.*

## 6.2 EFFECTS OF A MONETARY POLICY SHOCK UNDER OPTIMAL MACROPRUDENTIAL POLICIES

In order to understand the dynamics of the model and how the optimal LTV ratio interacts with the optimal RW, we simulate the impulse responses of the model using the optimal ratios and optimized parameters of the macroprudential rules we found in the previous section. We keep the estimated parameters of the model and supplement them with optimal ratios and parameters under the assumption of a loose monetary policy stance.

Figure 3 displays the expansionary effects of a 10 bps decrease in the monetary policy rate of the economy. This shock implies lower loan and effective borrowing rates. Consequently, mortgage loans increase as along with overall mortgage debt stock, leading to an increase in the debt-to-GDP and debt-to-income ratios (except under the scenario with LTV ratio alone). The increase in mortgage loans supplied by banks positively impacts housing demand thereby increasing house prices. The rise in the house value generates an upswing of output and consumption. As the collateral constraint is binding with the LTV policy, the increase in mortgage loans is exacerbated following the increase in house value. Inflation increases following the decline in the policy rate and subsequently due to the increase in total consumption. Bank capital increases as a consequence of higher profits stemming from an upswing of economic activity and housing loans.

Figure 3
Effects of a loose monetary policy




*Source: Calculs BCL.*
*Note: Time, measured in quarters, is on the horizontal axis. All variables are measured in % deviations from steady state, except inflation and the interest rates which are measured in annualized deviations from steady state.*

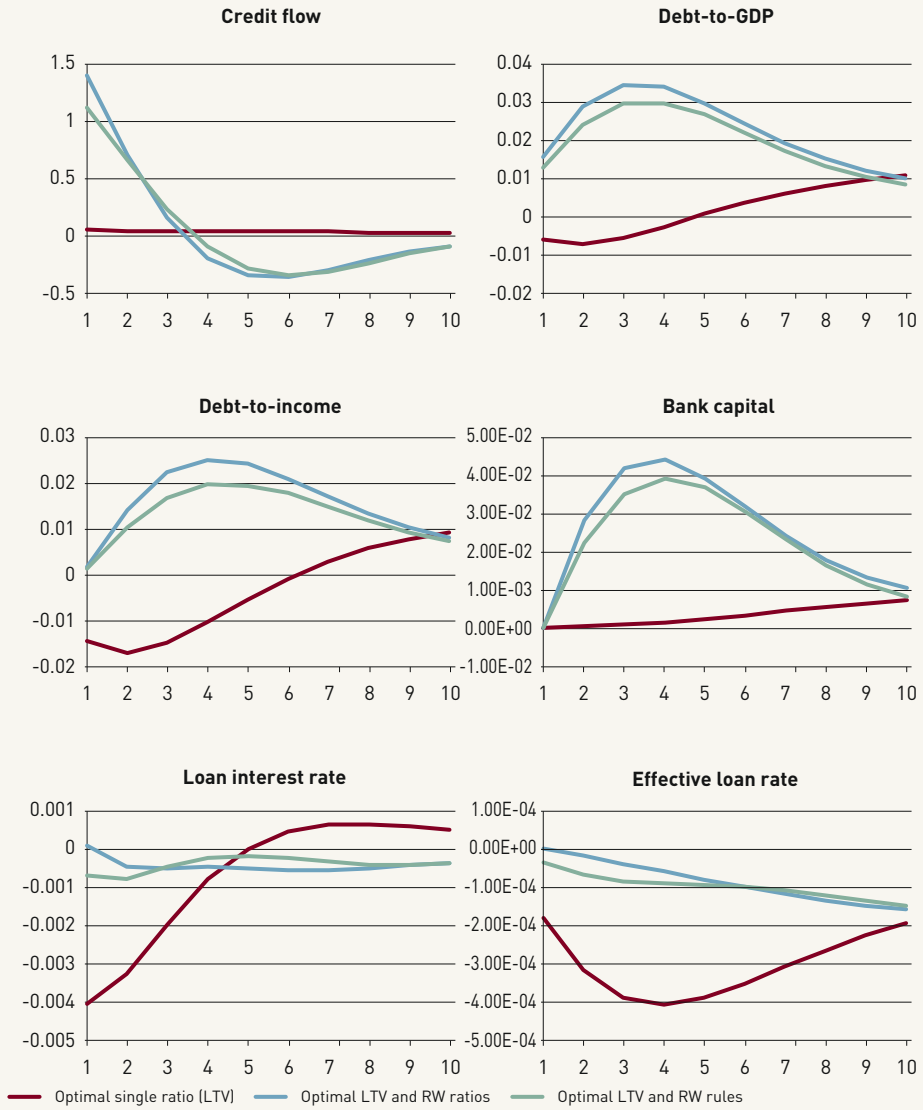
Comparing the impulse responses under different policy scenarios helps to provide some underlying economic intuition for the results discussed so far.

Figure 3 contrasts the optimal single ratio with the optimal two-instrument policy regime. As previously mentioned, mortgage credit flow is smoother under the single LTV policy case than the optimal two-instrument scenario. Therefore, debt-to-GDP and debt-to-income are decreasing

in the wake of the expansionary interest rate shock under the former while they go up in the latter where loans are more volatile and increase more. This channel affects all other variables in the economy. Indeed, house prices increase less in the case of the single LTV ratio scenario than in the case of the two-instrument scenario. Output increases more in the two-instrument policy compared to the single policy case. This is explained by agents' consumption pattern, which is subdued under the single policy regime due to a stronger mortgage loan restriction implied by a tight LTV ratio.

Overall, the differences between using LTV ratio alone and the two-instrument policy combination stem from the higher amount and volatility of loans in the latter policy scenario. As the optimal policy rules are not overly strict, Figure 3 shows that the paths of variables under that time varying policy scenario are close to those of the case of two-static ratios with the exception of the more stabilized mortgage credit, debt-to-GDP, debt-to-income and house prices under the time-varying policy rules scenario.

Figure 4
Effects of a loose monetary policy




*Source: Calculs BCL.*
*Note: Time, measured in quarters, is on the horizontal axis. All variables are measured in % deviations from steady state, except inflation and the interest rates which are measured in annualized deviations from steady state.*

## 7 CONCLUSIONS

In this work, we try to assess the optimal macroprudential policy for LTV and RW macroprudential instruments in Luxembourg. To address this question, we build a DSGE model and estimate it on Luxembourg data using the Bayesian techniques. In comparison to the literature, our modelling approach assumes a monopolistically competitive banking sector, a collateral constraint and an explicit differentiation between the flow and the stock of household mortgage debt. We further contribute to the existing literature on this topic by identifying the optimal ratios and rules of the loan-to-value cap and the risk weighted capital requirement for Luxembourg. Specifically, we analyse the welfare effects of these instruments from a financial stability perspective and determine the optimal combination of borrower and capital based macroprudential instruments for Luxembourg.

Based on a welfare analysis in the context of a loose monetary policy environment, we first find that the non-joint optimal individual LTV and RW ratios for Luxembourg seem to be 90% and 30%, respectively, while the joint optimal ratios are found at 100% and 10% respectively. We also find that combining LTV and RW measures welfare-dominates the use of LTV alone suggesting a possible complementarity between these instruments in terms of welfare. We note that the latter policy performs better than the former with respect to mortgage debt and house prices stabilization effects. This result suggests that the policy scenario that provides better stabilization effects on mortgage credits isn't necessarily the one that is welfare improving. In other words, LTV and RW measures can be considered as complements in terms of welfare, while their optimal combination diminishes the stabilization effects on mortgage debt and house prices. In particular, when LTV is applied alone in the context of an accommodative monetary environment, it is found to be too tight (i.e. 20%) to be realistic, leading to a welfare loss but helping to stabilize debt relative to the use of both LTV and RW ratios. In addition, the time-varying and endogenous LTV and RW rules improve overall social welfare and better stabilize the growth of mortgage loans and house prices relative to their static exogenous ratios. Finally, we find that the optimal interactions between LTV and RW ratios in our framework follow a convex shape. When LTV is increased, the corresponding optimal RW ratio is low and conversely when the RW ratio is increased, the corresponding optimal LTV ratio should be lowered.

In future work, we plan to extend the number and type of macroprudential instruments in the analysis by including amortization requirements and/or introducing debt-to-income (DTI)/debt service-to-income (DSTI) constraints in the model.

## REFERENCES


Albacete, N., Lindner, P. & Fessler, P. (2018), One policy to rule them all? on the effectiveness of LTV, DTI and DSTI ratio limits as macroprudential policy tools, Financial Stability Report (Austrian Central Bank) 35.

Alpanda, S. & Zubairy, S. (2017), Addressing household indebtedness: monetary, fiscal or macroprudential policy?, European Economic Review 92, 47–73.

Angelini, P., Neri, S. & Panetta, F. (2012), Monetary and macroprudential policies, European Central Bank, Working Paper No 1449/JULY 2012.

Beneš, J., Laxton, D. & Mongardini, J. (n.d.), Mitigating the deadly embrace in financial cycles: countercyclical buffers and loan-to-value limits, IMF Working Paper No 16/87.

Brooks, S. P. & Gelman, A. (1998), General methods for monitoring convergence of iterative simulations, Journal of computational and graphical statistics 7(4), 434–455.

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

Brzoza-Brzezina, M., Kolasa, M. & Makarski, K. (2017), Monetary and macroprudential policy with foreign currency loans, Journal of Macroeconomics 54, 352–372.

Calvo, G. A. (1983), Staggered prices in a utility-maximizing framework, Journal of monetary Economics 12(3), 383–398.

Chen, M. J. & Columba, M. F. (2016), Macroprudential and monetary policy interactions in a DSGE model for Sweden, IMF Working Paper No 16/74.

Deak, S., Fontagné, L., Maffezzoli, M. & Marcellino, M. (2011), LSM: a DSGE model for Luxembourg, Economic modelling 28(6), 2862–2872.

Fève, P., Pierrard, O. et al. (2017), Financial regulation and shadow banking: A small-scale DSGE perspective, Central Bank of Luxembourg, Working Paper Series No 111.

Galí, J. (2008), Monetary policy, inflation, and the business cycle: an introduction to the new Keynesian framework, Princeton University Press.

Galí, J. & Monacelli, T. (2005), Monetary policy and exchange rate volatility in a small open economy, The Review of Economic Studies 72(3), 707–734.

Galí, J. & Monacelli, T. (2008), Optimal monetary and fiscal policy in a currency union, Journal of international economics 76(1), 116–132.

Gambacorta, L. & Signoretti, F. M. (2014), Should monetary policy lean against the wind?: An analysis based on a DSGE model with banking, Journal of Economic Dynamics and Control 43, 146–174.

Gerali, A., Neri, S., Sessa, L. & Signoretti, F. M. (2010), Credit and banking in a DSGE model of the euro area, Journal of Money, Credit and Banking 42, 107–141.

Greenwald, D. (2018), The mortgage credit channel of macroeconomic transmission, MIT Sloan Research paper No.5184-16.

Grodecka, A. (2017), On the effectiveness of loan-to-value regulation in a multi-constraint framework, Sveriges Riksbank, Working Paper Series No 347/Nov 2017.

Guerrieri, L. & Iacoviello, M. (2017), Collateral constraints and macroeconomic asymmetries, Journal of Monetary Economics 90, 28–49.

Iacoviello, M. (2005), House prices, borrowing constraints, and monetary policy in the business cycle, American economic review 95(3), 739–764.

Iacoviello, M. & Neri, S. (2010), Housing market spillovers: evidence from an estimated DSGE model, American Economic Journal: Macroeconomics 2(2), 125–64.

Kannan, P., Rabanal, P. & Scott, A. M. (2012), Monetary and macroprudential policy rules in a model with house price booms, The BE Journal of Macroeconomics 12(1).

Kelly, R., McCann, F. & O'Toole, C. (2018), Credit conditions, macroprudential policy and house prices, Journal of Housing Economics 41, 153–167.

Kydland, F. E., Rupert, P. & Šustek, R. (2016), Housing dynamics over the business cycle, International Economic Review 57(4), 1149–1177.

Lubello, F. & Rouabah, A. (2017), Capturing macroprudential regulation effectiveness: A DSGE approach with shadow intermediaries, Central Bank of Luxembourg, Working Paper Series No 114.

Marchiori, L. & Pierrard, O. (2017), How does global demand for financial services promote domestic growth in Luxembourg? A dynamic general equilibrium analysis, Economic Modelling 62, 103–123.

Mendicino, C. & Punzi, M. T. (2014), 'House prices, capital inflows and macroprudential policy, Journal of Banking & Finance 49, 337–355.

Punzi, M. T. & Rabitsch, K. (2018), Effectiveness of macroprudential policies under borrower heterogeneity', Journal of International Money and Finance 85, 251–261.

Rubio, M. & Carrasco-Gallego, J. A. (2014), Macroprudential and monetary policies: Implications for financial stability and welfare, Journal of Banking & Finance 49, 326–336.

Sangaré, I. (2019), Housing sector and optimal macroprudential policy in an estimated DSGE model for Luxembourg, Mimeo.

Schmitt-Grohé, S. & Uribe, M. (2004), Solving dynamic general equilibrium models using a second-order approximation to the policy function', Journal of economic dynamics and control 28(4), 755–775.

Schmitt-Grohé, S. & Uribe, M. (2007), Optimal simple and implementable monetary and fiscal rules, Journal of monetary Economics 54(6), 1702–1725.

# 3. PROFITABILITÉ BANCAIRE ET CARACTÉRISTIQUES DES MODÈLES D'AFFAIRES AU LUXEMBOURG

Daniel Morell et Guillaume Queffelec[89]

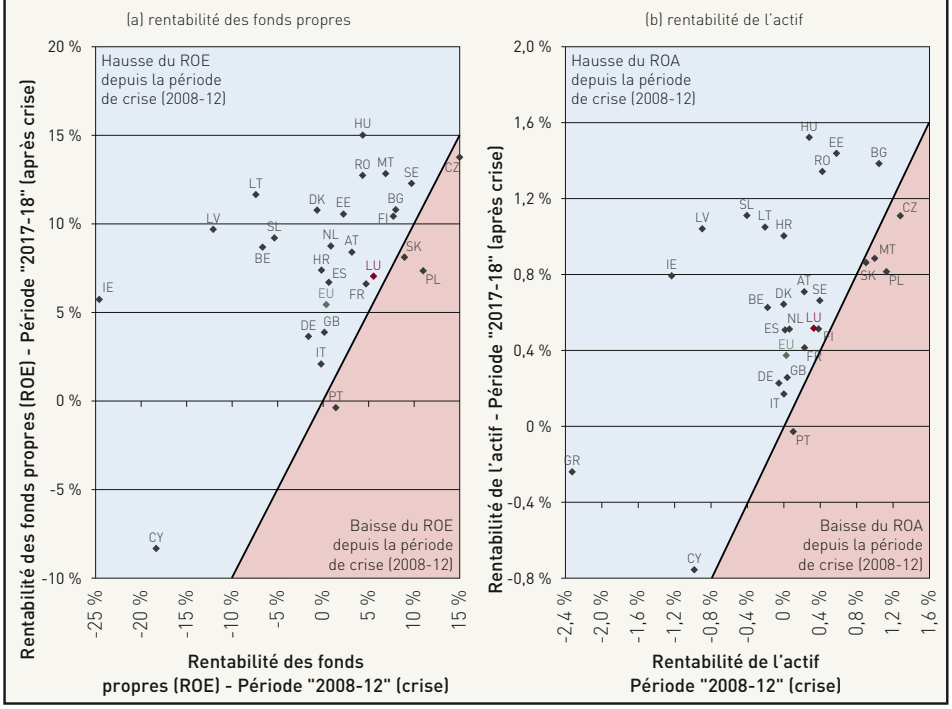
## INTRODUCTION

Depuis le début de la crise financière, la profitabilité bancaire en Europe s'est amoindrie en comparaison avec les standards historiques d'avant-crise (graphique 1). Pourtant, la profitabilité constitue à priori la « première ligne de défense » en cas de chocs négatifs car elle permet, à travers les bénéfices non distribués, d'alimenter les fonds propres, éléments essentiels de renforcement de la résilience du secteur bancaire. Aussi, elle contribue à attirer les investisseurs qui apportent le financement pour réaliser les investissements d'avenir et garantir aux agents économiques un accès au crédit. Enfin, les expériences récentes ont révélé que la baisse de la profitabilité incite les établissements de crédit à prendre des risques additionnels, ce qui est susceptible de menacer à terme la stabilité du système financier.

Pour ces raisons, la profitabilité bancaire fait partie des enjeux majeurs de stabilité financière en Europe depuis la crise et constitue aujourd'hui une priorité pour la supervision bancaire au niveau du Mécanisme de surveillance unique (*Single Supervisory Mechanism*, SSM).

Un entrelacs de facteurs cycliques et structurels pèse sur la profitabilité bancaire (ECB 2018a)[90]. Premièrement, l'environnement macroéconomique reste globalement peu favorable. Marquée par deux crises successives, l'Europe n'a pas connu un rebond économique aussi vigoureux qu'aux États-Unis par exemple. Celui-ci aurait pourtant accéléré le processus d'assainissement des bilans. En 2018, les banques des pays les plus touchés par la crise sont encore affectées par un stock élevé de prêts non-performants. Plus récemment, les incertitudes liées au Brexit et l'augmentation des tensions commerciales alimentent un risque de ralentissement de l'économie mondiale. S'il devait se confirmer, l'environnement macroéconomique pèserait donc davantage sur la profitabilité bancaire.

Graphique 1
Évolution de la profitabilité bancaire des pays de l'Union Européenne depuis la crise




*Source : BCE (SDW).*

89 Département de Stabilité financière et de Surveillance macroprudentielle, Banque centrale du Luxembourg

90 Voir aussi: speech by Danièle Nouy, Chair of the Supervisory Board of the ECB, 18. Handelsblatt Jahrestagung on European Banking Regulation, Frankfurt, 24 November 2017

Afin de soutenir l'activité économique, les politiques monétaires sont accommodantes et permettent de réduire les coûts de financement du secteur bancaire et de soutenir la demande de crédit et ainsi l'économie dans son ensemble. Cependant, les taux d'intérêt à court terme négatifs ou proches de zéro et l'aplatissement de la courbe des taux contribuent à diminuer les marges d'intérêt qui constituent une source de revenu importante pour les banques, notamment celles dont les modèles d'affaires sont plus traditionnels[91]. La BCE (Altavilla *et al.* 2017) et le Comité sur le système financier mondial (CGFS 2018) apportent ainsi des preuves empiriques de la diminution des marges d'intérêt dans l'environnement de taux bas. Néanmoins, ces travaux insistent sur la neutralité de la politique monétaire sur la profitabilité totale car les taux bas favorisent aussi la croissance du volume de crédit et supporte également les prix d'actifs. L'environnement de taux bas crée par conséquent un espace permettant d'accroitre le volume des activités et de se diversifier, notamment en direction des activités génératrices de commissions.

Depuis la crise, la régulation bancaire est aussi plus contraignante. Celle-ci contribue à la résilience du secteur bancaire en augmentant les exigences de fonds propres et en limitant les décalages de liquidité et de maturité au bilan par exemple. Aussi, le secteur bancaire doit se soumettre à de nouvelles exigences en termes de transparence et de *reporting* réglementaires. Cette évolution de la régulation s'accompagne donc d'un accroissement des coûts à court terme de mise en conformité mais a également un impact sur la profitabilité à long terme. Puisque les banques prennent moins de risque, elles sont de facto moins rentables pour les investisseurs. Aussi, toutes choses égales par ailleurs, l'augmentation des fonds propres se traduit mécaniquement par une baisse de la rentabilité de ces derniers. Par conséquent, comme le rappelle la BCE dans une étude récente (ECB 2018b), l'augmentation des obligations réglementaires fait qu'il est peu probable que les établissements bancaires puissent atteindre les niveaux de profitabilité d'avant crise. La BCE évalue donc une profitabilité soutenable à long terme pour le secteur bancaire comprise entre six et dix pourcents de rentabilité des fonds propres (*return on equity*, RoE).

Dans ce contexte macroéconomique et réglementaire exigeant se joue aussi une compétition exacerbée qui comprime les marges. Non seulement le secteur bancaire européen semble montrer des signes de surcapacité (ESRB 2014), mais il est aussi en concurrence avec d'autres intermédiaires financiers, moins sujets à la régulation. La modernisation du secteur bancaire, face aux enjeux de la digitalisation et à l'évolution des modes de consommation, impose également des coûts supplémentaires induits par la nécessité d'investissements dans des technologies nouvelles.

Face à l'ensemble de ces enjeux, certains établissements de crédit sont dans l'incapacité de générer la profitabilité exigée par les investisseurs. Le secteur bancaire doit donc s'adapter afin de garantir une profitabilité compatible avec le maintien d'un modèle d'intermédiation soutenable à long terme. Parmi les pistes avancées par certaines institutions internationales on trouve : la diversification des sources de revenus, des efforts en termes d'efficience et une accélération du processus de digitalisation. Une partie de la réponse se trouve par conséquent dans l'ajustement des modèles d'affaires à ce nouvel environnement.

Depuis la crise, l'analyse des modèles d'affaires s'est beaucoup développée (Mergaerts et Vennet. 2016, Rungporn et al. 2017). Pour la BCE celle-ci constitue l'une des clés de voute du Processus de surveillance et d'évaluation prudentielle (*Supervisory Review and Evaluation Process*, SREP) car elle offre une grille de lecture utile dans l'évaluation de la viabilité et de la soutenabilité des banques supervisées.

91 ECB (2018a). "The accommodative monetary policy eased the pressure on the cost of risk and supported loan growth, but also contributed to a squeeze of net interest margins."

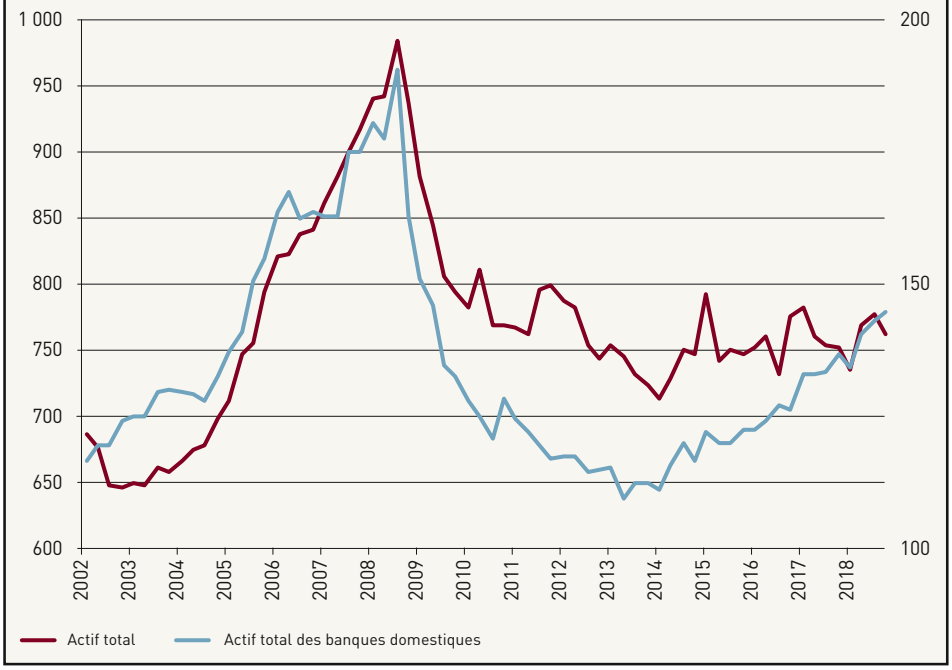
L'approche la plus répandue consiste à travailler sur des ratios mesurant la structure des bilans ainsi que celle des revenus afin de catégoriser les établissements de crédit par modèles d'affaires. L'étendue des activités de banques de détail peuvent, par exemple, être mesurées par le ratio des prêts au secteur privé non financier sur le total de l'actif. Les banques d'affaires, plus dépendantes du financement par le marché, peuvent être identifiées à l'aide du ratio des dépôts du secteur privé non-financier sur le total du passif. Enfin, les banques dépositaires et les gestionnaires d'actifs (banques privées), qui dépendent davantage des revenus de commissions, présentent un ratio des revenus hors intérêt sur le total des revenus généralement élevé.

Compte tenu de l'importance de cette problématique, on propose, à travers cette analyse, de décrire les résultats sur les relations entre la profitabilité bancaire et les modèles d'affaires au Luxembourg. Après un rapide tour d'horizon des conditions de profitabilité au Luxembourg et des caractéristiques des différents modèles d'affaires caractérisant le secteur bancaire domestique, cette étude met en perspective la profitabilité bancaire avec les spécificités des modèles d'affaires à l'aide d'approches statistiques. On observe que la baisse de la profitabilité bancaire au Luxembourg depuis la crise, mesurée par la rentabilité des fonds propres, s'explique d'abord par une baisse d'un recours au levier d'endettement. C'est donc la diminution de la prise de risque et l'accroissement de la résilience qui explique la baisse de la rentabilité des fonds propres. Pour le moment, le niveau de la profitabilité bancaire ne constitue pas un risque pour la stabilité financière au Luxembourg. Cependant, à plus long terme les banques devront probablement adapter leurs modèles d'affaires à leur nouvel environnement. Les résultats des analyses économétriques suggèrent que les efforts d'efficience à travers l'optimisation de la taille et la diversification des sources revenus pour les banques qui dépendent le plus des revenus d'intérêt constituent un facteur de profitabilité nécessaire à la soutenabilité de leurs activités à long terme.

## 1 PROFITABILITÉ BANCAIRE ET MODÈLES D'AFFAIRES AU LUXEMBOURG

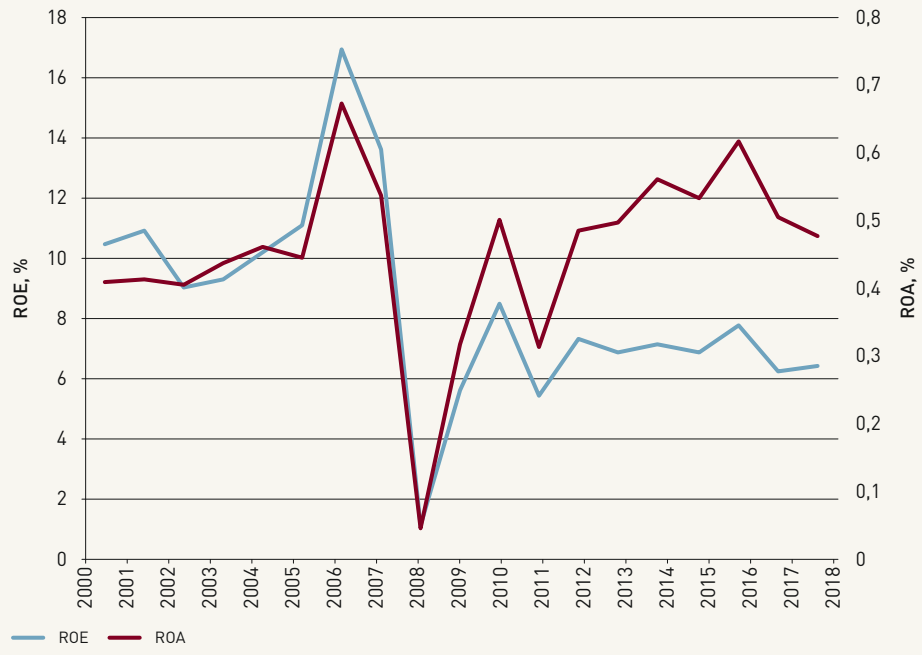
L'analyse de la profitabilité au Luxembourg est intéressante à moins deux égards. Premièrement, le secteur bancaire luxembourgeois évolue dans un contexte économique davantage favorable. Les prêts non performants, qui constituent le premier défi pour de nombreuses banques européennes dans les pays les plus touchés par la crise, sont à des niveaux contenus au Luxembourg. Qu'il s'agisse des ménages ou des sociétés non-financières, les ratios de prêts non-performants agrégés étaient inférieurs à 2 % au quatrième trimestre 2018.

Graphique 2
Actif total du secteur bancaire et des banques de détail
(Milliards d'euros)



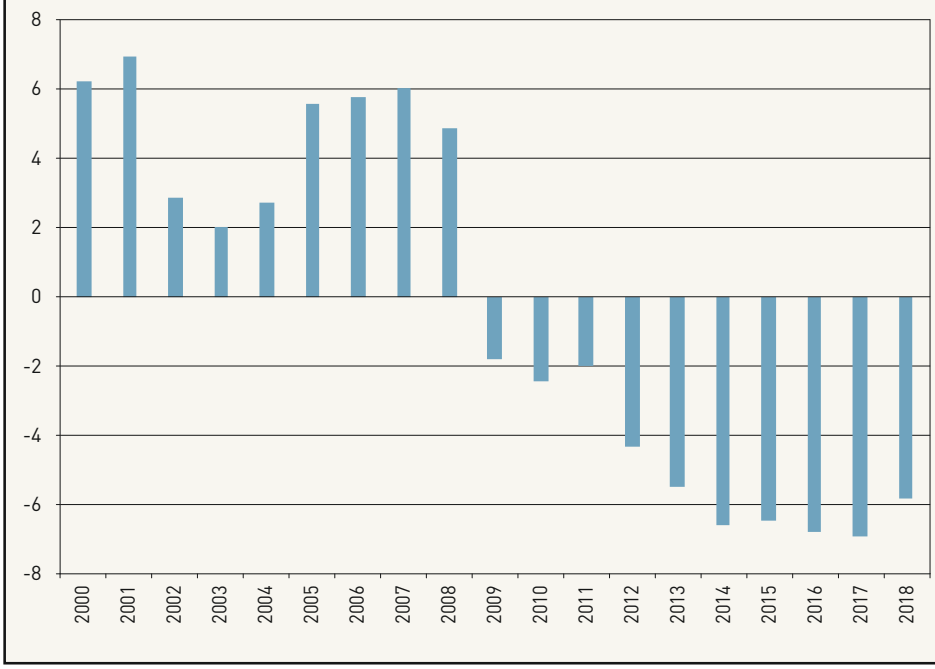

*Source : BCL. Période 2002-2018T4. Note : Les banques de détail représentent 90 % des prêts immobiliers hypothécaires aux ménages et 70 % des prêts au sociétés non-financières.*

Graphique 3
Rentabilité des fonds propres et rentabilité des actifs au niveau agrégé au Luxembourg




*Sources : BCL. Période 2001-2018T4.*

Graphique 4
Écart du multiplicateur de levier par rapport à sa moyenne de long terme




*Source : BCL. Période 2001-2018T4.*

De même, si l'environnement macroéconomique est moins favorable en zone euro et que celui-ci a des conséquences sur l'économie luxembourgeoise compte tenu de son ouverture, la croissance au Luxembourg était supérieure à celle de la zone euro ces dernières années. Bien que volatile, la croissance moyenne au Luxembourg entre 2012 et 2018 était d'environ 3 % par an. Pour les banques de détails qui financent directement l'économie au Luxembourg, l'environnement macroéconomique était certes contrasté ces dernières années mais plus favorable que dans les pays voisins.

Ainsi, on constate que les établissements bancaires dont le modèle d'affaires est orienté vers l'économie domestique (les banques de détail) sont plus dynamiques que le reste du secteur en termes de croissance de l'actif. Celles-ci bénéficient d'une demande de crédit soutenue de la part du secteur privé non-financier, notamment pour le crédit immobilier résidentiel.

Il semble cependant que la pression concurrentielle soit particulièrement exacerbée au Luxembourg. Les données de sondage recueillies auprès des banques (voir l'Encadré 3.3 sur l'enquête trimestrielle sur la distribution du crédit bancaire) montre l'impact très prononcé au Luxembourg de la perception de la concurrence dans le relâchement des critères d'octroi de crédits. Au niveau européen, les établissements de crédit luxembourgeois offrent les coûts d'emprunt parmi les plus faibles. La concurrence entre établissements

de crédit contribue donc à comprimer la marge nette d'intérêt, principale source de revenu des banques de détail.

Le graphique 3 présente l'évolution de profitabilité bancaire agrégée mesurée par la rentabilité des fonds propres (courbe bleue sur le graphique, échelle de gauche) et la rentabilité de l'actif (courbe rouge sur le graphique, échelle de droite) depuis 2001.

On peut observer que la rentabilité des fonds propres est très inférieure à la période d'avant crise, passant d'un maximum de 17 % au niveau agrégé en 2006 à 6,5 % au quatrième trimestre 2018. Celle-ci se situe dans la partie basse de l'écart de profitabilité soutenable tel que proposée par la BCE (entre 6 % et 10 %). Toutefois, on constate aussi que la rentabilité de l'actif, bien qu'impactée par la crise, a rapidement retrouvé ses niveaux d'avant crise dès 2010.

Afin de mieux comprendre les développements de la profitabilité, le RoE peut être décomposé selon l'équation 1[92] :

$$RoE = \frac{Revenu\ net}{Actif\ total} \times \frac{Actif\ total}{Fonds\ propres} \quad (1)$$

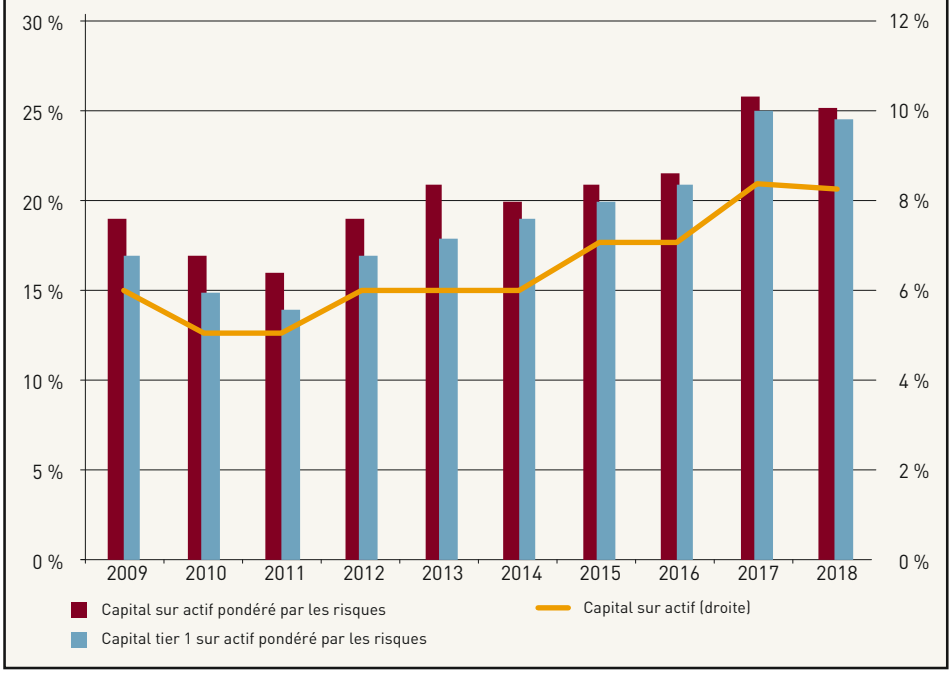
Ou encore :

$$RoE = RoA \times Levier \quad (2)$$

L'équation (2) permet de mettre en lumière l'impact du multiplicateur de levier sur la profitabilité bancaire. Le graphique 4 présente l'écart du celui-ci par rapport à sa moyenne de long terme calculée sur l'échantillon. Il présente la forme d'un cycle, c'est à dire une phase de *boom* suivie d'un bust qui caractérise la dynamique du cycle financier. De cette manière, on comprend qu'au Luxembourg la baisse du RoE s'explique d'abord par une baisse du montant des leviers d'investissement au niveau agrégé, c'est-à-dire une réduction de la prise de risque.

La baisse du levier au Luxembourg depuis la crise s'explique à la fois par une baisse de l'actif total du secteur bancaire (*deleverage*, voir graphique 2), ainsi que l'augmentation de la quantité de fonds propres (graphique 5). Ce mouvement de consolidation des bilans permet au secteur bancaire luxembourgeois

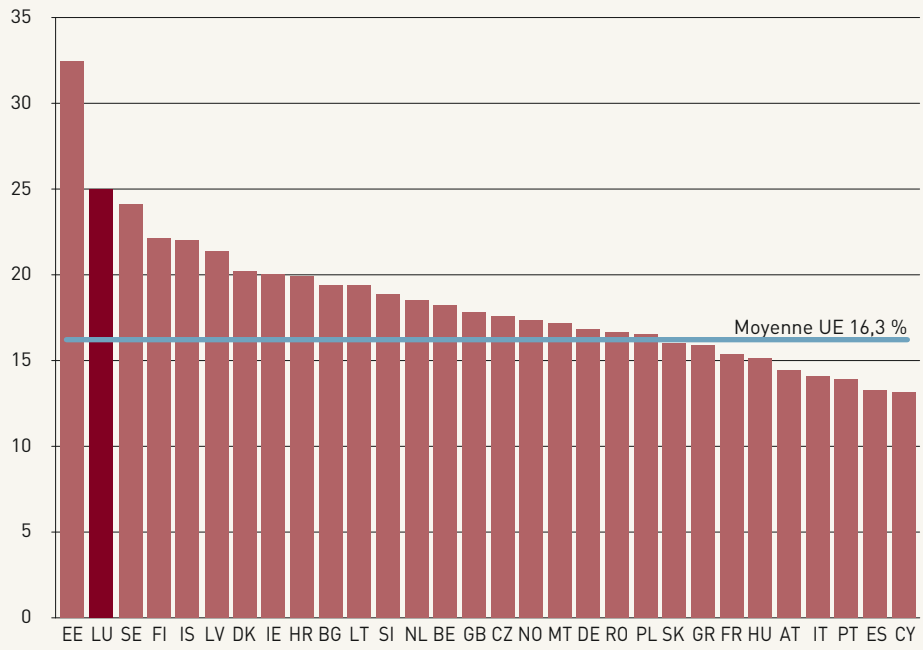
Graphique 5
Ratios de capital au Luxembourg




*Source : BCL ; Période : 2009-2018.*

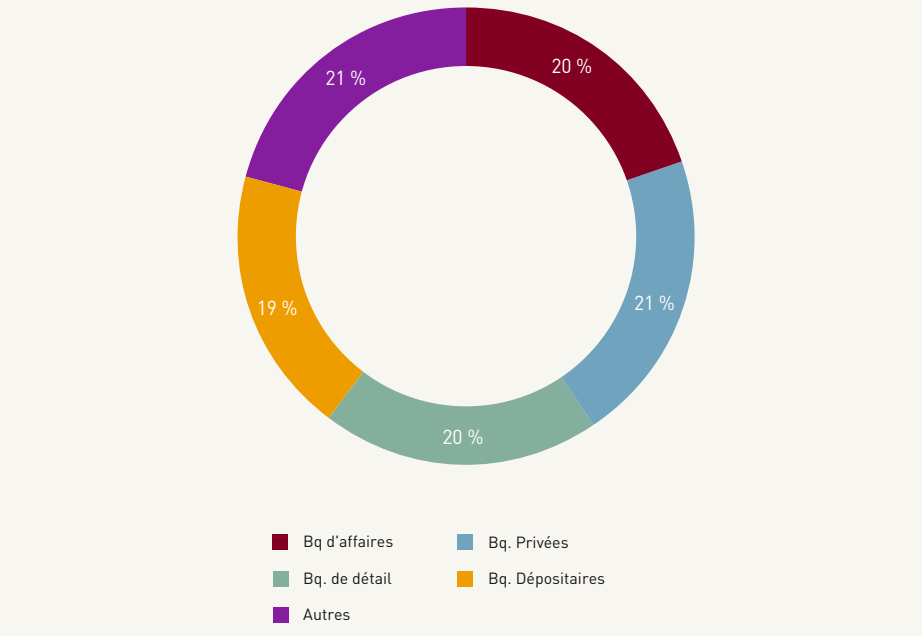
92 Voir aussi ECB (2010) ou EBA (2019).

Graphique 6
Ratio de capital Tier 1 en Europe




*Source : EBA Risk Dashboard. 2018T3.*

Graphique 7
Ventilation de l'actif total au Luxembourg par modèles d'affaires




*Sources : BCL. Période 2018T4. Note : la catégorie « Autres » inclue Covered bonds, gestion de liquidité intra-groupe et compensation et le règlement.*

d'être le deuxième pays le mieux capitalisé d'Europe derrière l'Estonie au troisième trimestre 2018 (graphique 6).

Le secteur bancaire luxembourgeois présente des spécificités en ce qui concerne sa taille et son caractère international, l'importance du marché interbancaire et intragroupe et la coexistence de divers modèles d'affaires. Une première classification des banques luxembourgeoises par modèles d'affaires a été réalisée par la BCL et la CSSF dans le cadre du « programme d'évaluation du secteur financier » par le Fonds monétaire international en 2016.

On distingue principalement quatre grands modèles d'affaires (graphique 7). Les banques de détails qui s'adressent à la clientèle domestique (ménages et sociétés non-financières), les banques d'affaires qui fournissent des services financiers à des sociétés internationales, les banques dépositaires qui proposent des services de garde d'actifs pour le compte de gestionnaires de portefeuilles et d'investisseurs institutionnels et enfin les banques privées qui proposent leurs services de gestion d'actifs et de patrimoine à des clients fortunés. Il faut également rappeler que les banques luxembourgeoises sont pour une large part des succursales ou des filiales de groupes bancaires européens et mondiaux (plus de 90 % du total des licences bancaires en 2018) à vocation internationale (75 % du montant total des prêts sont accordés à des entités étrangères) et entretiennent des relations étroites avec

leurs sociétés mères. Les autres modèles d'affaires reposent sur des activités de niche et sont par conséquent très hétérogènes.

Le tableau 1 détaille la composition des bilans par types de modèles d'affaires. Le portefeuille de prêts représente environ 80 % de l'actif total pour l'ensemble de ces modèles. Les 20 % restants sont composés d'instruments négociables - principalement des obligations (de 10 % à 20 %), tandis que les actions ne dépassent jamais 2,5 % du total du bilan. Les banques de détail et les banques privées détiennent les portefeuilles de prêts les plus diversifiés qu'il s'agisse du secteur économique ou du type de contrepartie. Les prêts interbancaires (dans le tableau 1 « prêts aux sociétés de dépôts ») représentent une part importante du portefeuille de prêts - de 20 % pour la banque de détail à 70 % pour les banques dépositaires. Les dépôts à la banque centrale sont également significatifs dans tous les modèles d'affaires, représentant au moins 9,5 % du portefeuille de prêts. Les banques privées détiennent la plus grande part des dépôts auprès des banques centrales -28 % du portefeuille de prêts.

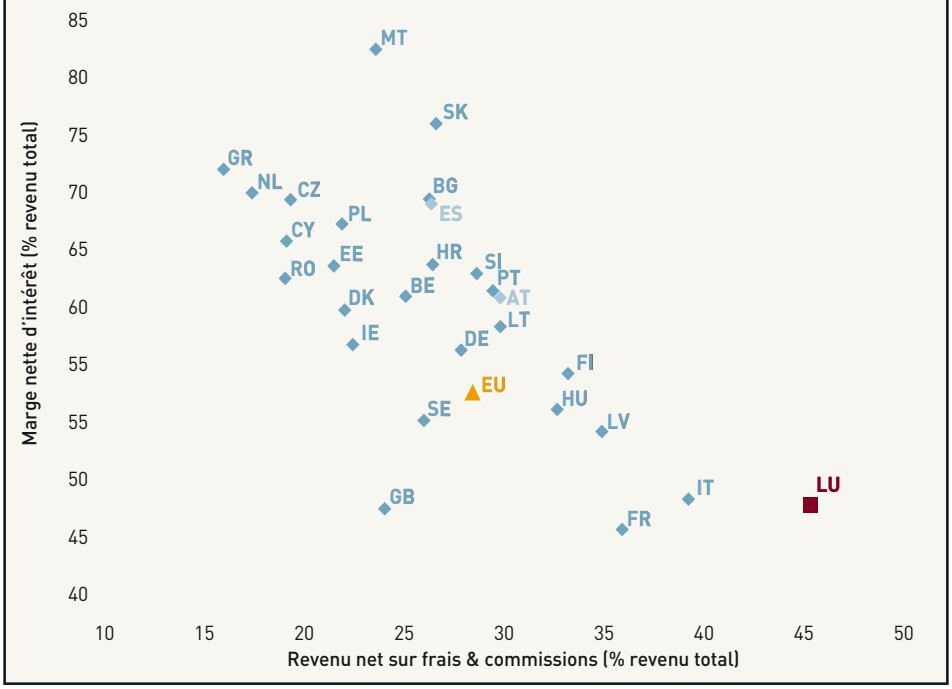
Tableau 1 :
**Bilans synthétiques par modèles d'affaires**

| | BANQUES DE DÉTAIL | BANQUES DÉPOSITAIRES | BANQUES D'AFFAIRES | BANQUES PRIVÉES |
|---|---|---|---|---|
| ACTIF | | | | |
| **Prêts** | 76,50 % | 82,60 % | 90,40 % | 81,90 % |
| Admin. publiques | 2,00 % | 0,00 % | 0,40 % | 0,00 % |
| Sociétés non financières | 17,80 % | 0,20 % | 30,40 % | 12,20 % |
| Ménages | **32,40 %** | 0,50 % | 0,90 % | 9,90 % |
| Banque centrale | 9,70 % | 24,60 % | 9,50 % | 27,70 % |
| Institutions de dépôt | 23,90 % | **69,30 %** | 50,60 % | 39,20 % |
| Sociétés financières | 14,20 % | 5,40 % | 8,30 % | 10,90 % |
| **Titres de créance détenus** | **19,00 %** | **14,60 %** | **7,10 %** | **13,50 %** |
| **Titres de participation détenus** | **2,20 %** | **0,90 %** | **0,90 %** | **2,30 %** |
| **Actifs non-financiers** | **0,70 %** | **0,30 %** | **0,00 %** | **0,50 %** |
| **Autres actifs** | **1,50 %** | **1,50 %** | **1,40 %** | **1,80 %** |
| PASSIF | | | | |
| **Dépôts** | **91,70 %** | **98,00 %** | **70,10 %** | **92,80 %** |
| Admin. publiques | 8,20 % | 0,00 % | 1,10 % | 0,00 % |
| Sociétés non financières | 11,20 % | 1,80 % | 7,80 % | 4,10 % |
| Ménages | 36,90 % | 0,90 % | 2,70 % | 13,70 % |
| Banque centrale | 1,60 % | 0,10 % | 0,00 % | 0,10 % |
| Institutions de dépôt | 8,50 % | 27,80 % | **80,70 %** | 39,30 % |
| Sociétés financières | 33,50 % | **67,50 %** | 7,60 % | 42,00 % |
| **Titres de créance émis** | **7,30 %** | **0,00 %** | **24,40 %** | **3,90 %** |
| **Capital & Éléments assimilables** | **1,00 %** | **2,00 %** | **5,40 %** | **3,40 %** |

*Source : BCL ; Periode 2018T4.*

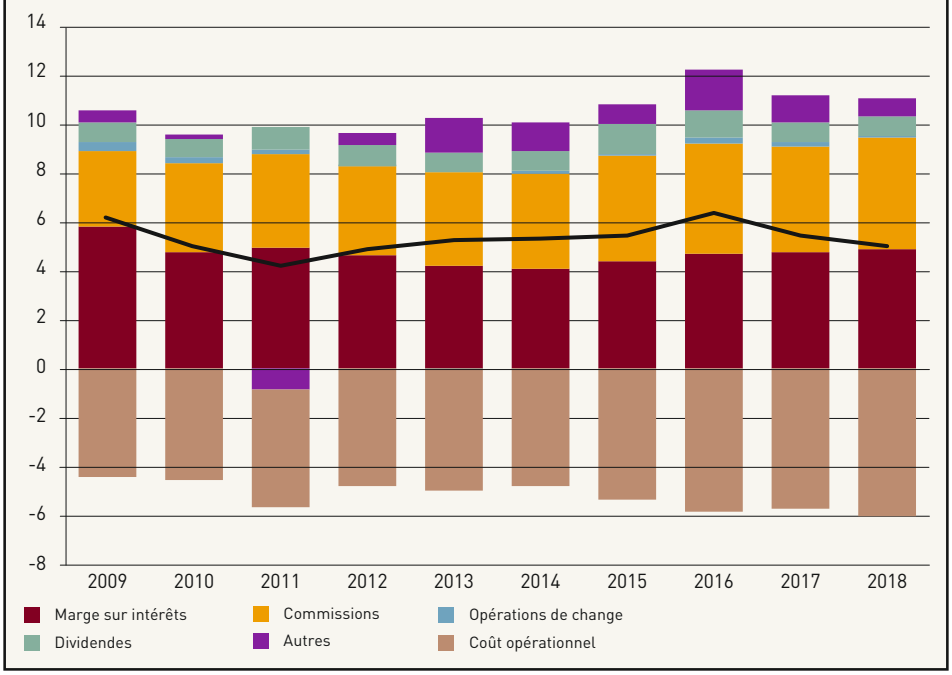
Au passif, le dépôt est la principale source de financement de tous les modèles d'affaires. Si les banques commerciales sont celles qui comptent le moins sur les dépôts, elles représentent néanmoins 70 % de leurs passifs. Les banques de détail ont une base de dépôts diversifiée dans tous les secteurs économiques, les ménages et les sociétés financières représentant chacun 35 % du total des dépôts. Cependant, le financement interbancaire est plutôt limité pour les banques de détail. Les principales sources de dépôts des banques dépositaires sont les sociétés financières (70 %), dont 55 %

Graphique 8
Parts des revenus d'intérêts et des frais et des commissions dans le revenu total par pays en Europe




*Source : BCE (ESDW). Période : 2018Q3.*

Graphique 9
Sources de revenus du secteur bancaire au niveau agrégé




*Source : BCE (ESDW). Période : 2009-2018.*

de fonds d'investissement. Par ailleurs, les banques d'affaires détiennent des engagements interbancaires importants du côté du passif, les banques représentant 80 % de leur base de dépôts. Les banques d'affaires ont généralement des expositions intragroupe importantes.

La présence de nombreux modèles d'affaires non traditionnels au Luxembourg fait que la structure des revenus au niveau agrégé se distingue clairement des autres pays européens. Comme on peut l'observer sur le graphique 8, la part que représente les frais et les commissions dans le revenu total est la plus élevée d'Europe, soit environ 45 %. Au niveau agrégé, les parts des revenus d'intérêt et des frais et des commissions sont donc très bien équilibrées. On observe par ailleurs sur le graphique 9 que la contribution relative des différentes sources de revenus au revenu total s'est peu modifiée depuis la crise.

Le graphique 10 présente les parts des revenus d'intérêt et des frais et des commissions au Luxembourg par banques et par modèles d'affaires. On constate qu'il existe un continuum entre, d'un côté, les banques de détail dont la principale source de revenu sont les revenus d'intérêt et de l'autre, les banques dépositaires qui dépendent principalement des revenus de frais et de commissions. De manière intéressante, les banques privées sont assez bien réparties sur ce continuum. Il semble donc qu'au sein de ce modèle d'affaires plusieurs types d'activités coexistent.

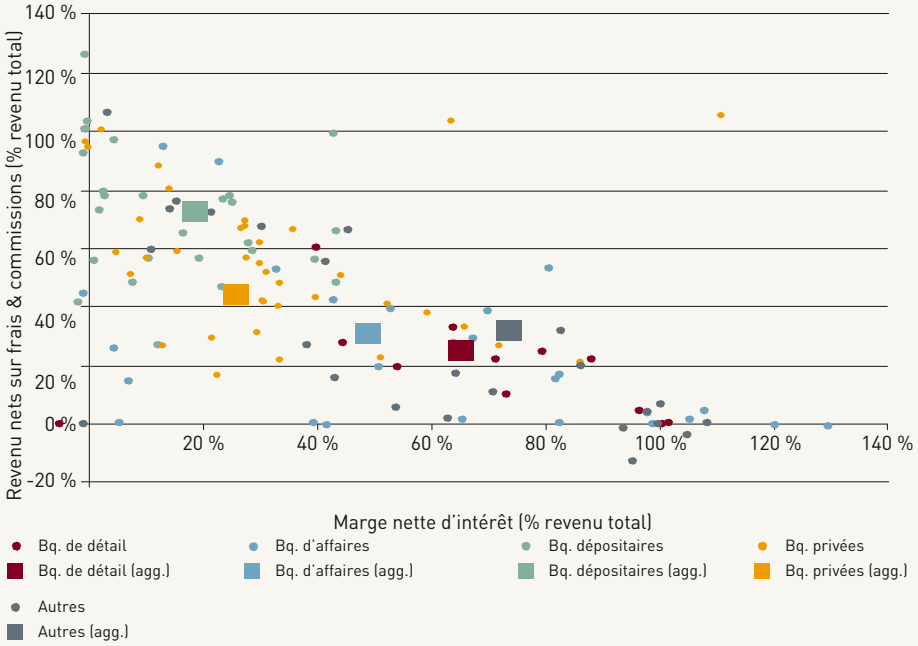
Le graphique 11 (a et b) présente la rentabilité des fonds propres et de l'actif par modèles d'affaires depuis 2001. Avant la crise, les différences en termes de niveaux de profitabilité sont très prononcées entre modèles d'affaires. Au plus haut du cycle financier entre 2006 et 2007, les banques dépositaires avaient une rentabilité des fonds propres de 40 % en moyenne contre 10 % seulement pour les banques d'affaires. La profitabilité des banques de détail était également remarquable à cette période et dépassait les 20 %. Les banques privées, bien qu'en léger retrait, avaient néanmoins une rentabilité des fonds de plus de 15 %. La rentabilité de l'actif respecte tout à fait cette hiérarchie par modèles d'affaires, avec en tête les banques dépositaires à environ 1,4 %, puis les banques de détails et les banques privées à 0,9 % et enfin les banques d'affaires à 0,5 %.

À la fin de l'année 2018, les banques dépositaires restent les plus profitables avec une rentabilité des fonds propres de 9,9 % contre 5,7 % pour les banques de détail, 4,2 % pour les banques d'affaires et 4,1 % pour les banques privées.

On observe toutefois une certaine convergence des types de banques en termes de profitabilité sur la dernière décennie. Le mouvement de consolidation des bilans depuis la crise et la diminution des leviers semble donc relativement homogène à travers les modèles d'affaires.

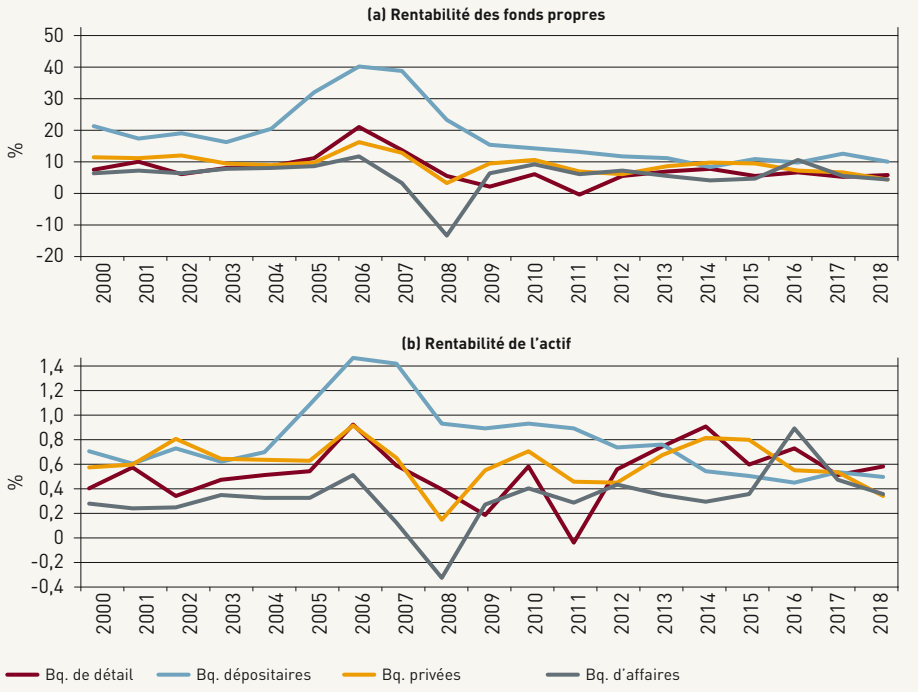
Il est néanmoins important de rappeler que ces mesures de

Graphique 10
Parts des revenus d'intérêt et des frais et des commissions au Luxembourg par banques et par modèles d'affaires



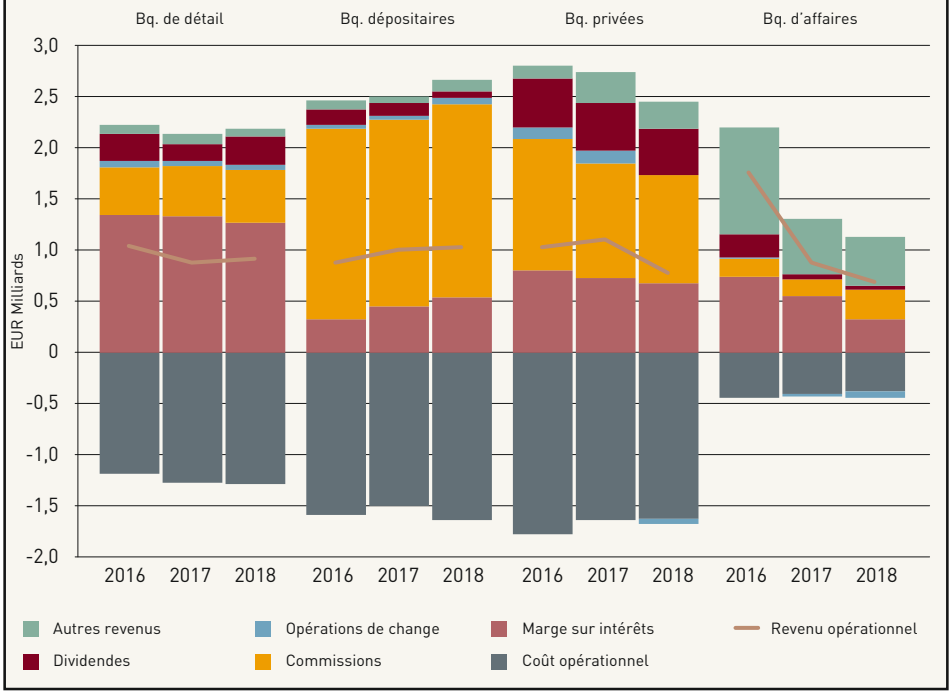

*Source BCL : Période 2018T4.*

Graphique 11
Profitabilité par modèles d'affaires



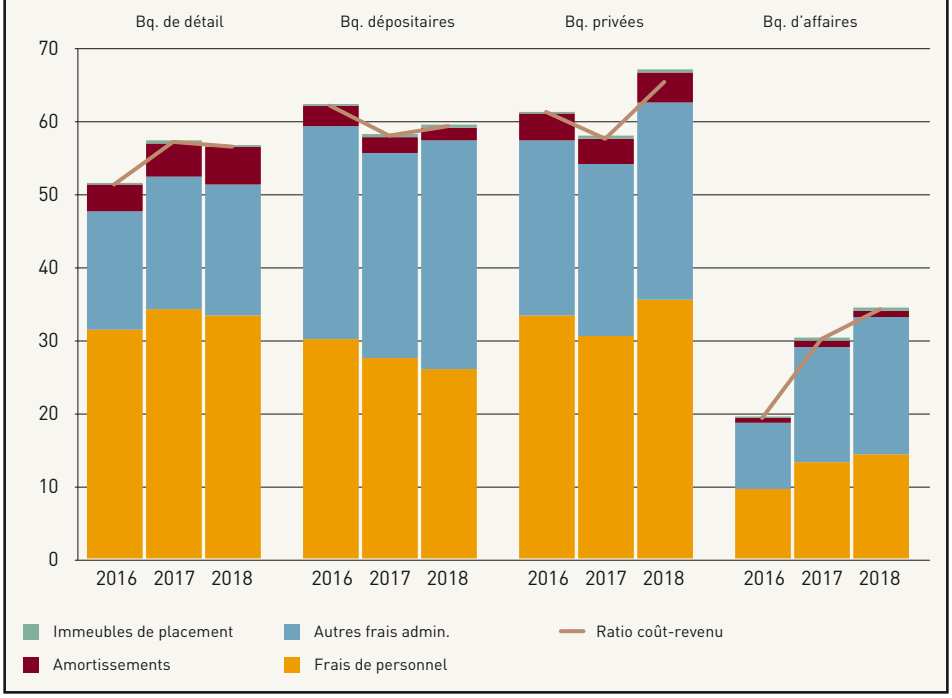

*Source BCL : Période 2001-2018.*

Graphique 12
Sources de revenu des banques luxembourgeoises par modèles d'affaires




*Source BCL : Période 2016-2018.*

Graphique 13
Ratio coût-sur-revenu par modèles d'affaires




*Source BCL : Période 2016-2018.*

profitabilité sont moins appropriées pour les banques dépositaires et ont tendance à être biaisées à la hausse. En effet, la garde d'actifs pour le compte de clients n'implique pas automatiquement une progression des bilans bancaires, les montants étant inscrits au hors bilan. Seuls les dépôts placés à la banque dépositaires sont inscrits au passif du bilan. Par conséquent, la taille du bilan ainsi que le montant de fonds propres ne sont pas toujours représentatifs du niveau d'activité d'une banque dépositaire. Ce constat est aussi vrai pour les banques privées spécialisées dans la gestion de portefeuille et qui font peu de crédits à leur clientèle.

Les différences sont importantes en termes de composition du revenu (graphique 12). Pour les banques de détail, les revenus d'intérêts représentent 78,8 % de leurs sources de revenu. Les revenus hors intérêts (frais et commissions) représentent la part restante soit, 17,4 %. Les banques d'affaires ont une structure de revenus très similaire avec des revenus d'intérêts et hors intérêts qui représentent 67,9 % et 18,1 % de leur revenu total respectivement. La structure de revenus des banques dépositaires, et dans une moindre mesure des banques privées, est inversée. Les frais et commissions représentent 75 % des revenus des banques dépositaires et 49 % des revenus des banques privées. Si les revenus d'intérêts représentent encore 25,9 % des revenus des banques privées, ceux-ci sont tout à fait marginaux pour les banques dépositaires et ne représentent que 9,3 % du total des revenus.

Le graphique 10 présente le ratio coût sur revenu afin de mesurer l'efficience de la structure de coûts par modèles d'affaires. Les structures de coûts présentent des différences importantes. Les banques privées et les banques de détail ont proportionnellement des frais de personnel supérieurs aux autres modèles d'affaires. Pour les banques dépositaires les « autres frais administratifs », qui incluent les dépenses en technologies de l'information, représentent la part la plus importante. Les banques dépositaires entretiennent souvent des plateformes informatiques coûteuses afin de gérer les actifs des fonds d'investissement. Pour cette raison, l'activité de banque dépositaire est marquée par des coûts d'entrée importants et des rendements d'échelle croissants. Les banques privées sont les moins efficients avec un ratio coûts qui atteignent en 2018 près de 70 % du revenu.

L'efficience du secteur bancaire s'est légèrement dégradée sur la période récente. Depuis 2016, les banques de détail, les banques privées et les banques d'affaires ont vu leur ratio de coût sur revenu augmenter. Seules les banques dépositaires ont réalisé des gains sensibles en termes d'efficience. Pour les banques privées et les banques d'affaires, l'augmentation du ratio coûts-sur-revenus peut s'expliquer par l'entrée en vigueur de la régulation MIFID II. Celle-ci a notamment exigée pour les banques des efforts conséquents en termes de transparence dans la tarification des services financiers.

## 2 ANALYSE DE RÉGRESSION

Afin d'évaluer l'impact des caractéristiques des modèles d'affaires sur la profitabilité bancaire, on propose une estimation sur des données de panel regroupant 68 banques luxembourgeoises. L'échantillon est constitué de données annuelles de 2002 à 2018. La spécification du modèle repose sur une vaste littérature empirique dédiée à la profitabilité bancaire. On s'inspire ici plus particulièrement de deux articles récents du Fond monétaire international (Detragiache, et al. 2018, Xu et al. 2019) dans lesquels les auteurs contrôlent l'impact des modèles d'affaires à travers différentes spécifications. On propose d'estimer l'équation suivante :

$$y_{i,t} = c + y_{i,t-1} + \beta \Delta X_{i,t} + \delta \Delta M_t + \epsilon_{i,t} \quad (3)$$

Avec $y_{i,t}$ la rentabilité des fonds propres ou de l'actif de la banque i au temps t, $y_{i,t-1}$ la rentabilité décalée d'une période et $\Delta X_{i,t}$ des variables mesurant les caractéristiques des modèles d'affaires en différence première. L'environnement macroéconomique est appréhendé par le terme $\Delta M_t$. Pour cet exercice, celui-ci est mesuré à travers la croissance du produit intérieur brut en zone euro. On propose de travailler à la fois sur les niveaux des indicateurs de profitabilité et sur leur variation entre deux années afin de dissocier les effets de long terme et de court terme.

Parmi les variables spécifiques aux banques, on introduit le logarithme de l'actif total ainsi que la croissance de l'actif. Ces deux variables permettent simplement d'évaluer si la taille d'une banque ou sa croissance rapide contribue à expliquer sa profitabilité.

L'impact des caractéristiques des modèles d'affaires est évalué à l'aide de ratios permettant de représenter la structure des bilans et la composition du revenu des banques présentes dans le panel. Le ratio des prêts au secteur non-financier sur le total de l'actif mesure à quel point une banque se rapproche d'une banque de détail. Le ratio des dépôts du secteur privé non-financier sur le total du passif mesure à quel point les banques font appel au financement par le marché et permet de distinguer les banques d'affaires des banques de détails par exemple. Le ratio des revenus nets d'intérêt sur le total des revenus permet d'appréhender le degré de diversification des sources de revenu et de distinguer par ailleurs, les banques dépositaires et dans une moindre mesure les banques privées des banques

de détail. On introduit également le ratio du coût sur revenu afin de mesurer l'impact de l'efficience sur la profitabilité bancaire. De plus, le ratio des fonds propres sur le total de l'actif mesure l'effet de levier sur la profitabilité. Enfin, on introduit un ensemble de variables indicatrices pour chaque modèles d'affaires. Celles-ci permettent de mesurer l'effet inobservé associé à l'appartenance d'une banque à une catégorie de modèle d'affaires.[93] Pour cette première tentative, on propose d'estimer le modèle par moindres carrés ordinaires avec et sans effets fixes.

Tableau 2 :
**Résultats des estimations**

| | ROA | | ROA | | Δ ROA | | Δ ROE | |
|---|---|---|---|---|---|---|---|---|
| | OLS | FE | OLS | FE | OLS | FE | OLS | FE |
| $Y_{i,t-1}$ | **0,673*** ** | **0,281*** ** | **0,672*** ** | **0,417*** ** | **0,262*** ** | **0,222*** ** | **0,309*** ** | **0,254*** ** |
| log(Actif) | **-0,025*** | **-0,157*** ** | -0,066 | **-1,77**** | -0,009 | **-0,116*** ** | **-0,345*** | **-3,33**** |
| Croissance de l'actif | **-0,004*** ** | **-0,002*** ** | -0,002 | 0,006 | **-0,003*** ** | **-0,002*** | -0,001 | 0,006 |
| Fonds propres sur total actif | **0,012*** | **0,0182**** | -0,02 | -0,113 | **0,0429*** ** | **0,045*** ** | **-0,200**** | **-0,325*** |
| Prêts du SPNF sur total de l'actif | **-0,004*** | **-0,002**** | -0,004 | -0,016 | -0,001 | **-0,004**** | -0,001 | **-0,064**** |
| Dépôts du SPNF sur total passif | 0,001 | **0,002*** | -0,022 | -0,021 | 0,0002 | 0,002 | 0,011 | 0,046 |
| Revenus hors intérêt sur total des revenus | **0,002**** | **0,013**** | **0,029**** | **0,024+** | **0,006*** ** | **0,006*** ** | **0,054*** ** | **0,0605**** |
| Coût opérationnel sur revenu | **-0,007*** ** | **-0,009*** ** | **-0,088*** ** | **-0,106*** ** | **-0,017*** ** | **-0,019*** ** | **-0,220*** ** | **-0,237*** ** |
| Croissance du PIB | 0,015 | 0,013 | **0,337**** | **0,371**** | **0,041*** ** | **0,035*** | **0,817*** | **0,660**** |
| Banques de détail | 0,055 | | 0,35 | | 0,073 | | 1,735 | |
| Banques d'affaires | 0,054 | | 1,1 | | 0,062 | | 0,445 | |
| Banques privées | 0,054 | | 0,80 | | 0,075 | | 0,634 | |
| Banques dépositaires | **0,115**** | | **2,15*** ** | | -0,014 | | 0,232 | |
| $R^2$ | **0,2** | **0,36** | **0,19** | **0,35** | **0,44** | **0,45** | **0,43** | **0,423** |

*Source : BCL.*

Les paramètres associés au logarithme de l'actif total et la croissance de l'actifs sont généralement significatifs et négatifs. Par conséquent, accroitre la taille de la banque ne permet pas d'augmenter la profitabilité que ce soit à court ou à long terme. Ce résultat est potentiellement important pour les banques de détail qui ont augmenté la taille de leurs bilans depuis 2014.

Bien que le paramètre associé au ratio des prêts au secteur privé non-financier sur le total de l'actif ne soit pas toujours significatif, celui-ci est systématiquement estimé avec un signe négatif. Ce résultat renforce la conviction que les activités de banques de détail sont généralement moins profitables et plus particulièrement dans l'environnement actuel.

Le paramètre associé au ratio des dépôts du secteur privé non-financier sur le total de l'actif est rarement significatif. Il semble donc que la stratégie de financement, par les dépôts ou les marchés, n'a pas de conséquences sur la profitabilité bancaire au Luxembourg.

93 Les variables indicatrices ne sont testées que dans les modèles linéaires sans effets fixes individuels car elles sont colinéaires avec ces derniers.

Le ratio des revenus hors intérêt sur le total des revenus est dans l'ensemble très significatif et positif. Ce résultat est conforme à l'hypothèse que les banques qui diversifient leurs sources de revenus sont plus profitables. Ce résultat est important dans l'environnement de taux bas actuel car il indique que pour les banques de détail, une augmentation des revenus de frais et de commission pourrait être bénéfique.

Enfin la mesure d'efficience, le ratio du coût opérationnel sur le revenu est également très significatif et négatif. Les banques qui réalisent les plus grands efforts d'efficience sont donc logiquement les plus profitables.

## CONCLUSION

Depuis la crise financière de 2008, la profitabilité bancaire en Europe est sous la pression d'un environnement peu favorable combinant un ensemble de facteurs cycliques et structurels : une croissance moins dynamique que dans d'autres régions du monde, des taux d'intérêt bas, des stocks élevés de prêts non-performants dans certains pays, une régulation plus contraignante et enfin une compétition accrue du secteur non-bancaire dans une période de profondes ruptures technologiques.

La soutenabilité de la profitabilité bancaire à long terme contribue à la résilience du secteur bancaire en cas chocs en lui permettant de constituer les coussins de fonds propres. Cette question est donc devenue une priorité pour la stabilité financière en Europe.

Par rapport aux autres pays européens, la profitabilité bancaire au Luxembourg semble moins affectée. Celle-ci bénéficie en particulier d'un montant limité de prêts non-performants dans les bilans bancaires et, pour les banques de détails, d'une croissance plus favorable que dans le reste de l'Union Européenne. Ainsi, la baisse de la profitabilité mesurée par la rentabilité des fonds propres s'explique pour une large part par la diminution du montant des leviers et de l'accroissement de la résilience du secteur bancaire. Néanmoins, le contexte actuel de profitabilité constitue un enjeu d'avenir pour les banques luxembourgeoises qui devront très probablement adapter leurs modèles d'affaires et réaliser les investissements en nouvelles technologies afin de rester compétitives.

Les premiers résultats empiriques dévoilés dans cette étude suggèrent que pour les banques qui dépendent le plus des revenus d'intérêt, une plus grande diversification des sources de revenu serait bénéfique à long terme. Ce résultat est important pour les banques de détail. Aussi, la recherche d'efficience, notamment à travers l'investissement en technologies financières, dans un environnement hautement concurrentiel, devrait garantir des niveaux de profitabilité soutenable à long terme.

## BIBLIOGRAPHIE

Altavilla C., M. Boucinha et J-L. Peydró (2017). Monetary policy and bank profitability in a low interest rate environment. ECB Working Paper Series. N°2105. Octobre.

Committee on the Global Financial System (2018). Financial stability implications of a prolonged period of low interest rates. CGFS Papers No. 61. Juillet.

Detragiache E., T. Tressel et R. Turk-Ariss (2018). Where have all the profits? European bank profitability over the financial cycle. IMF working paper 18/99. Avril.

European Banking Agency (2019). The EBA methodological guide – Risk indicators and detailed analytical tools. Mars.

European Central Bank (2010). Beyond RoE – How to measure bank performance. Appendix to the report on EU banking structures. Septembre.

European Central Bank (2016). Adapting bank business models: financial stability implications of greater reliance on fee and commission income. Special feature C. Financial Stability Review. Novembre.

European Central Bank (2018a). SSM thematic review on profitability and business models. Report on the outcome assessment. Septembre.

European Central Bank (2018b). How can euro area banks reach sustainable profitability in the future? Special feature A. Financial Stability Review. Novembre.

European Systemic Risk Board (2014). Is Europe Overbanked? Report of Reports of the Advisory Scientific Committee N°4. Juin.

Mergaerts F.et R. V. Vennet. (2016), Business models and bank performance: A long-term perspective, Journal of Financial Stability, Volume 22, 2016, Pages 57-75.

Rungporn R., N. Tarashev; K. Tsatsaronis et V. Alan, Bank Business Models: Popularity and Performance (December 2017). BIS Working Paper No. 682.

Xu T., K. Hu et U. Das (2019). Bank profitability and financial stability. IMF working paper 19/05. Janvier.