

4 ANALYSES

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1. MVAR IMPULSE RESPONSE FUNCTIONS COMPARED TO A VAR MODEL: A FIRST ASSESSMENT OF THE MACRO-FINANCIAL LINKAGES OF THE BANKING SECTOR IN LUXEMBOURG

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ABSTRACT

In this study we provide a first assessment of the macro-financial linkages of the Luxembourg banking sector. To capture the links between banking sector counterparty credit risk and the macroeconomic environment, both a normal VAR model as well as an MVAR model have been estimated using data that links multiple macroeconomic variables to banking sector counterparty risk. The macroeconomic data include a Luxembourg residential property price index, euro area and Luxembourg real GDP growth and the EURIBOR 3 months interest rate. Based on the model estimation output, impulse response functions (IRFs) have been computed to illustrate the response of counterparty credit risk to Cholesky one standard deviation macroeconomic shocks. The results of the IRF analysis conform to the expected effects of the shocks on banking sector counterparty default risk. The results also highlight the importance of accounting for macro-financial linkages as input into macro-prudential policymaking decisions given their ability to shed light on the interactions between financially relevant variables and the broader economy.

INTRODUCTION


Following the lessons learned during the crisis, stress testing has become common practice among financial supervisory authorities and it represents an important component in the overall process of macro-prudential surveillance and assessment of risks. Stress testing helps to facilitate authorities' understanding and assessment of how the regulatory capital ratio of banks may respond to severe but plausible macroeconomic shocks. If a bank's capital ratio is assessed, based on both the quantitative evidence of a stress test complemented by expert judgment, to be insufficient to withstand such shocks, supervisory authorities may require the bank to hold additional capital as a buffer against adverse events.

To assess the resilience and counterbalancing capacity of the Luxembourg banking sector to adverse macroeconomic shocks, the Banque centrale du Luxembourg (BCL) regularly employs a macro-prudential stress testing framework. This framework is based on a mixture vector autoregressive model (MVAR). The MVAR model is well-suited for stress testing applications as it uses a weighted combination of VAR models in order to better capture the tail risks that are associated with systemic risk and increased fragility. The MVAR model and the stress testing framework used here are both described in more detail in Guarda, Rouabah and Theal (2013)².

In addition to facilitating the assessment of the effects of adverse shocks on banks' core equity tier 1 (CET1) ratios, the MVAR model can also help to provide some insight into the channels by which banks'

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² P. Guarda, A. Rouabah and J. Theal. "A mixture vector autoregressive framework to capture extreme events in macroprudential stress tests", *Journal of Risk Model Validation*, 12/2013; 7(4):1-31.



counterparty credit risk may be affected by the macroeconomic environment. These interconnections are called macro-financial linkages and they represent the channels through which financial stability indicators, like the probability of default and relevant macroeconomic variables, such as GDP growth, interest rates and property prices, interact and affect one another.

For macro-prudential authorities, it is important to understand those macro-financial linkages that could have a detrimental effect on the banking sector and its subsequent ability to extend credit to the economy. In particular, the creditworthiness of a bank's loan counterparties is one of the significant factors that determine a bank's willingness to lend. In addition, counterparty credit risk can be used in the evaluation of the resilience of a bank to adverse economic or financial shocks. If counterparty risk is elevated during a period of stress, banks may need to increase their CET1 levels in order to bolster their counterbalancing capacity in the event that an adverse macroeconomic scenario materializes. In addition, if banks' lending activities are assessed to be systemically relevant for the stability of the financial system, a deepened understanding of the macro-financial linkages may also be used to gauge the potential need for authorities to apply macro-prudential instruments, such as the countercyclical capital buffer.

DATA AND ESTIMATION OF THE VAR AND MVAR MODELS

In this study, both a VAR and MVAR model were estimated in order to establish the relationships between the financial and macro variables. The setup of both models was similar and they consist of a joint system of five linear equations for the probability of default, euro area real GDP growth, the real growth rate of Luxembourg GDP, the real interest rate and the growth rate of a Luxembourg property price index. In the MVAR case, the model is a weighted combination of two individual VAR models rather than a single VAR estimation. This specification allows the component VAR models to capture feedback effects between the macroeconomic variables and the probability of default series. Furthermore, the use of two lags of the endogenous variable in each equation of the respective models allows us to capture the persistence and transmission of exogenous shocks through the system.

Mathematically, the basic VAR model specification used in this study takes the following form for both the VAR and MVAR models:

$$Y_t = c + \Theta_1 Y_{t-1} + \Theta_2 Y_{t-2} + \dots + \Theta_p Y_{t-p} + e_t$$

The data used to estimate the models consisted of proxies for historical probabilities of default (PD) calculated on a quarterly basis over the period spanning the first quarter of 1995 until the fourth quarter of 2014. In addition to the probability of default, the MVAR and VAR models incorporated data on euro area real GDP growth, the real interest rate and the change in real property prices for a Luxembourg residential property price index. Given that Luxembourg is a small, open economy with a large number of foreign banks, the series for euro area real GDP growth effectively provides an appropriate explanatory variable for the profitability of the banking sector in Luxembourg. Property prices and the real interest rate have been used to capture balance sheet effects as well as changes in counterparty creditworthiness. The choice of variables permits the stress testing framework to capture the feedback effects between the probability of default series and the macroeconomic variables and hence facilitates an assessment of the macro-financial linkages and possible variable interactions.

The results of the estimation of the VAR model are given in the accompanying table 1. The column headings define the dependent variable equations while those in the rows show the lagged independent variables for each equation in the VAR. A total of two lags were used for the estimation. Coefficients

displayed in bold text indicate statistical significance while quantities in italic text provide the standard errors of the coefficient estimates.

Table 1:

VAR Model Coefficient Estimates

	YJT	EURO AREA REAL GDP GROWTH	LUX. REAL GDP GROWTH	REAL INTEREST RATE	REAL PROPERTY PRICE GROWTH
Yjt (-1)	0.924680	0.014415	0.089937	-0.003952	-0.002164
	<i>(0.11559)</i>	<i>(0.00685)</i>	<i>(0.02450)</i>	<i>(0.00731)</i>	<i>(0.01523)</i>
Yjt(-2)	0.046602	-0.015577	-0.095200	0.004462	-0.000255
	<i>(0.11290)</i>	<i>(0.00669)</i>	<i>(0.02393)</i>	<i>(0.00714)</i>	<i>(0.01487)</i>
euro area real GDP growth (-1)	3.471511	0.389929	0.772439	-0.197604	-0.054502
	<i>(2.57836)</i>	<i>(0.15282)</i>	<i>(0.54652)</i>	<i>(0.16308)</i>	<i>(0.33961)</i>
euro area real GDP growth (-2)	2.828341	-0.140901	-0.609060	0.278556	-0.262784
	<i>(2.14864)</i>	<i>(0.12735)</i>	<i>(0.45543)</i>	<i>(0.13590)</i>	<i>(0.28301)</i>
Lux. Real GDP growth (-1)	-0.562061	0.062972	-0.448872	0.068693	0.175949
	<i>(0.62346)</i>	<i>(0.03695)</i>	<i>(0.13215)</i>	<i>(0.03943)</i>	<i>(0.08212)</i>
Lux. Real GDP growth (-2)	-0.363419	0.061000	0.093955	0.009486	0.126832
	<i>(0.64770)</i>	<i>(0.03839)</i>	<i>(0.13729)</i>	<i>(0.04097)</i>	<i>(0.08531)</i>
real interest rate(-1)	0.202098	-0.206449	-0.168042	1.041587	-0.427649
	<i>(1.99069)</i>	<i>(0.11799)</i>	<i>(0.42195)</i>	<i>(0.12591)</i>	<i>(0.26220)</i>
real interest rate(-2)	-0.757861	0.238551	0.344225	-0.121623	0.382018
	<i>(1.99606)</i>	<i>(0.11831)</i>	<i>(0.42309)</i>	<i>(0.12625)</i>	<i>(0.26291)</i>
property price growth (-1)	0.174925	-0.015176	-0.312664	-0.107577	0.469779
	<i>(0.97210)</i>	<i>(0.05762)</i>	<i>(0.20605)</i>	<i>(0.06149)</i>	<i>(0.12804)</i>
property price growth (-2)	1.983934	0.066227	0.346888	0.075447	0.248547
	<i>(0.99085)</i>	<i>(0.05873)</i>	<i>(0.21002)</i>	<i>(0.06267)</i>	<i>(0.13051)</i>
C	0.112427	0.006019	0.033052	-0.002671	0.013064
	<i>(0.08928)</i>	<i>(0.00529)</i>	<i>(0.01892)</i>	<i>(0.00565)</i>	<i>(0.01176)</i>

Source: BCL.

The estimation results show that increases in the growth rate of euro area GDP result in an increase in the value of the transformed variable Y_t which is inversely related to the probability of default. Correspondingly, a decrease in euro area economic growth could result in a positive increase in the probability of default, thereby increasing the risk for the Luxembourg banking sector given its sensitivity to the euro area macroeconomic environment owing to the large number of foreign banking groups in the financial sector. A similar effect can be observed for the property price index growth. In addition, an increase in the real interest rate will negatively affect Y_t given that the sum of the coefficients of the real interest rate variable is less than one. Finally, although not statistically significant, the coefficient on the lagged value of Y_t was found to be positive, suggesting that exogenous shocks will persist for a time horizon exceeding the duration of the shock. For the remaining macroeconomic variable equations the model seems to capture the expected dynamics between the macroeconomy and the probability of default. We note, however, that the sign on Luxembourg real GDP growth is the inverse of that which is expected; i.e. it is negative rather than positive. This is due to the presence of a large number of foreign branches and subsidiaries that, although located in Luxembourg, do not undertake activities that are linked to Luxembourg real GDP growth. In this manner, they may also be potentially subject to inward spillovers from the euro area rather than being negatively affected by economic developments in the Luxembourg economy.

Having estimated the models, we can now compute the impulse response functions in order to assess the macro-financial linkages between Luxembourg counterparty credit risk and the economic variables.

IMPULSE RESPONSE FUNCTIONS OF THE MVAR MODEL

To illustrate the impulse response functions (IRFs) and how they can help to understand the linkages between financial stability variables like the probability of default and macroeconomic developments, we first consider the specification of the MVAR model which can be written as a weighted combination of VAR(p) models in the following manner:

$$F(y_t | \mathfrak{S}_{t-1}) = \sum_{k=1}^K \alpha_k \Phi \left(\Omega_k^{-1/2} \left(Y_t - \Theta_{k0} - \Theta_{k1} Y_{t-1} - \Theta_{k2} Y_{t-2} - \dots - \Theta_{k1p} Y_{t-p_k} \right) \right)$$

Here y_t is the conditional expectation of Y_t , p_k is the autoregressive lag order of the k^{th} component, \mathfrak{S}_{t-1} is the available information set up to time $t-1$, $\Phi(\cdot)$ is the cumulative distribution function of the multivariate Gaussian distribution, α_k is the mixing weight of the k^{th} MVAR component distribution, Θ_{k0} is an n -dimensional vector of constant coefficients and $\Theta_{k1}, \dots, \Theta_{k1p_k}$ are the autoregressive coefficient matrices of the k^{th} component distribution. Lastly, Ω_k is the $n \times n$ variance-covariance matrix of the k^{th} component distribution.

The IRF from a VAR model represents the deterministic response of the model variables to a standardized shock applied to one of the variables used in the estimation of the model. Because the variables of a VAR form a system of equations, studying the IRF functions of an econometric model helps to facilitate an understanding of the response of a variable (or variables) to an impulse – in this case a exogenous macroeconomic shock – on one of the other variables of the model. In the context of analyzing macro-financial linkages an increase in, for example, the interest rate or a negative shock to GDP may lead to an increase in counterparty credit risk levels. Depending on their regulatory capital level, the resulting increased credit risk may oblige banks to enhance their resilience through various measures, including through the application of macro-prudential measures by national authorities under the CRD IV/CRR framework.

The actual IRF functions are derived based on the estimated coefficient matrices of the MVAR model. In order to obtain a general expression for the impulse response function a VAR(p) model (or equivalently the component VAR models of the MVAR) can first be written in moving average (MA) form as follows;

$$y_t = \sum_{i=0}^{\infty} \Psi_i e_{t-1}$$

Here $\Psi_0 = I_n$ and Ψ_i is the i^{th} coefficient matrix of the MA representation of the VAR model. By extending the formula to n periods (i.e. the horizon of the impulse function) we obtain a general expression y_{t+n} for over the entire impulse function horizon:

$$y_{t+n} = \sum_{i=0}^{\infty} \Psi_i e_{(t+n)-1}$$

It follows that the actual IRF at period n is therefore given as:

$$\{\Psi_n\}_{i,j} = \frac{\partial y_{it+n}}{\partial e_{jt}}$$

This equation gives the response of $y_{i,t+n}$ to a shock in y_{jt} under the condition that all other variables are held constant, thereby isolating the response of individual variables. In practice, the IRF can be

computed by using Cholesky decomposition in order to orthogonalize the impulses and subsequently trace the effect of a one standard error shock through the VAR system. Given that the MVAR model consists of a weighted combination of VAR models, the IRFs for each component of the MVAR can be evaluated individually and then be combined according to the MVAR weighting factors, α_k .

Following the estimation of the MVAR stress testing model, the IRFs for each component VAR were computed by applying a one standard deviation shock to the individual macroeconomic variables then evaluating the model equations (i.e. by computing the responses of y_{jt} to the impulse) over a period of 25 quarters. As described above, the individual MVAR IRFs were combined according to the estimated model weights, α_k . In addition to the MVAR model a normal VAR(p) was also estimated and the IRFs for the VAR were computed for purposes of comparison. In computing the IRFs, the variable Y_{jt} was used as the shock target. We recall that this variable is related to the probability of default by the following equation:

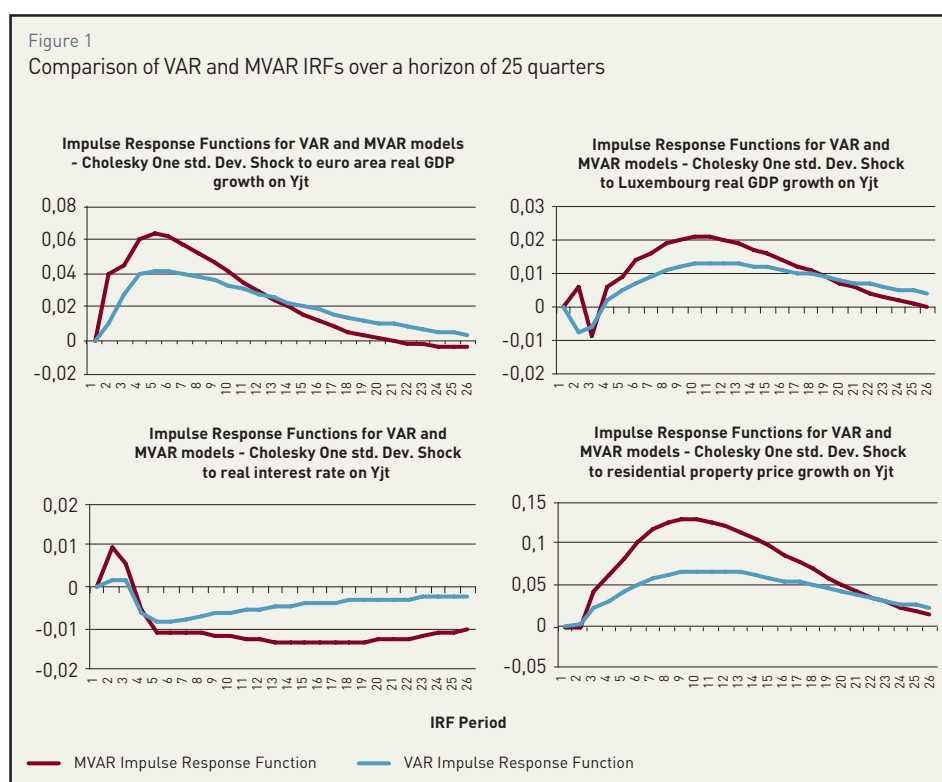
$$y_t = \ln\left(\frac{1-p_t}{p_t}\right)$$

Here the probability of default, p_t , is transformed such that y_t takes on values in the interval $-\infty < y_t < \infty$. The result is that, after the transformation, y_t and p_t will be inversely related; a relationship that will also apply to the first difference of the y_t series.


COMPUTATION OF THE IMPULSE RESPONSE FUNCTIONS

The impulse response functions of the MVAR model were estimated and used to provide an indication of the possible channels of interaction between counterparty creditworthiness and the relevant macroeconomic variables that are of importance for the banking sector in Luxembourg. These latter factors include euro area real GDP growth, Luxembourg real GDP growth, the real (EURIBOR 3 months) interest rate and a residential real estate price index for Luxembourg.

Figure 1 below shows the IRFs for both the MVAR and VAR models resulting from a Cholesky one standard deviation shock to the four individual macroeconomic variables and the resulting response of Y_{jt} , the logit-transformed value of the probability of default proxy described previously.



Source: BCL Calculations.



The response of y_{jt} to orthogonal shocks to euro area real GDP growth, Luxembourg real GDP growth, the real interest rate and the growth of Luxembourg residential property prices suggest that there are interesting and potentially important differences between the IRFs computed using the two different models. Notably, in all four of the graphs, the amplitude of the MVAR IRF exceeds that of the VAR model equivalent.

It is important to underscore that in the graphs a positive shock to euro area real GDP growth implies a decline in the probability of default since the PD is inversely related to y_{jt} . As a result, the increase in euro area real GDP growth is consistent with a decline in counterparty credit risk. In addition, the effect of the shock is temporary as the impact on y_{jt} begins to decline after about 5 quarters, eventually returning to zero. For the shock resulting from Luxembourg real GDP growth, the effect on y_{jt} is similar for the MVAR (an initial increase followed immediately by a decline), but for the VAR there is an initial decline. The conflicting results are due to the volatile nature of the Luxembourg GDP series. Nevertheless, the impact of the shock remains transitory and the effect eventually declines to zero in a manner similar to that observed in the case of euro area real GDP. In any event, the VAR regression coefficient for Luxembourg real GDP growth in the equation for Y_{jt} is not statistically significant. Furthermore, the wrong sign on this particular regression coefficient can be explained by the disconnection between the banking sector and Luxembourg real GDP; the latter resulting from the large number of foreign banks that are not connected to the domestic economy and whose banking activities are internationally oriented.

For the real interest rate shock, the VAR and MVAR responses of y_{jt} are very similar with the exception that the amplitude of the MVAR IRF exceeds that of the VAR (both on the positive and negative sides). The interpretation here is that the impact of the shock is more significant and more sustained in the MVAR case, illustrating the model's ability to capture the tail events associated with the effects of systemic stress and tail risk. Again, the impact eventually dies out towards the end of the IRF horizon of 25 quarters. It is important to take account of the fact that the response by y_{jt} to an unexpected and substantial interest rate shock may be significant given the long and sustained period of low interest rates within the European Union. The effects of an unexpectedly large interest rate increase could potentially have a substantial impact on counterparty credit risk levels for the banking sector.

For the real property price IRF, the MVAR and VAR models also give similar results. However, the effect of the impulse on y_{jt} only materializes approximately 2 quarters after the onset of the unit shock. The interpretation is that there is a delay in the pass through of the shock to real estate prices which could be attributed to the high net worth of Luxembourg households and their subsequent debt servicing capacities. Nevertheless, the amplitude of the shock under the MVAR remains elevated compared to the VAR, suggesting that if some banks are highly concentrated in mortgage lending the materialization of a possible risk related to real estate lending could not be ruled out, especially against the background of persistently low interest rates.

CONCLUSION

The impulse response functions of a VAR model help to provide insights into the dynamics underlying the links between financial stability indicators and the macroeconomic environment. They permit authorities to assess how counterparty risk may be affected by developments related to macroeconomic conditions and vice versa. In the case of the MVAR, the impulse response functions seem to be able to capture additional aspects of risk that a normal VAR model IRF cannot as has been seen in the increased amplitudes of the comparable IRFs as well as the response of the credit risk variable to a shock in real GDP growth, for example.

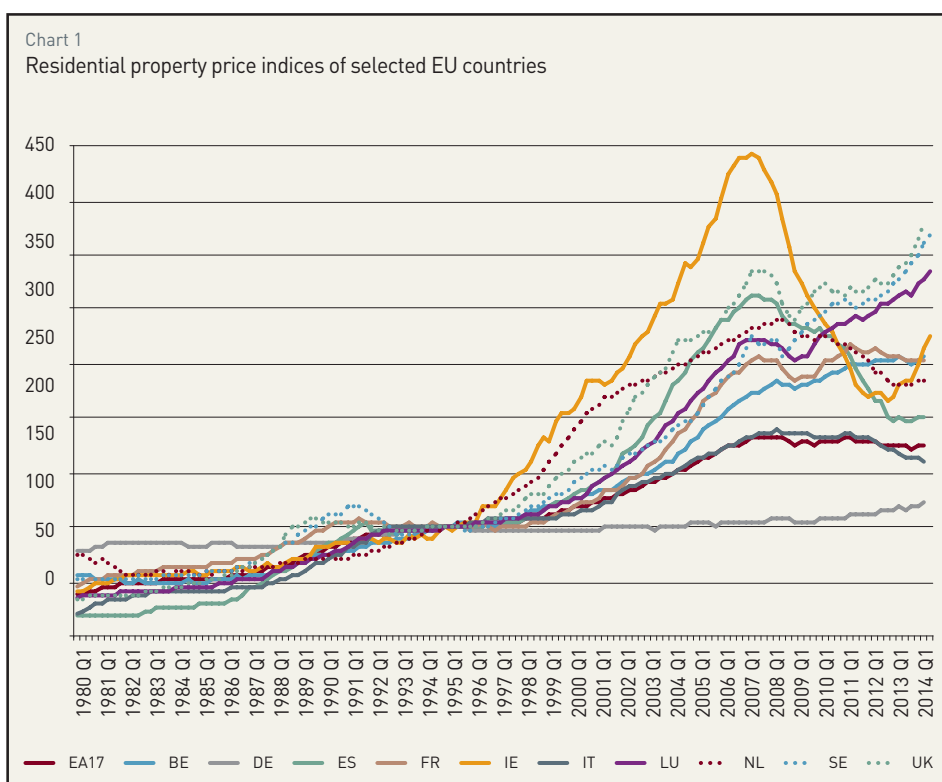
A deep understanding of the macro-financial linkages between the economy and the banking sector is an important element in authorities' assessment of systemic risk. The reason for the high importance is because developments in the macroeconomic environment can ultimately help to determine the regulatory requirements of banks. In addition, the linkages need to be understood in order for regulatory authorities to make informed policy decisions that can help to mitigate the severe systemic risk that is known to precipitate financial crisis episodes. In addition, a detailed understanding of these economic and financial linkages can help to guide the use and application of macro-prudential tools and to assess their potential effects on the real economy. Such information will be invaluable to bodies such as national systemic risk committees that are responsible for the implementation of macro-prudential measures in the context of CRD IV and the CRR framework in individual EU Member States.

2. AN ASSESSMENT OF LUXEMBOURG'S RESIDENTIAL REAL ESTATE MARKET

Gabriele Di FILIPPO³

ABSTRACT

This article analyses the residential property market in addition to mortgage market developments in Luxembourg. One of the main issues from a financial stability perspective is banks' vulnerability to a sudden and sharp correction in residential property prices. Altogether, the analysis attaches a low probability to this event. Indeed, the results show that residential property prices have evolved broadly in line with their fundamentals at the end of the period under consideration. Nevertheless, the analysis emphasizes the continued need for monitoring and surveillance of property price developments in the periods ahead given the potential for Luxembourg residential property prices to continue increasing against a background of elevated demand in combination with supply constraints. In addition, continued vigilance with respect to the evolution of households' mortgage debt burden, mortgage issuance by banks in an environment characterized by low interest rates and large increases in the interest rate seems warranted. The latter is important from a financial stability viewpoint in order to ensure that potential risks resulting from sudden increases in interest rates are contained, particularly given the importance of households' mortgage debt burden.



Sources: BCL, BIS, ECB-SDW, 1995=100

1. INTRODUCTION

Chart 1 presents the evolution of residential property price indices of selected EU member countries. In 2014, a first group of countries experiences moderate growth rates in prices (BE, DE, ES, FR, IT, NL) while relatively stronger growth rates in prices prevail in a second group of countries (IE, LU, SE, UK), including Luxembourg. The current level of residential property prices in Luxembourg is elevated in comparison to its historical average and its earlier peak in 2007. A question that arises naturally is whether such dynamics could have an impact on financial stability in Luxembourg.

One of the main financial stability issues for Luxembourg is the potential onset of a sharp and sudden correction in residential property prices. Such a correction

3 Financial Stability Department, Banque centrale du Luxembourg.

might induce wealth losses for households. Debtors could potentially encounter difficulties repaying their mortgages or any other debt backed by their wealth depending on their debt servicing capacity. Therefore, banks face three major risks on the asset-side of their balance sheet: a fall in property value held as collateral, an increase in non-performing loans and capital losses on real estate investments. Given that in Luxembourg, three banks hold more than 70% of mortgages,⁴ it suggests that authorities should continue to monitor concentration levels.

Against this background, this article analyses potential risk sources stemming from the residential property market and the mortgage market.⁵ One of the main objectives is to investigate whether residential property price dynamics are justified by or disconnected from their fundamentals.⁶

To this aim, section 2 undertakes chart-based analyses of developments on the demand side (section 2.1) and on the supply side (section 2.2) of the residential property market, accompanied by ratio-based and model-based analyses (section 2.3). Risks related to mortgage market developments are investigated in section 3 on the borrowers' side (section 3.1) and on the lenders' side (section 3.2). Section 4 concludes.

2. RISKS STEMMING FROM THE RESIDENTIAL PROPERTY MARKET

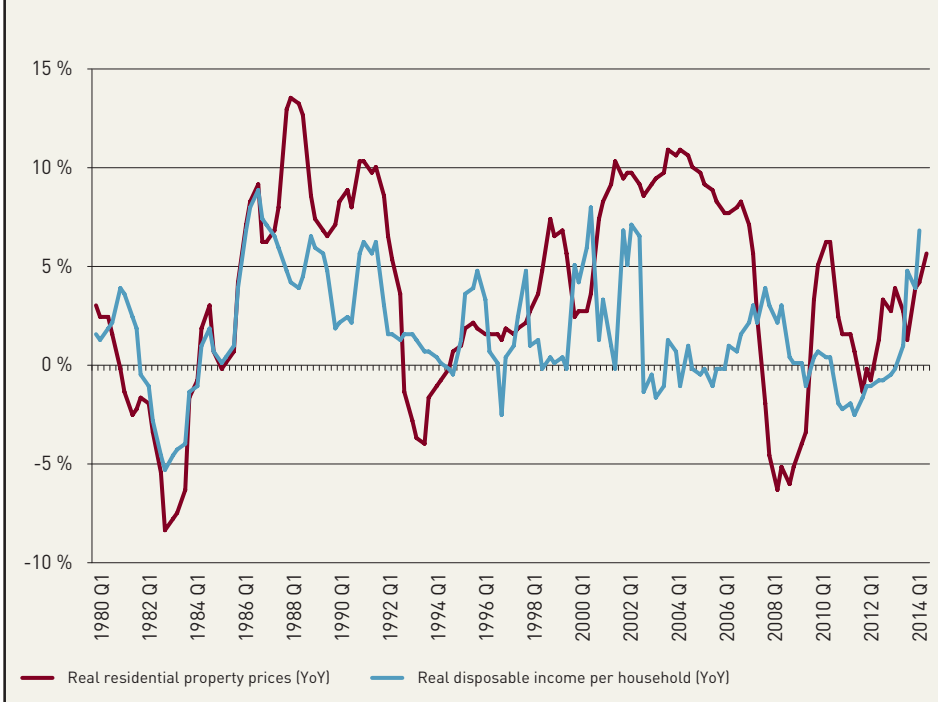
The analysis of risks stemming from the residential property market boils down to investigating whether price dynamics are justified by their fundamentals. On the demand side of the residential property market, several fundamentals drive residential property price dynamics: wealth (disposable income, employment), demographics (population growth, net migration, household size), housing finance indicators (mortgage loans, mortgage rates), return indicators (price-to-rent ratio, imputed rent-to-actual rent ratio, risk-adjusted returns of various asset classes, taxation) and sentiment indicators (household confidence index, household financial condition, household sentiment about housing purchase/investment). On the supply side, dwellings investment, building permits, construction cost, employment in the construction sector, business sentiment in the construction sector, and taxation are the most forward-looking indicators driving the evolution of residential property prices.

⁴ In Luxembourg, five banks hold 90% of total mortgages.

⁵ Investigating potential risks originating from the real estate market also necessitates the analysis of risks stemming from the mortgage market. Indeed, according to the latest figures provided by the Household Finance and Consumption (HFCN) survey, in 2008, about half of Luxembourg households resort to mortgages to afford buying a residential property. Therefore, mortgage market developments could play an important role in residential property market developments.

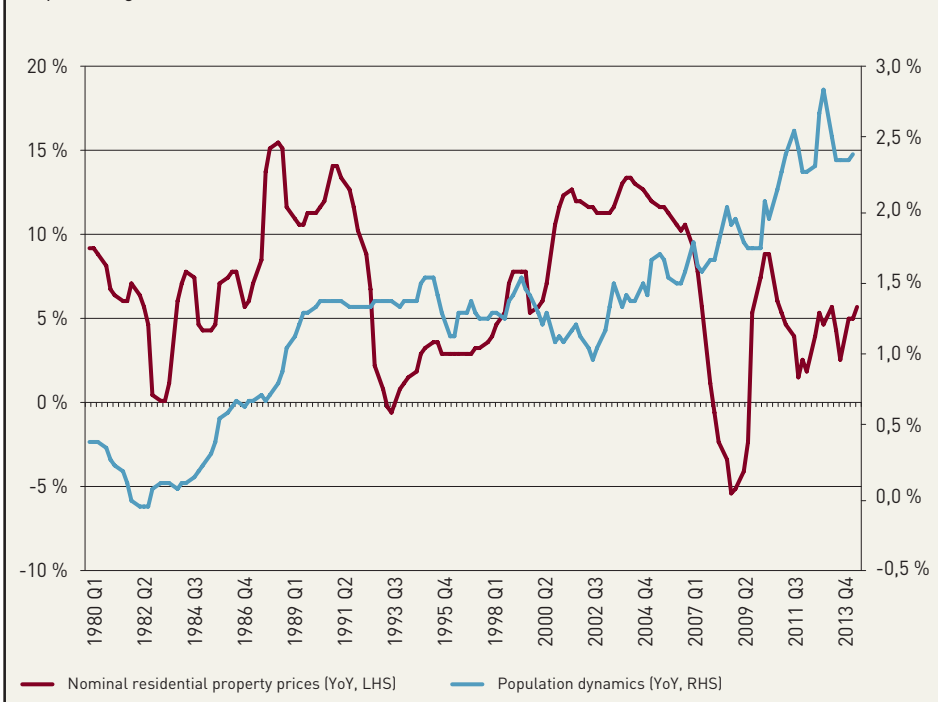
⁶ Fundamentals are defined as macroeconomic and financial variables that play a significant role in the determination of demand and supply of residential properties, and hence in the determination of residential property prices.

Chart 2.1
Disposable income per household



Sources: BCL, STATEC

Chart 2.2
Population growth



Sources: BCL, STATEC

2.1 Demand side

Chart 2.1 presents the evolution of residential property prices and disposable income per household in real terms. Real disposable income per household grew slower than real residential property prices in 2000Q1-2007Q4 and in 2010Q1-2013Q4. The disconnection is more acute in the former period than in the latter one. This led to a decline in the disposable income level of households willing to buy a residential property during these periods. Indeed, households must, *ceteris paribus*, increase their share of income allocated to the purchase of a residential property. Since 2014Q1, real residential property prices and real disposable income per household have been growing approximately at the same rate.

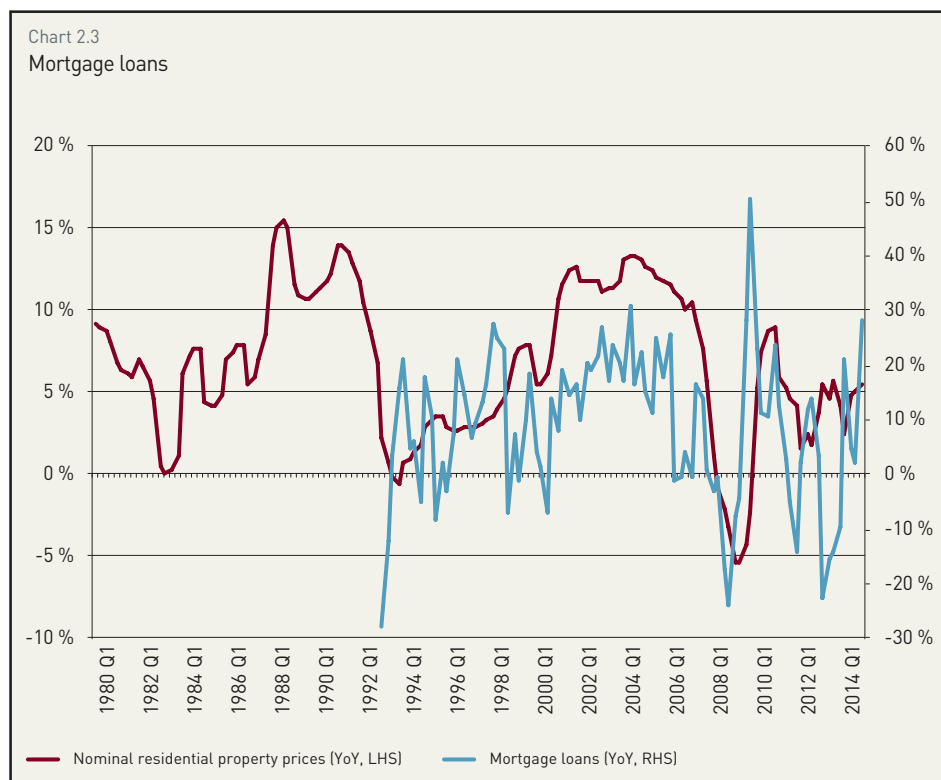
The population growth rate has maintained a positive trend since 2003Q1, reaching an average rate of 1.8% a year (Chart 2.2). The population increase is driven by strong net migration,⁷ which can potentially be explained by relatively better labor market conditions in Luxembourg compared to other European countries. Demographics in Luxembourg are also characterized by a decrease in the average size of households (from 2.51 in 2000 to 2.41 in 2010, according to STATEC's population

⁷ Net migration is defined as the difference between the number of persons entering and leaving Luxembourg during a year.

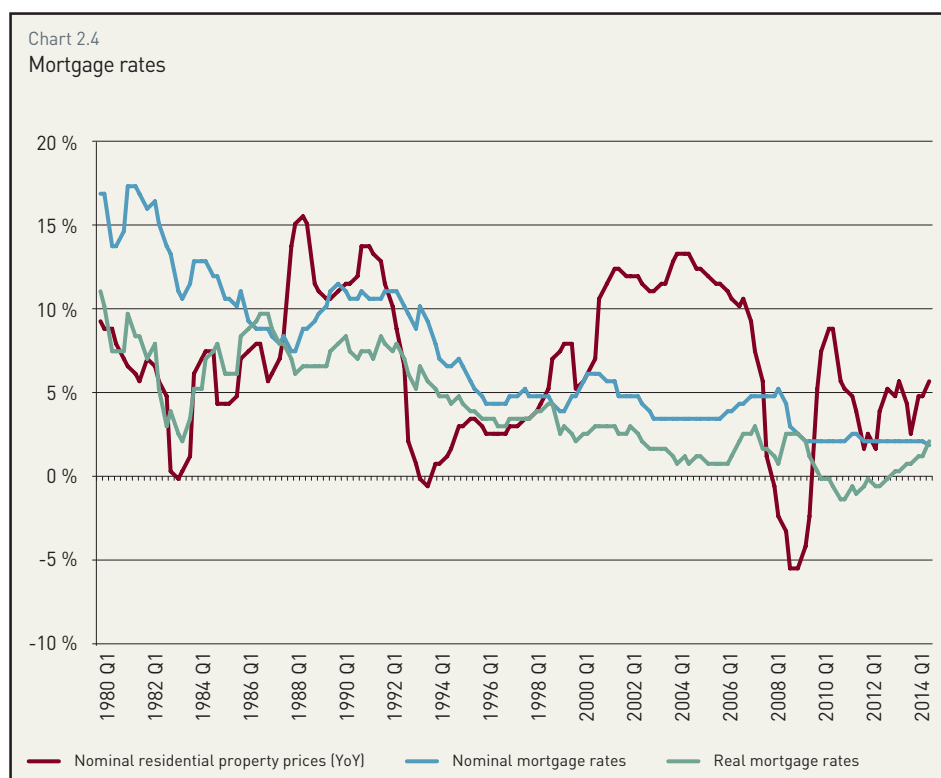
census).⁸ Hence more households are living separately. This can be explained by socio-cultural factors putting some upward pressure on residential property prices.

Housing finance indicators can help to explain residential property price dynamics. Indeed, the evolution of mortgages appears to be correlated with residential property price dynamics (Chart 2.3). Mortgage demand should typically increase when mortgage rates decline since this decreases households' borrowing costs. On the other hand, banks may issue more mortgages when risks become subdued and economic outlook improves. Since 2009Q2, mortgage rates decreased in nominal terms (Chart 2.4), due to an accommodative monetary policy in the euro area, and also in real terms, due to weak inflation rates in Luxembourg. However, over the same period, the growth rate of mortgage loans became more volatile (Chart 2.3). A possible explanation is that banks may not have had a clear view on borrowers' risks due to the large uncertainty prevailing in the economic environment during this period. Nevertheless, recent figures highlight a relative increase in mortgage issuance in 2014 compared to 2013 (Chart 2.3). The Bank Lending Survey confirms this trend, projecting a reduction

⁸ See STATEC, "Résultats du Recensement de la Population 2011", available at: <http://www.statistiques.public.lu/fr/population-emploi/rp2011/menages/index.html>. See also: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=423&IF_Language=fra&MainTheme=2&FldrName=1&RFPPath=72.

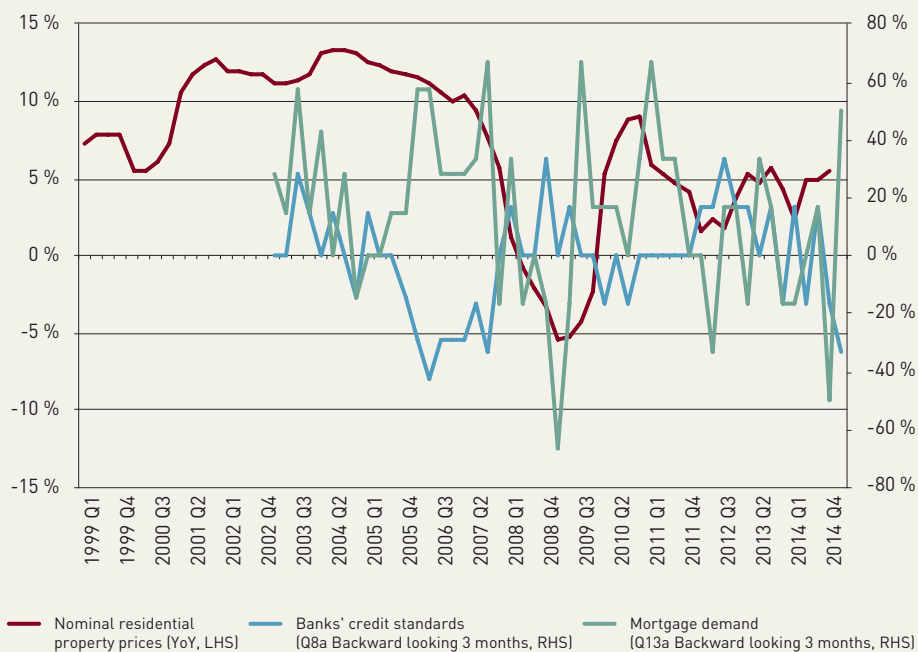


Sources: BCL, STATEC



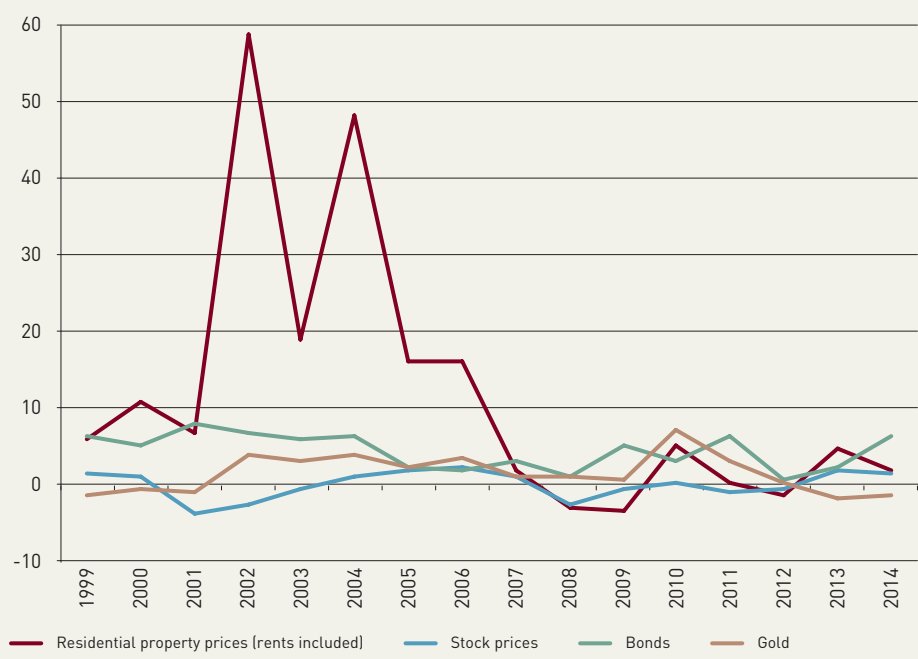
Sources : BCL, ECB-SDW (MIR survey)

Chart 2.5
Lending standards in the mortgage market



Source: Bank Lending Survey (BLS); the survey is carried out for seven Luxembourgish banks

Chart 2.6
Risk-adjusted returns of various asset classes



Sources: ECB-SDW, STATEC, BCL

in banks' credit standards and an increase in mortgage demand in 2015Q1 (Chart 2.5). This could contribute to sustained growth in residential property prices.

Chart 2.6 reports risk-adjusted returns⁹ of various asset classes. Any abnormal risk-adjusted returns could suggest overheating in the market. Concomitant to the positive growth cycle in Luxembourg residential property prices, risk-adjusted returns in residential property investments were substantially higher than in other asset classes between 2002 and 2006. However, since 2007, investments in residential properties produced broadly the same yield as other asset classes.

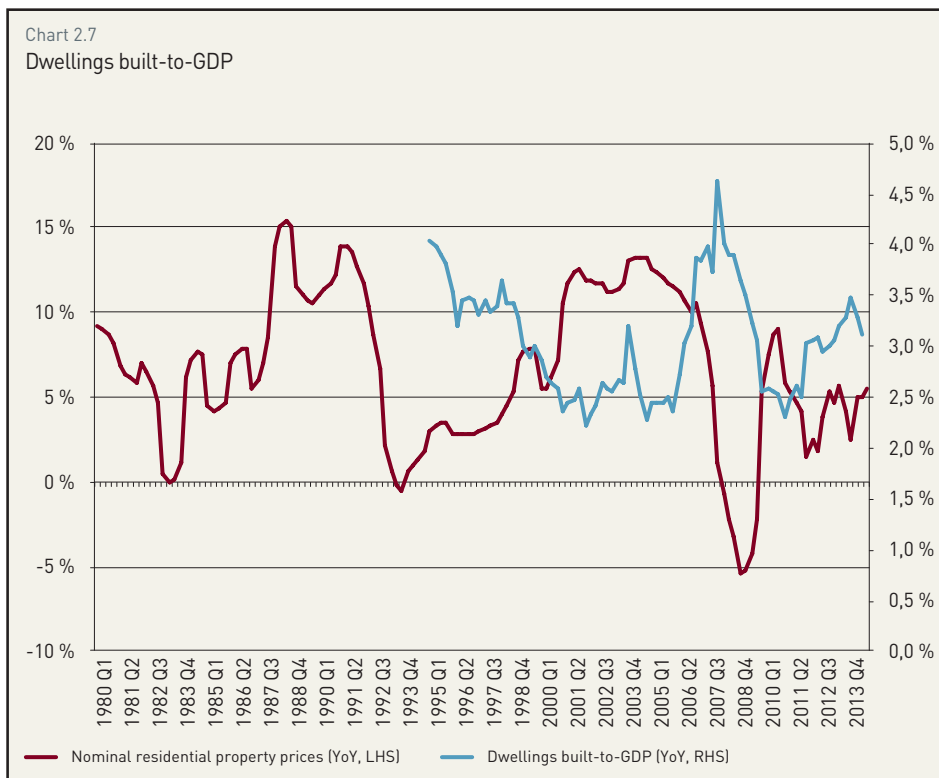
2.2 Supply side

According to Schneider (2013), a housing construction sector that accounts for a disproportionately high percentage of GDP could imply a state of overheating in the residential property market. The ratio of dwellings built-to-GDP (Chart 2.7) represents the share of housing construction in the wealth produced by the country. The ratio increased from 2006Q1 and peaked in 2008Q1 at more than 4.5% of GDP. This peak could suggest overheating in the residential property market over this period. After falling in 2008-2010, the ratio increased in 2011 and stabilized at around 3% in 2014Q3.

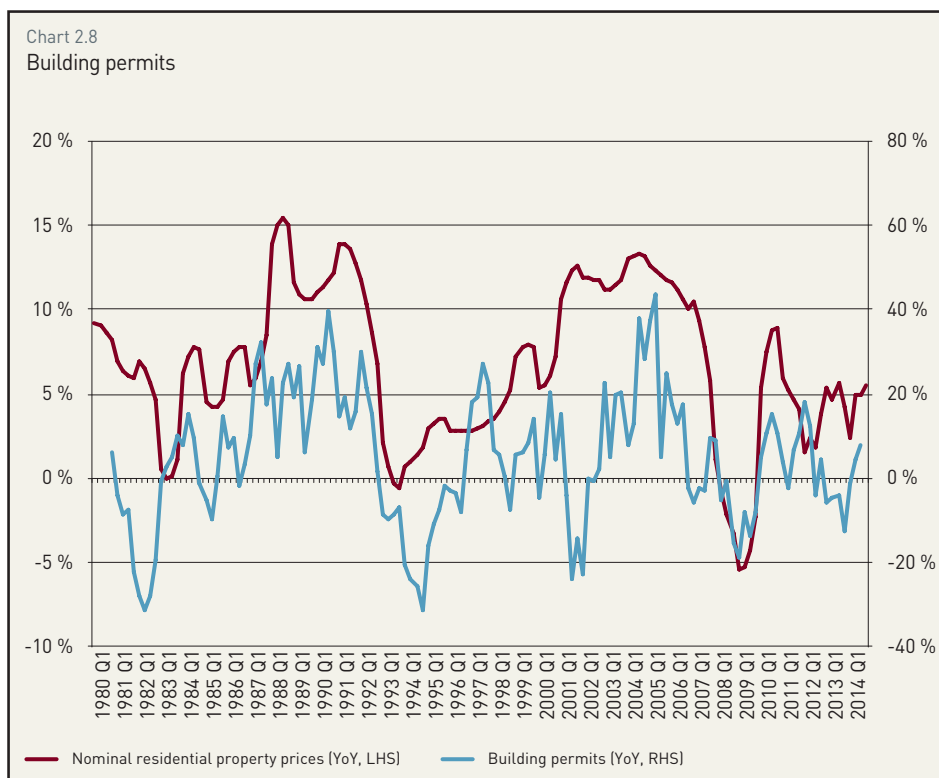
⁹ Risk-adjusted returns are defined as the average returns over one year, divided by the standard deviation of returns in the considered asset over one year. All returns are expressed in euro and in real terms (deflated by CPI inflation in Luxembourg).

Chart 2.8 presents the evolution of building permits, which are a determinant of construction activity in the residential property market and an indicator of demand overhang in the residential property market. Over the period, building permits appear correlated with residential property prices. They increased significantly during the positive growth cycle in 1999-2007 suggesting a demand surplus in the market. This pattern also justifies the increase in the share of dwellings built-to-GDP over this period (Chart 2.7), as rising property prices stimulated construction. Recent figures show that since 2010, the growth rate in building permits has stabilized.

Construction costs help explain residential property price dynamics in the long run. If residential property prices evolve close to their fundamentals, property prices should share the same evolution as construction costs. During the positive growth cycle in 1999-2007, residential property prices drifted away from construction costs (Chart 2.9). Since 2012, residential property prices have evolved closer to construction costs.

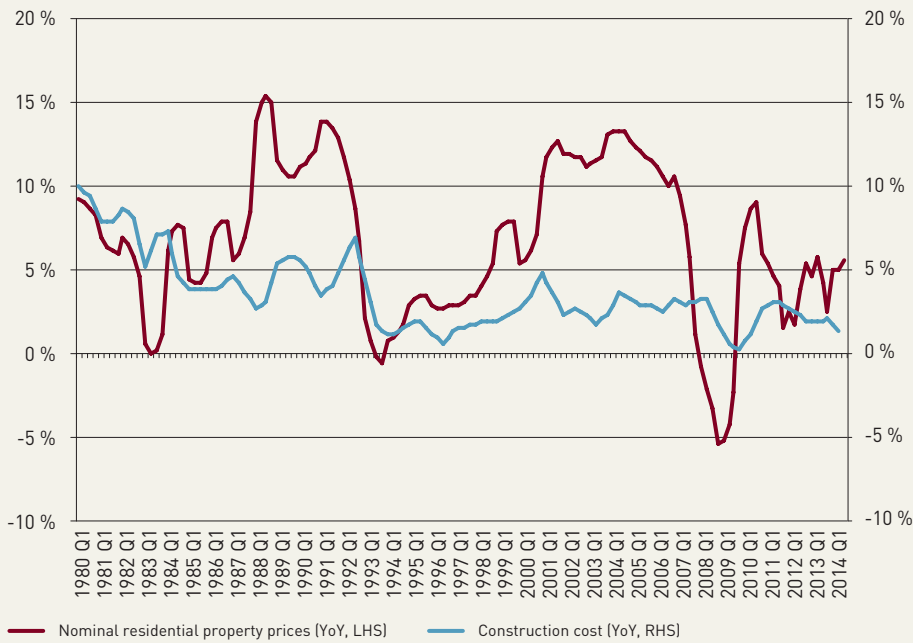


Source: STATEC



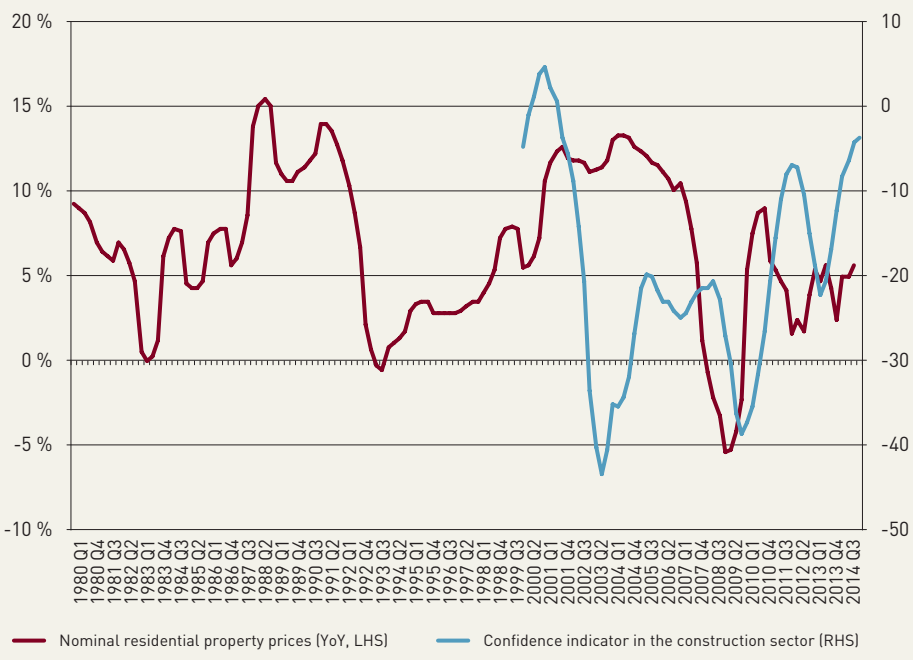
Source: STATEC

Chart 2.9
Construction cost



Source: STATEC

Chart 2.10
Business sentiment in the construction sector



Source: STATEC

Recent figures on business sentiment in the construction sector point to better prospects in the residential property market (Chart 2.10). This could herald an increase in construction activity that could mitigate any rise in residential property prices stemming from strong supply constraints.

2.3 Disconnection of prices from their fundamentals

We now use both univariate ratios and multivariate model analysis to complete the examination of the potential disconnection of residential property prices from their fundamentals.

2.3.1 Ratio-based analysis

The ratio-based analysis considers two ratios that provide insight into price pressure in the residential property market.

The price-to-income ratio (*i.e.* the affordability ratio) represents a gauge of whether housing is within the reach of an average buyer. An increase in this ratio indicates deterioration in the affordability of residential property. Households will normally reduce their demand for dwellings, thereby driving house prices down.

The price-to-rent ratio assesses the attractiveness of renting a home relative to the attractiveness of purchasing a home. If property prices increase relative to rents, more households should choose to rent rather than to buy, driving rents up and property prices down. This ratio is also an

indicator of the potential return on housing investment,¹⁰ where an increase in this ratio indicates a lower return on investment.

In a perfect economy without frictions, residential property prices should cointegrate with income and rents. In other words, residential property prices could wander away from the dynamics of the aforementioned variables in the short run, but revert back to their respective dynamics in the long run.

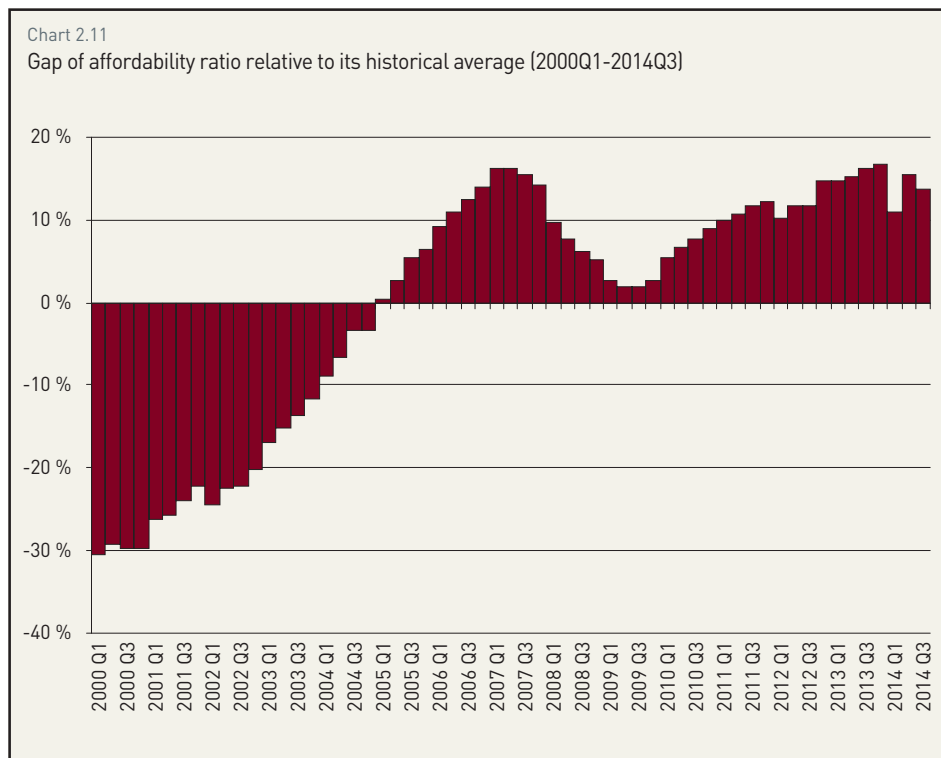
Both ratios evolve above their historical average since 2005 (Charts 2.11 and 2.12). This suggests that, on average, residential property prices grow faster than disposable income per household and rents. This in turn places downward pressure in prices in the medium run, although nominal prices are still growing at an average annual rate of 4.5% in 2014.

One of the major drawbacks of the ratio-based analysis is the reliance on a single fundamental, while residential property prices dynamics are affected by a larger number of fundamentals stemming from the demand-side and the supply-side of the market. The model-based analysis circumvents this shortcoming.

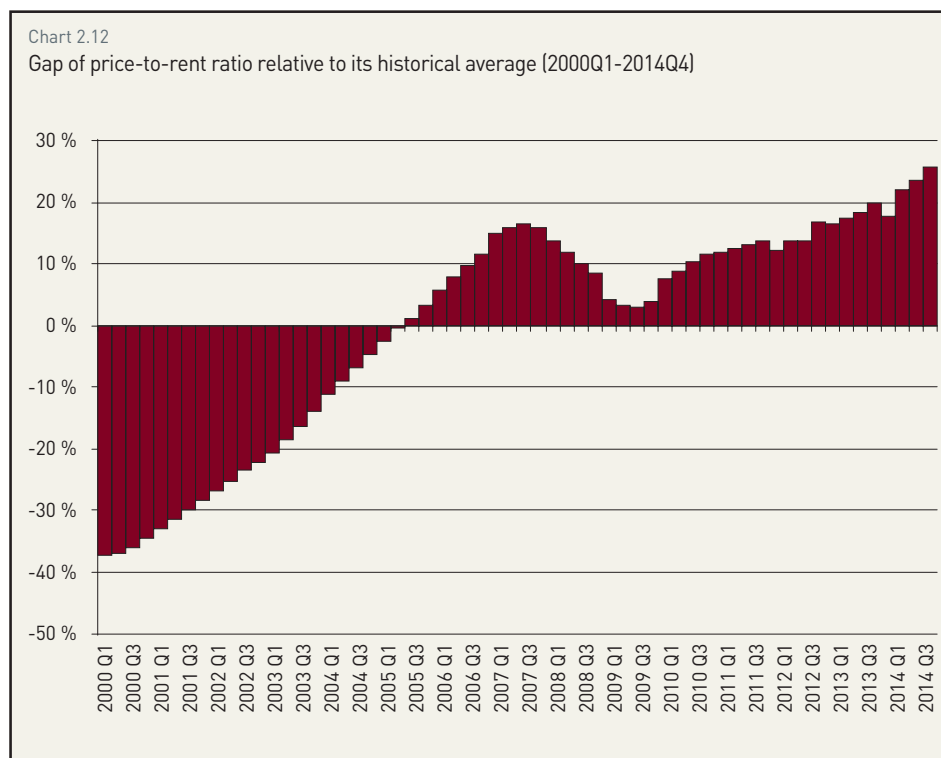
2.3.2 Model-based analysis

The model-based analysis relies on three models, each of which

¹⁰ In this case, the measure is akin to the price-to-dividend ratio in the stock market, assuming rental income is analogous to dividend payments.

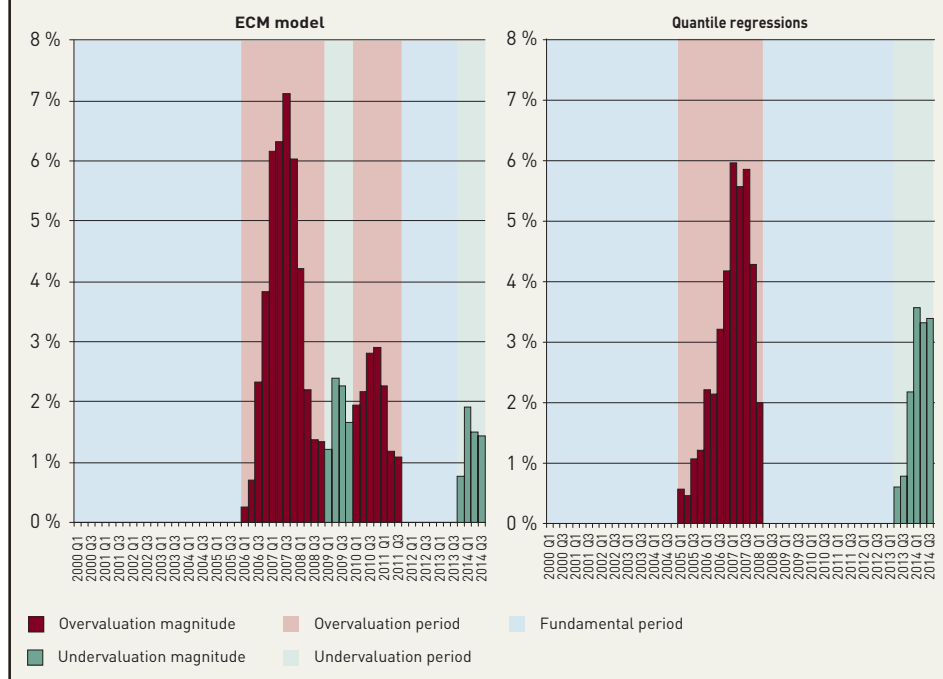


Source : BCL calculations. The affordability ratio is defined as the ratio of residential property prices over disposable income per household.



Source : BCL calculations.

Chart 2.13
Disconnection between actual and fundamental levels of residential property prices



Source : BCL calculations. Estimation period: 1980Q1-2014Q3.

by the 80th (20th) quantile, the indicator highlights overvaluation (undervaluation) phases in the market. When prices evolve within the interval defined by the latter fundamental values, prices are assumed to evolve in accordance with their fundamentals.

Estimation results show an overvaluation period in 2006Q1-2008Q4 (ECM model, Chart 2.13) and in 2005Q1-2008Q1 (quantile regressions, Chart 2.13). While quantile regressions suggest prices evolve in line with their fundamentals after this overvaluation period, the ECM model points to an undervaluation period (2009Q1-2009Q4) followed by an overvaluation phase (2010Q1-2011Q3). Both approaches identify price undervaluation at the end of the period.

A third indicator characterizes the growth regime of residential property prices by relying on a two-state Markov switching framework (Corradin and Fontana (2013)). The model assumes that prices switch between a high-growth regime and a moderate-growth regime. Regimes are identified with smoothed probabilities estimated for each regime over time.

Estimation results (Chart 2.14) show that prices experienced a high-growth regime in 2000Q3-2007Q1 followed by a moderate-growth phase (2007Q2-2009Q4) and then a high-growth period (2010Q1). The indicator suggests that residential property prices currently evolve within a moderate-growth regime.

11 The user cost of owning a dwelling is defined as the costs inherent to holding a residential property by the occupying owner. The user cost is computed following the method of Poterba (1984). It notably takes into account the mortgage rate, the residential property tax rate applied to the property occupied by the owner and the other costs associated to the holding of a residential property (e.g. the depreciation and the maintenance of the dwelling, etc.).

includes the following set of demand-side and supply-side fundamentals: disposable income per household, the user cost of owning a dwelling,¹¹ the number of households and the stock of dwellings.

To identify any disconnection of prices from their fundamental value, we build two indicators. The first indicator relies on an error correction model (Stock and Watson (1993)). The indicator predicts overvaluation (undervaluation) periods when prices evolve above the upper (lower) fundamental bound. It supposes that prices are in line with their fundamentals when prices evolve within the interval defined by the aforementioned bounds. The second indicator is based on quantile regressions (Gerdesmeier *et al.* (2012)). When prices evolve above (below) their fundamental value as estimated

Overall, the model-based indicators suggest that in 2014Q3, the current level of actual residential property prices evolve below their equilibrium value as predicted by fundamentals. Moreover, a moderate-growth regime characterizes residential property price dynamics. Hence, after a high-growth period in 2000-2007, residential property prices experienced relatively lower growth rates since the spark of the global financial crisis in 2008.

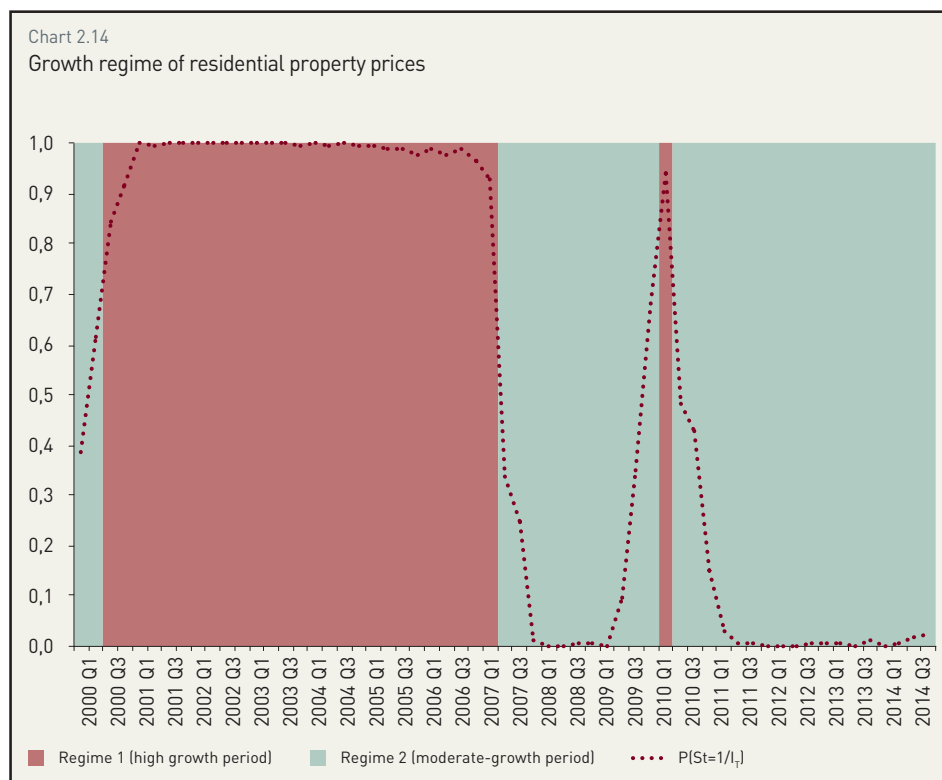
3. RISKS STEMMING FROM THE MORTGAGE MARKET

Mortgage market risks are analysed for both borrowers (households) and lenders (banks). On the borrowers' side, the risk of excessive build-up in mortgage loans and the burden of households' mortgage debt are analysed. Risks pertaining to households' deteriorating ability to repay mortgage debt are also investigated. On the lenders' side, credit risk (*i.e.* the risk of a deterioration in asset quality induced by borrowers' default on mortgage debt repayment) and banks' capacity to absorb risks in case of an unexpected adverse shock stemming from the residential property market are considered.

3.1 Borrowers' risks

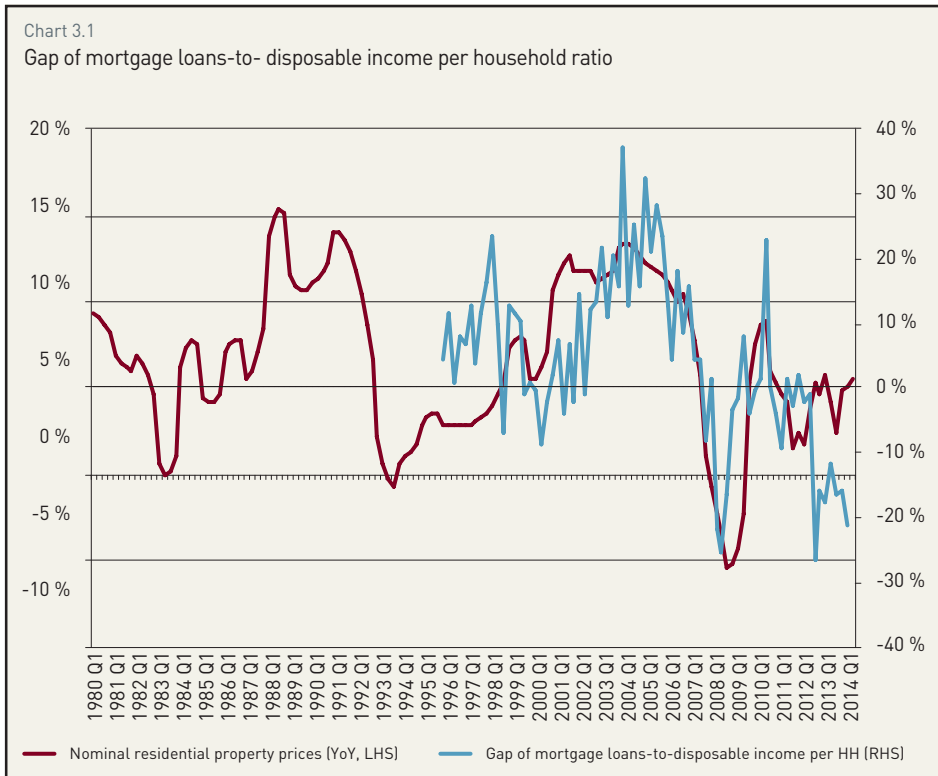
When the housing market is booming, households become more optimistic about future economic prospects and mortgage demand to purchase a home tends to increase. As the growth in residential property prices inflates the value of borrowers' collateral, banks may issue more mortgages by relaxing lending standards. However, if the build-up in mortgages is excessive, risks can arise. To highlight any excessive build-up in mortgage loans, we analyse the gap¹² of the ratio of mortgage loans-to-disposable income per household (Chart 3.1). The larger the gap, the higher the risk of excessive build-up in mortgages. During the positive growth cycle in prices (1999-2007), the ratio evolves far above its trend (the gap is highly positive). In 2014Q3, the ratio evolves below its trend (the gap is negative) suggesting a containment of risks pertaining to excessive build-up in mortgages.

The ratio of mortgage debt relative to households' disposable income (Chart 3.2) is used to assess households' mortgage debt burden. A high ratio (potentially higher than 100%) could make it more



Source: BCL calculations. Estimation period: 1980Q1-2014Q3.

¹² To compute the trend, we use a recursive one-sided (or "real-time") Hodrick-Prescott filter (Alessi and Detken (2011)) with a smoothing parameter of 400.000 (Andersen et al. (2014)).



Sources: BCL, STATEC

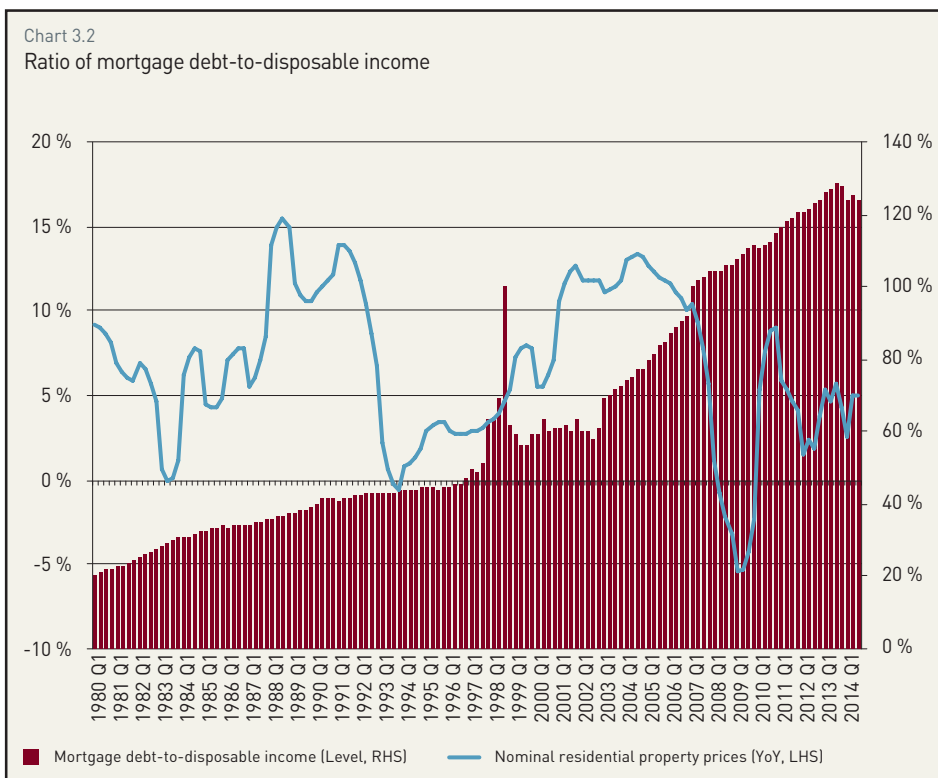
difficult for households to repay their debt, notably in the event of unexpected and sudden negative shocks affecting households' wealth (e.g. fall in GDP, increase in interest rates, etc.). The ratio experiences a positive trend between 1999Q1 and 2013Q3. Between 2013Q4 and 2014Q3, the ratio stabilises and reaches 124% in 2014Q3.

This elevated ratio raises some concerns regarding households' mortgage debt sustainability. As a result, the evolution of households' mortgage debt must be monitored in order to avoid any dramatic deterioration in their repayment capacity.

Given the long period of low interest rates prevailing in the euro area since 2009, one of the main risks that borrowers may face is an unexpected increase in mortgage rates. Indeed, the majority of Luxembourgish households with mortgages are indebted with adjustable-rate mortgages (ARMs; see Chart 3.3). Since 2003Q1, ARMs represent on average 82% of mortgages issued by banks. In 2014, 76% of mortgages granted by banks were ARMs.¹³

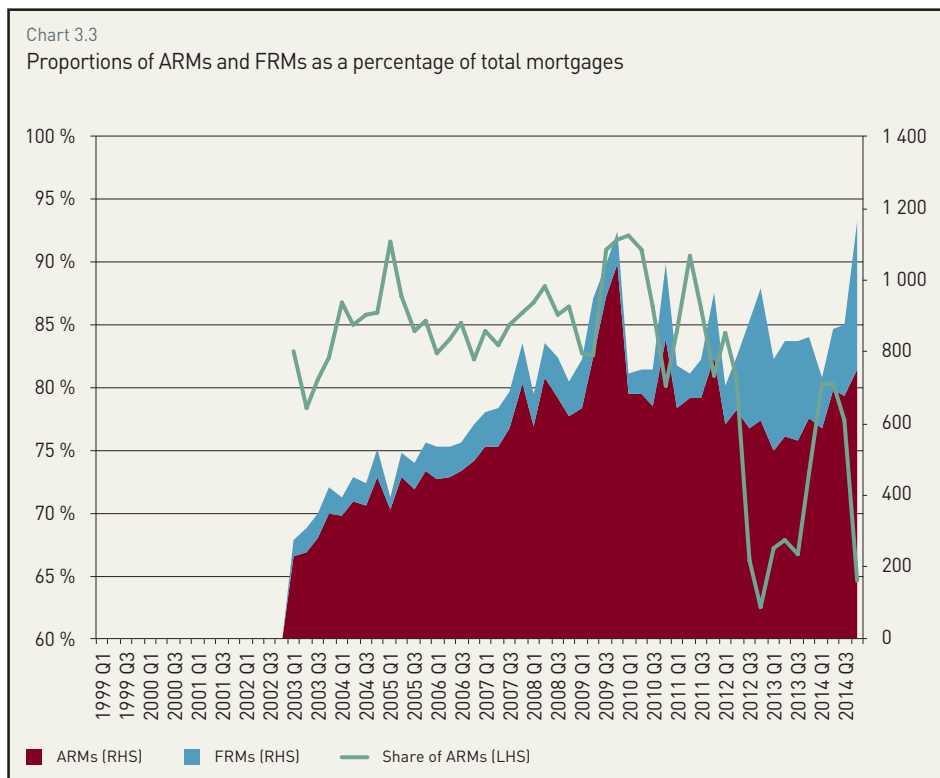
Some of the possible risks related to the low interest rate environment are now considered. Chart 3.4 presents the evolution of mortgage rates and economic activity

¹³ Since 2012, the proportion of ARMs slightly decreased to the benefit of FRMs (Chart 3.3). A possible explanation is that the protracted period of low interest rates had led borrowers to favor FRMs since borrowers expect a likely increase in interest rates in the future, during their debt repayment period.

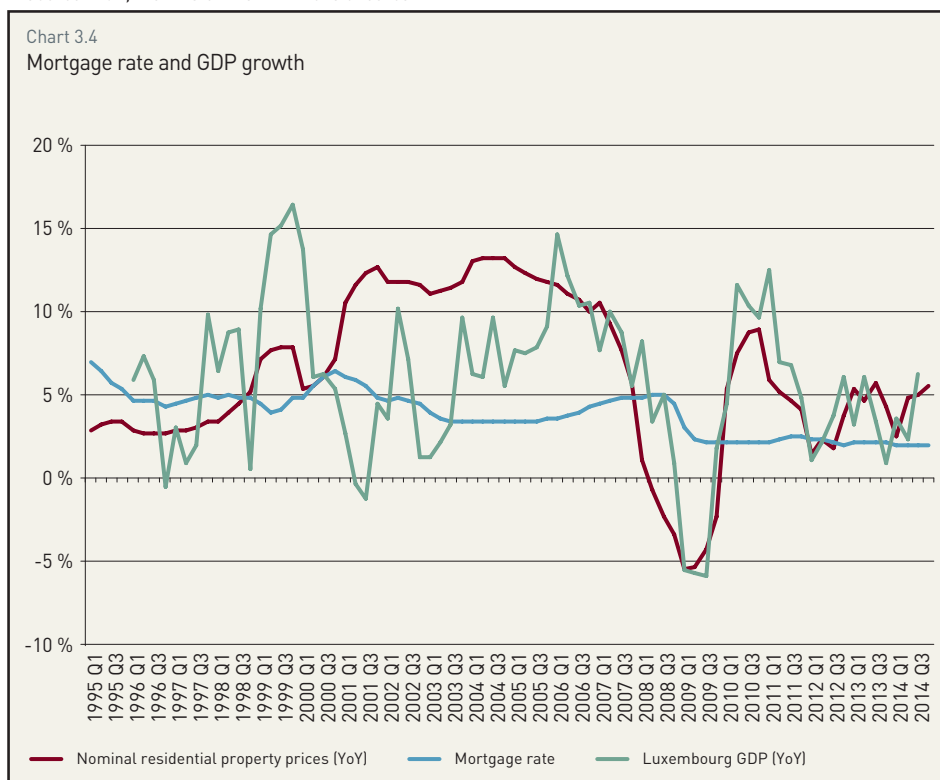


Sources: BCL, STATEC, ECB-SDW

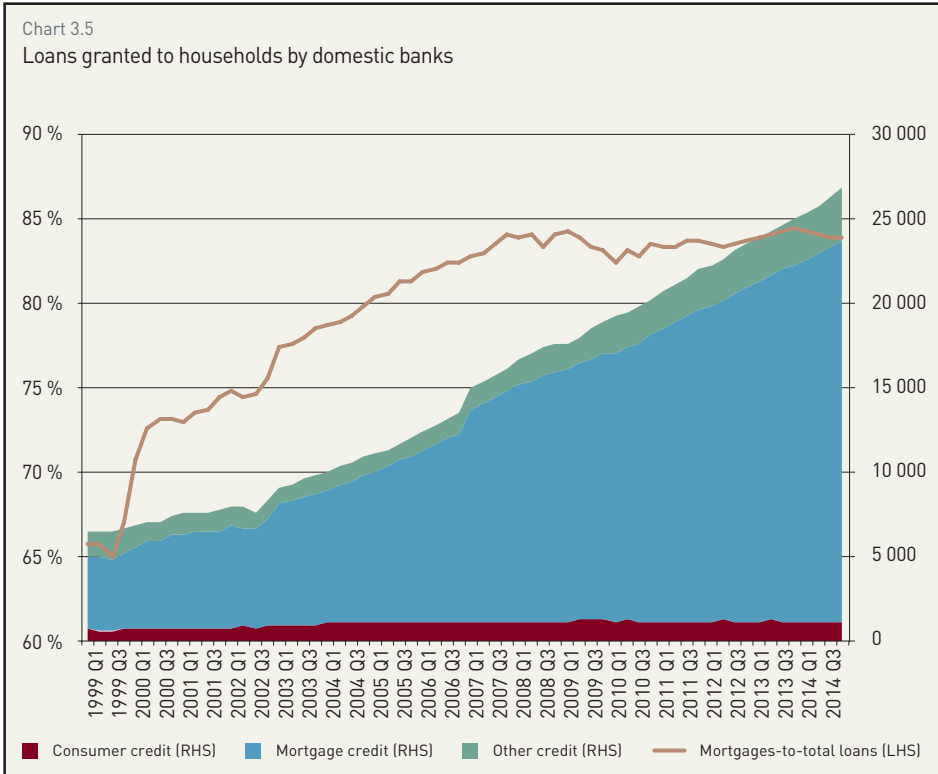
(proxied by GDP) in Luxembourg. When the gap between the economic growth rate and the interest rate becomes large for a long period of time, the actual economic growth rate could drift away from its structural rate, overheating the economy. During the positive growth cycle in residential property prices (1999-2007), nominal interest rates were actually lower than economic growth which could have nurtured the boom in the residential property market. Since 2012, mortgage rates have evolved closer to the growth rate of economic activity in Luxembourg, therefore resulting in a low probability of materialization of an adverse scenario.



Source: BCL; the RHS unit is in millions of euros.



Sources: ECB-SDW, BCL



Source: BCL; the LHS unit is in millions of euros.

3.2 Lenders' risks

Mortgage loans account for a large share of banks' loans granted to households (Chart 3.5). Financial intermediaries are therefore exposed to risks stemming from the residential property market. However, banks in Luxembourg appear to be able to monitor and screen credit risks since non-performing loans represent a low share of total gross loans (below 1%, see Chart 3.6).

Moreover, banks' capital levels appear rather comfortable in Luxembourg when measured relative to risk-weighted assets (Chart 3.7). Indeed, the regulatory Tier 1 capital-to-risk-weighted assets ratio and the regulatory capital-to-risk-weighted assets¹⁴ ratio evolve above the minimum thresholds required by the regulator (respectively, 6% and 10% under Basel III) and are among the highest capital requirement ratios in the euro area. This increases the banks' capacity to absorb risks stemming from the residential property market.

The index of the relative change in the loan-to-value (LTV) ratio on new mortgages granted to households (HHs) (Chart 3.8) represents a measure of risk-taking by banks. When the ratio increases, banks magnify their risk exposure in the mortgage market (and *vice versa*). The LTV ratio increased dramatically from 2005 to 2009, suggesting that banks took higher risks over this period. Then, between 2010 and 2012, banks' risk exposure

¹⁴ Risk-weighted [i.e. risk-adjusted] assets are the total of all assets held by the bank weighted by credit risk.



Source: BCL

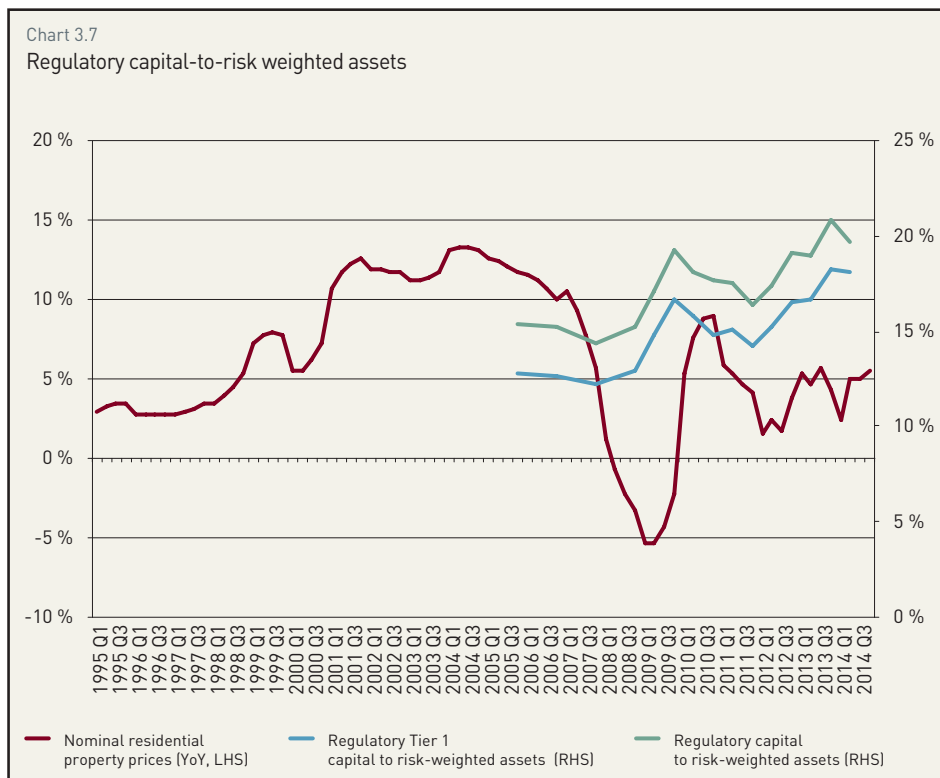
stabilized. From 2013 onwards, the LTV ratio decreases suggesting lower risk exposure by banks in the mortgage market.

4. Concluding remarks and ways forward

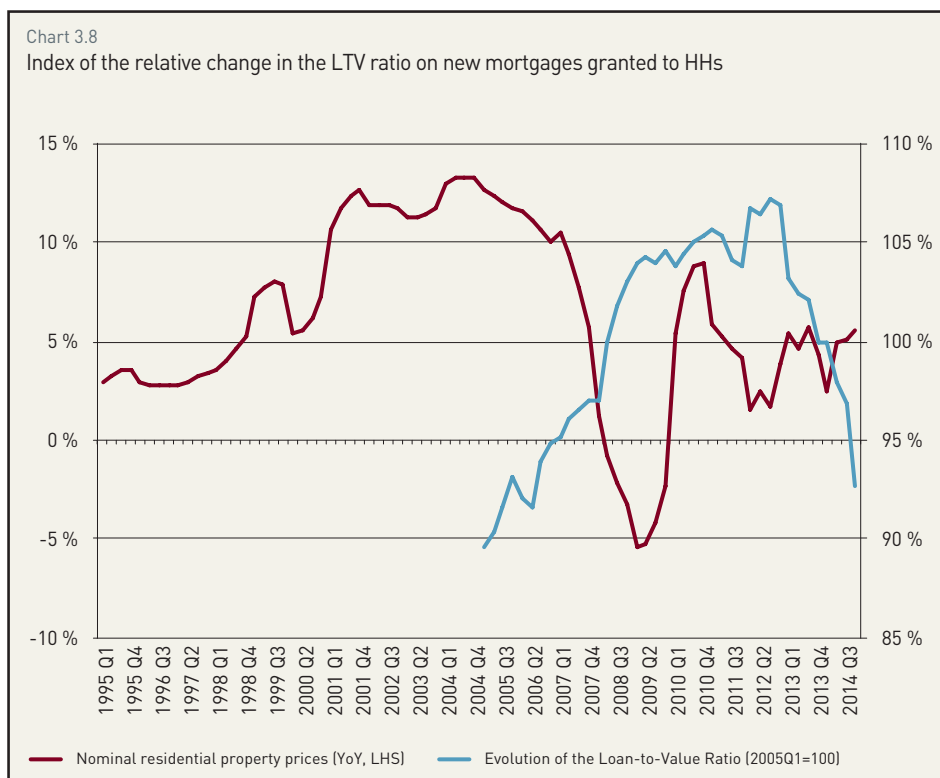
The article analyses financial stability issues related to the residential property market and mortgage lending in Luxembourg. One of the main issues that warrant ongoing monitoring is the banks' vulnerability to a sudden and sharp correction in residential property prices. However, the analysis attaches a low probability to this event. Indeed, results show that residential property prices evolved broadly in line with their fundamentals at the end of the period under consideration.

Additional areas of the residential real estate sector that should continue to be closely monitored by authorities include the risk of a disconnection of residential property price dynamics from the path predicted by fundamentals, the evolution of households' mortgage debt burden (including the amount of mortgage issuance by banks in a low interest rate environment) and interest rate risk (i.e. ensure that risks coming from sudden increases in interest rates are manageable, given the importance of households' mortgage debt burden).

In view of these potential risk sources, authorities should remain vigilant and be prepared to adopt any necessary measures that would help to attenuate adverse developments in the real estate sector.



Source: BCL



Source: BCL



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3. INTERCONNECTEDNESS BETWEEN BANKS AND MARKET-BASED FINANCING ENTITIES IN LUXEMBOURG

Jean-Baptiste GOSSÉ and Nejc SMOLE¹⁵

ABSTRACT

This study focuses on the interconnectedness between banks and market-based financing entities in Luxembourg. The market-based financing entities group within this study includes other investment funds (OIFs), money market funds (MMFs) and securitisation vehicles. Although some domestic banks have notable exposures toward the OIF sector, the network analysis demonstrates that overall the domestic banking sector's exposure to market-based financing entities is rather limited. On the liability side, domestic OIFs account for a significant share of banks' liabilities. OIFs mostly provide banks with short-term liquid funding which is more susceptible to withdrawals and seem to have contributed more to the variations of banks' liabilities since the collapse of Lehman Brothers. Most banks showing high levels of OIF funding are either foreign branches or relatively small banks, while domestically oriented banks appear to have a very low level of funding stemming from market-based entities. However, for banks more considerably reliant on OIF funding a thorough assessment is warranted in order to determine whether they maintain adequate levels of liquidity buffers as regards the potential withdrawal of funding from the OIFs.

1. INTRODUCTION

Close ties between different components of the financial sector have the potential to generate systemic risk. Modern financial markets have become more complex and involve a collection of interconnected institutions which are increasingly interdependent. Shocks impacting one sector can spill over to other sectors and provoke illiquidity, losses and insolvency. The interconnectedness between the domestic banking sector and *market-based financing entities*¹⁶ – the group consistent of other investment funds (OIFs), money market funds (MMFs) and securitisation vehicles – is important for regulators given that shocks impacting the market-based financing entities could potentially affect the funding of the real economy.

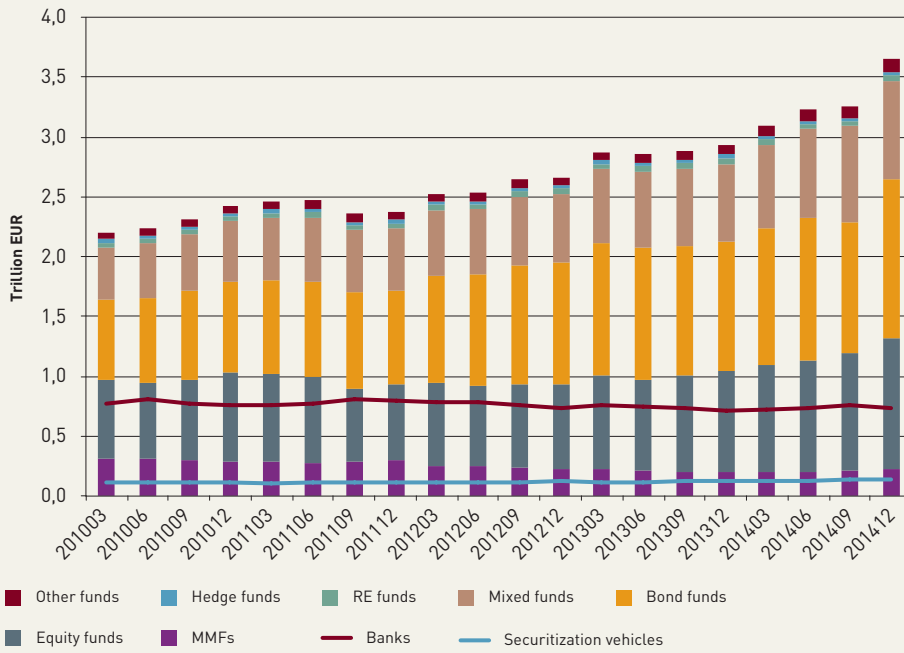
The banking sector is directly connected to market-based financing entities through two channels. Firstly, banks are exposed to the market-based financing entities through various kinds of assets with specific characteristics implying different risks. Consequently, if negative shocks occur in the market-based financing entities, banks may encounter losses. Secondly, banks receive funding from the market-based financing entities. The liabilities can take different forms and the more liquid they are, the faster they can be withdrawn in case funds would need them to absorb any negative shocks. Luxembourg domestic banks' asset exposure toward market-based financing entities have remained contained in the past few years while, at the same time, the share of banks' obligations toward the market-based financing entities has increased. Therefore, it is crucial to analyse the nature and the extent of domestic banking sector asset and liability exposures to market-based financing entities.

The note builds upon the network of domestic banking sector and market-based financing entities in order to interpret the network structure and observe the channels potentially propagating shocks. Then, we analyse the exposures to market-based entities through the asset and the liability sides of bank

¹⁵ Financial Stability Department, *Banque centrale du Luxembourg*.

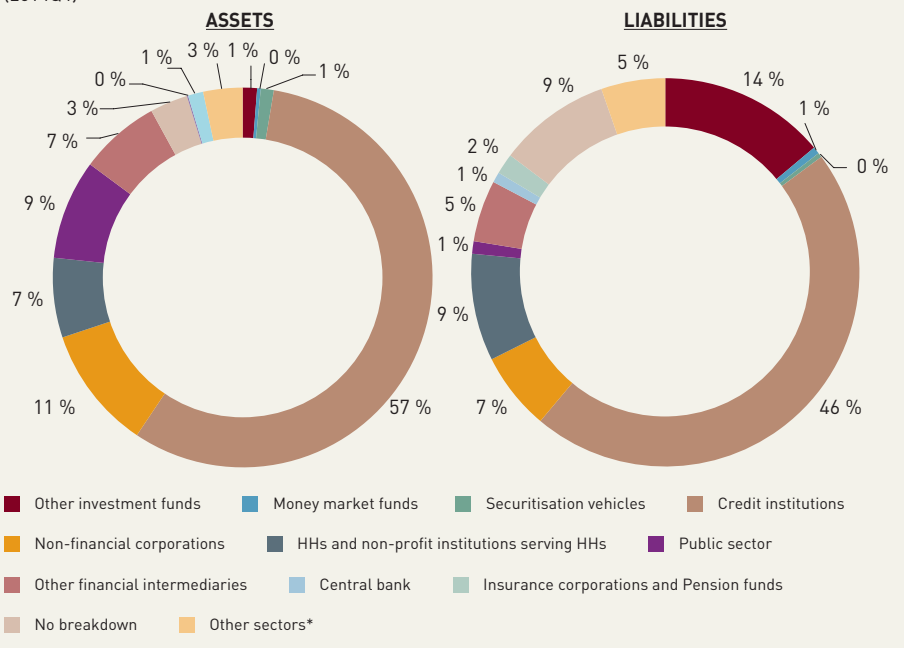
¹⁶ More commonly referred to also as the shadow banking system entities.

Chart 1
Total assets for Luxembourg banking sector and market-based financing entities total assets (2010Q1 to 2014Q4)



Source: BCL

Chart 2
Sector distribution of Luxembourg banks assets and liabilities (2014Q4)



Source: BCL

*Note: Other sectors include International institutions except the ECB, Financial auxiliaries, Securitisation institutions, Central counterparties, and Other MFIs.

balance sheets. Subsequently, we study the interconnectedness between banks and investment funds from a fund's perspective. Finally, we develop an indicator framework to evaluate the level of credit and funding risks throughout the domestic financial sector.

2. GENERAL OVERVIEW OF THE DOMESTIC BANKING SECTOR AND THE MARKET-BASED FINANCING ENTITIES WITHIN LUXEMBOURG

The fund industry has grown by 66% in the past four years, as observed in Chart 1. The most significant increases in the value of assets under management have been reported by the funds specialising in bond investments, as well as mixed funds. In the observed period, assets under management for bond funds have doubled in size, whereas the mixed funds recorded growth of 85%. Equity funds grew by about 67%, while hedge funds shrunk their total assets under management by about 4%.

The balance sheets of the domestic banking sector and MMFs declined in the observed period. The assets of banks went down by about 5%. The MMF industry recorded a drop in assets under management of 28%, which is most likely related to the protracted low yield environment at the short end of the yield curve. Finally, we observe that total assets reported by securitisation vehicles have increased by approximately 20% since year 2010, although they remain relatively modest.

Panels (a) and (b) of chart 2 display the asset and the liability exposures (as a proportion of total assets and liabilities respectively) of the Luxembourg banking industry to various sectors for assets and liabilities. In 2014Q4, funding from OIFs accounts for approximately 14% of Luxembourg banking industry's total liabilities, whereas the share of funding from MMFs accounted for merely 0.6% of total liabilities. The contribution of securitisation vehicles amounted to only about 0.4% of total domestic banking sector liabilities in 2014Q4.

Domestic banks' have less exposure to the OIFs on the asset side. Investments in OIFs and securitization vehicles each represented about 1% of total domestic banking sector exposures. The MMF exposure corresponded to a mere 0.3% of aggregate domestic bank balance sheet size.

3. NETWORK ANALYSIS

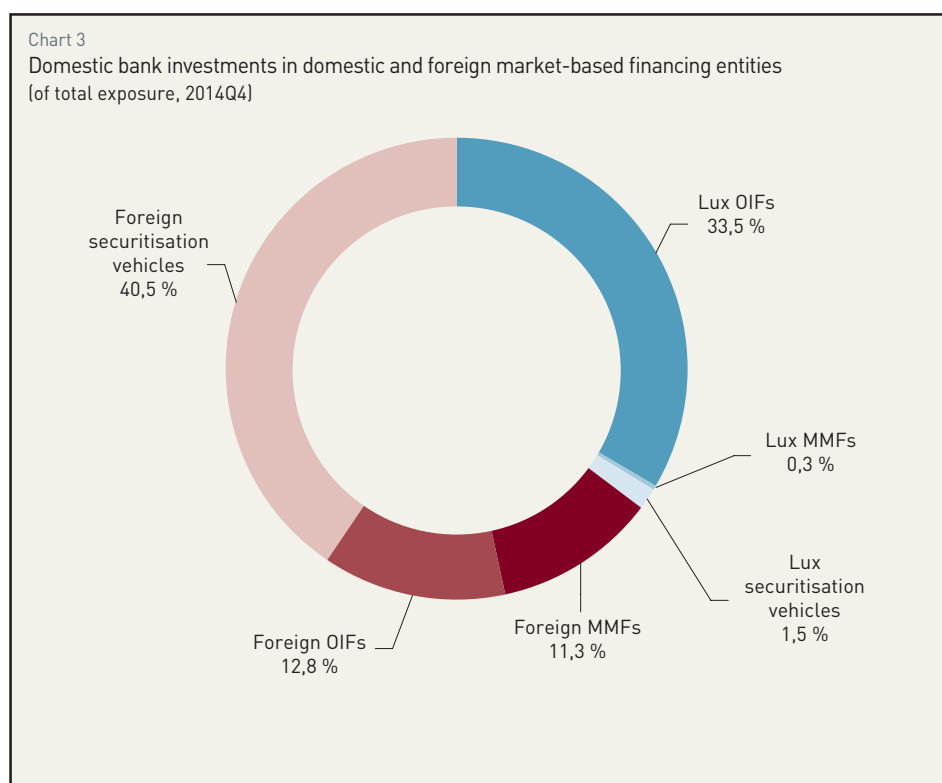
The aim of the section is twofold. First, we want to provide a visual representation of the interconnectedness between the domestic banking industry and the market-based financing entities domiciled in Luxembourg and abroad. An additional objective is to address the proportion of exposures of domestic market-based financing entities to domestic/foreign banking sector.

3.1 Share of domestic bank investments in domestic/foreign market-based financing entities

- **Predominately foreign exposure**

Domestic banks are inclined to invest in foreign market-based financing entities. The share of domestic market-based financing entities was about 35% in 2014Q4.

Nevertheless, when the domestic banking sector exposures toward market-based financing entities are decomposed into separate subsectors, an uneven geographical distribution appears. In terms of MMF and securitisation vehicle exposures, Luxembourg banks tend to invest abroad (about 97% of total MMF investments and about 96% of total securitisation vehicle exposures), whereas a larger proportion of investments in OIFs are invested domestically (about 72% of total other investment fund exposures).



Source: BCL

3.2 Network of domestic banking sector exposures to domestic/foreign market-based financing entities

The directed networks displayed in Charts 4 and 5 are a visual representation of aggregate nominal exposures of the Luxembourg banking sector vis-à-vis domestic/foreign market-based financing entities in 2014Q4. The arrows in black indicate the part of the network under review. The *thickness* of the lines connecting the vertices reflect the proportion of nominal vertex exposure vs. aggregate nominal value of exchanged funds (low: thin, high: thick) within the network.

The market-based financing entities are represented by the light blue vertices. The sizes of vertices are determined by the proportion of the funds provided (in the case of the banking sector in Chart 4) or the received funds (in the case of market-based financing entities in Chart 4) to the total volume of transactions within the observed network.

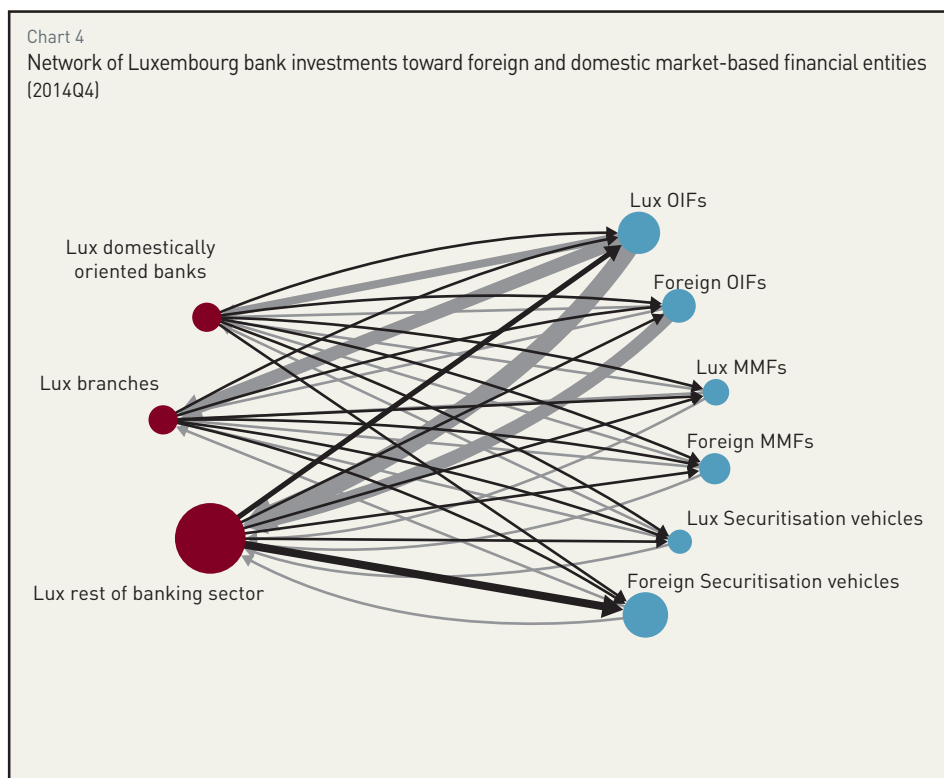
Luxembourg credit institutions, represented by dark blue vertices, are split into three clusters: (i) *domestically oriented banks* – this cluster is composed of 7 credit institutions that form a group of entities which are closely intertwined with the real economy in Luxembourg, (ii) *foreign branches* – this cluster is composed of 9 credit institutions which are significant due to their low levels of equity and significant degree of parent bank involvement at different levels, as opposed to managing subsidiaries, which are considered to be separate entities from their parent banks with regulatory required minimum capital levels; and (iii) *rest of the banking sector entities* – the cluster counts 59 credit institutions, which do not qualify as any of the two groups previously specified (e.g. domestic banks or subsidiaries of foreign banking groups which do not have extensive links with the domestic real economy).

Splitting the vertices into clusters, based on the level of interconnectedness, provides a clearer view

on the potential spill-over effects to the real economy in case vulnerabilities developed in any of the nodes representing the market-based financing entities. For example, the domestic real economy is much more reliant on credit issued by domestically oriented banks than by branches and other credit institutions located in Luxembourg. Therefore, a shock originating from market-based financing entities could be managed and contained if the group of domestically oriented banks was not significantly exposed.

- **Gravitating toward domestic OIFs and foreign securitisation vehicles**

The combined Luxembourg banking sector exposure to



Source: BCL

market-based financing entities, and hence also the network size, is about 18 billion euros. The proportions of domestic banking exposures to market-based financing entities are exhibited by the sizes of nodes representing each cluster of credit institutions: (i) *domestically oriented banks* have an 8% share, (ii) *foreign branches* have a 6% share, and *rest of the domestic banking sector* has an 86% share.

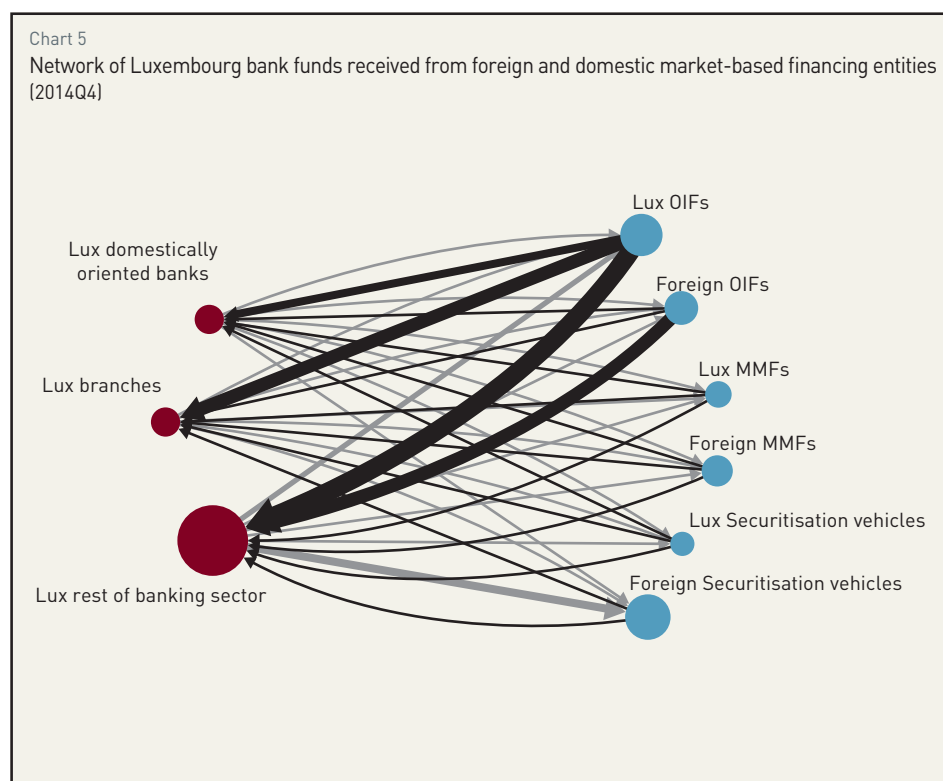
The majority of the domestic bank investments are concentrated in domestic OIFs and foreign securitisation vehicles, the two clusters account for about 74% of total domestic bank investments in market-based financing entities.

From Chart 4 it can be observed that *Luxembourg foreign branches* have no significant exposure to domestic MMFs. The MMF sector in general exhibits the smallest degree of exposure, representing about 11% of total domestic banking sector exposures. The bulk of this exposure arises from a single bank within the cluster denoted by *rest of banking sector*, which accounts for about 95% of total MMF exposures. One additional significant single-bank exposure within the cluster of *rest of banking sector* is an exposure of about 4 billion euros toward the foreign securitisation vehicles cluster, which at the same time is the largest single exposure in the entire network, itself representing about 22% of the network size.

- **Domestic OIFs represent the most significant source of funds among market-based financing entities**

The network in Chart 5 displays the liability exposures of banks to domestic/foreign market-based financing entities. Banking sector nodes dimensions are determined by the proportion of total borrowed funds (cluster borrowed funds vs. total borrowed funds), while the market-based financing entities node sizes are determined by the proportion of transferred funds to total transferred funds. The total size of the network in Chart 5 was about 104 billion euros, which is almost 6 times larger than the network discussed in Chart 4.

The group of banks within the cluster representing *rest of domestic banking sector* have been the receivers of the largest share of funds in 2014Q4, accounting for about 81% of total borrowed funds from the market-based financing entities. Main providers of funds were the domestic OIFs; contributing about 75% of total market-based financing entities funds. The total OIF sector (domestic and foreign OIFs combined) accounted for about 93% of the network size. As a share of total borrowed



Source: BCL

funds from market-based financing entities, the allocation of OIF sector funds across banking sector clusters is the following: (i) *domestically oriented banks*: 82%, (ii) *foreign branches*: 86%, (iii) *rest of the banking sector*: 95%.

3.3 Network of domestic market-based financing entities exposures to domestic/foreign banking sectors

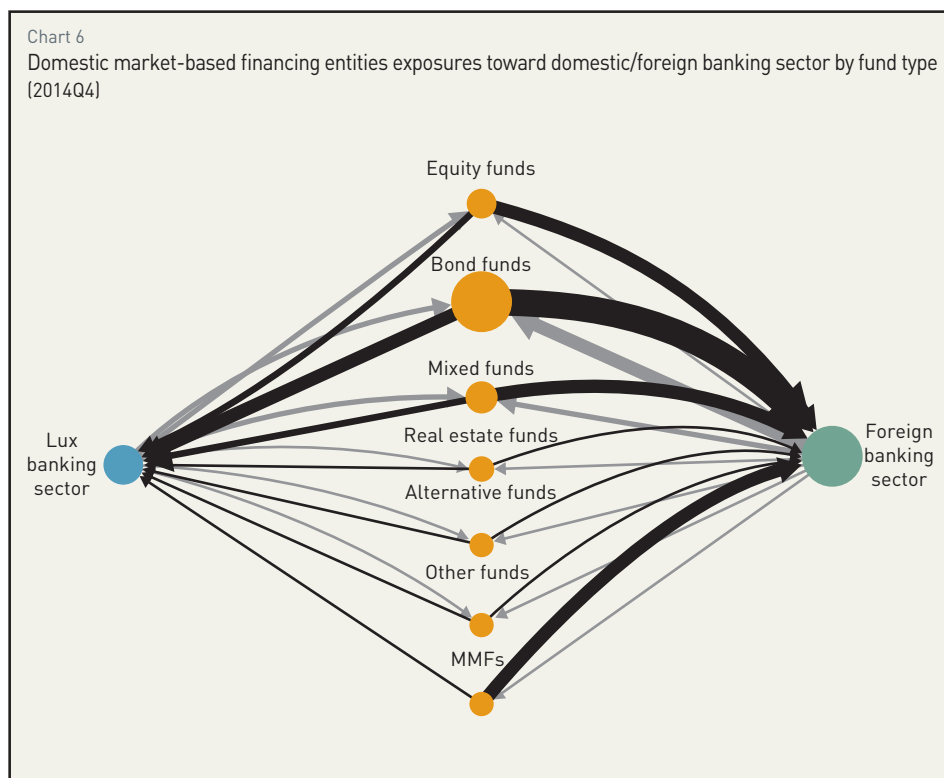
The network analysis of aggregated sectors is a good starting point to develop a broad understanding of the degree and magnitude of links between different counterparties' components of the financial sector network. However, the next step is to disaggregate¹⁷ the "Lux OIF" node into the individual components constituting this vertex, namely all the various types of funds. A more granular perspective of the network provides a more detailed view and a clearer perception of potential risks originating within the domestic fund industry. The network in Chart 6 and Chart 7 also includes the foreign banking sector dimension, which has not been included in the analysis so far. Similarly to the directed network above in Chart 4 and Chart 5, the arrows in black should indicate which entity is investing in the other.

- **The big bond funds**

With the foreign banking sector component included in the interconnectivity analysis, the nominal value of flows¹⁸ within the network becomes much larger. The exposure of the domestic fund industry toward

the banking sector network (foreign bank exposures included) has nominal flows of 831 billion euros versus 96 billion euros (excluding the securitised vehicles exposures) in the previous network. Therefore, about 13% of the fund transactions conducted by the domestic fund industry is with the domestic banks.

Bond funds are the most exposed component of the domestic fund industry to the banking sector, with the vast majority of exposures toward foreign bank entities (about 35% of the entire network). The largest exposure within the fund industry to the domestic banking sector is held by bond funds and amounts to 36% of combined domestic bank exposures. The second largest exposure of 31% is held by mixed funds.



Source: BCL

¹⁷ In order to perform a more detailed analysis, the existing reporting framework was not sufficient due to limited granularity options. An additional reporting source had to be included to perform a more granular analysis of fund industry exposures. For the same reason, the more granular fund industry network analysis does not include securitised vehicles exposures within the network. Therefore the main focus of the network analysis below is the fund industry as opposed to all market-based financing entities.

¹⁸ The domestic fund industry exposures to the banking sector include nominal values of derivatives.

3.4 Bank exposures toward OPC sector by fund type

The network of bank exposures vis-à-vis the fund sector is much smaller in terms of aggregate flow of funds than the network of fund sector exposures toward banks. In total, bank exposures to the fund industry add up to 223 billion euros, with the domestic banking sector exposures representing about 8% of the total. The most significant exposure of the domestic banking sector is bond funds, which account for roughly 44% of the total domestic banking sector exposures versus 30% for mixed funds and 17% for equity funds.

On the other hand, foreign banks invest predominately in bond funds (76% of total foreign bank investments) and mixed funds (12% of total foreign bank investments) funds.

4. DOMESTIC BANKING SECTOR INVESTMENTS TOWARD MARKET-BASED FINANCING ENTITIES

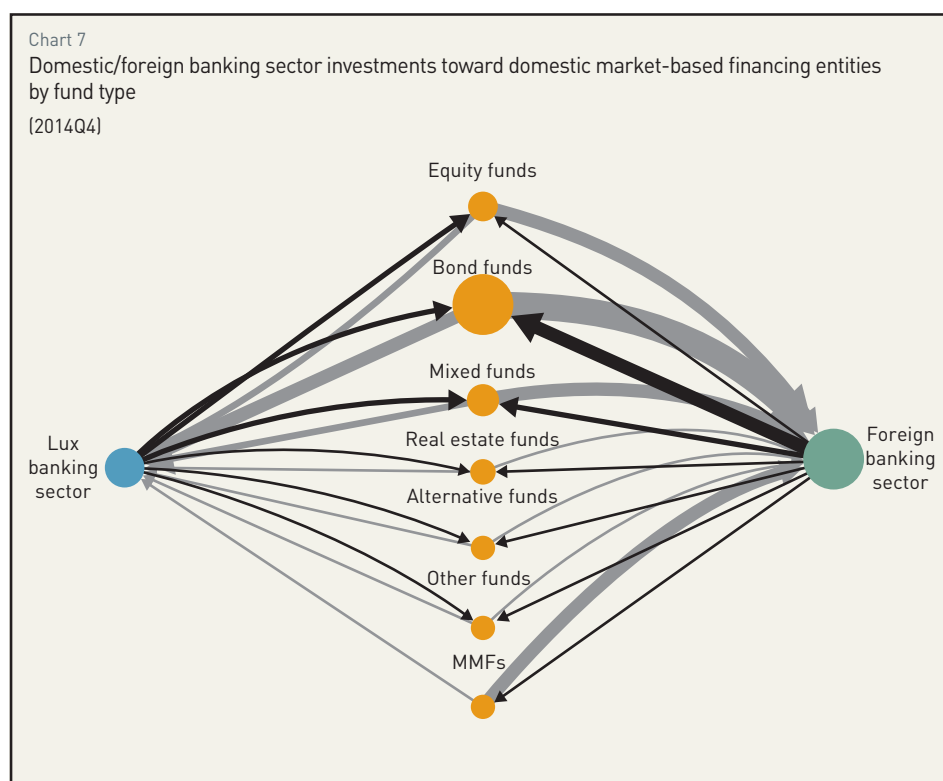
This section provides a detailed analysis of domestic bank exposures to market-based financing entities. Luxembourg bank exposures toward market-based financing entities are first examined by asset type. Then the market-based financing entities' investments are split into three parts: (i) OIFs, (ii) MMFs, and (iii) securitisation vehicles exposures. Furthermore, the three segments of market-based financing entities are examined through: (i) his-

torical observation of domestic and foreign investment flows, (ii) individual bank exposures to each of the constituents of the market-based financing entities group, and (iii) geographical breakdown of domestic banking sector investments in market-based financing entities.

4.1 Bank investments in OPC sector by asset types

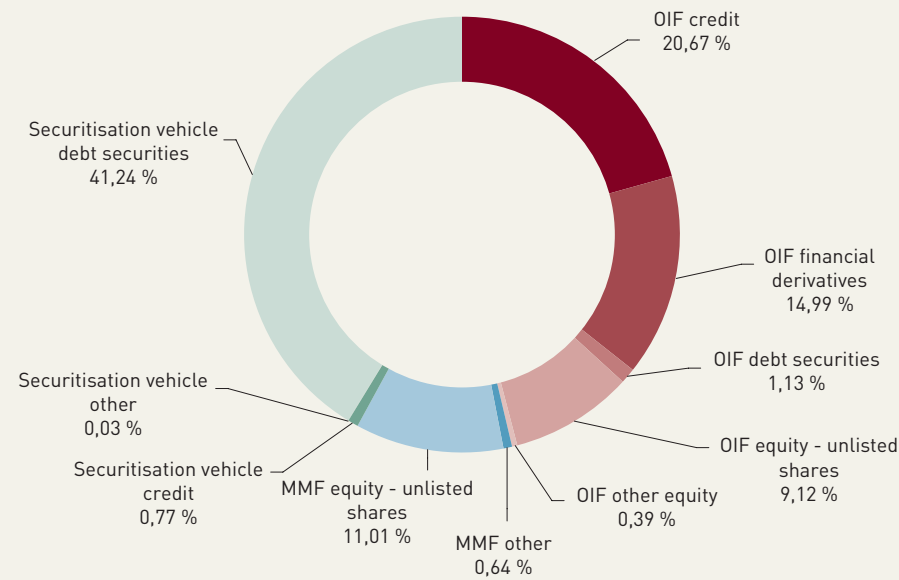
- **Buying securitised bonds and lending to OIFs**

Within the Luxembourg banking sector, investments in securitised debt are the most common type of exposure to the market-based financing entities, as displayed in Chart 8. Furthermore, credit to OIF entities accounts for about 21% of total exposures. Holdings of unlisted MMF and OIF shares are also commonly reported investments among domestic banks. In addition, domestic banks quite frequently act as counterparties in various financial derivatives transactions with OIFs.



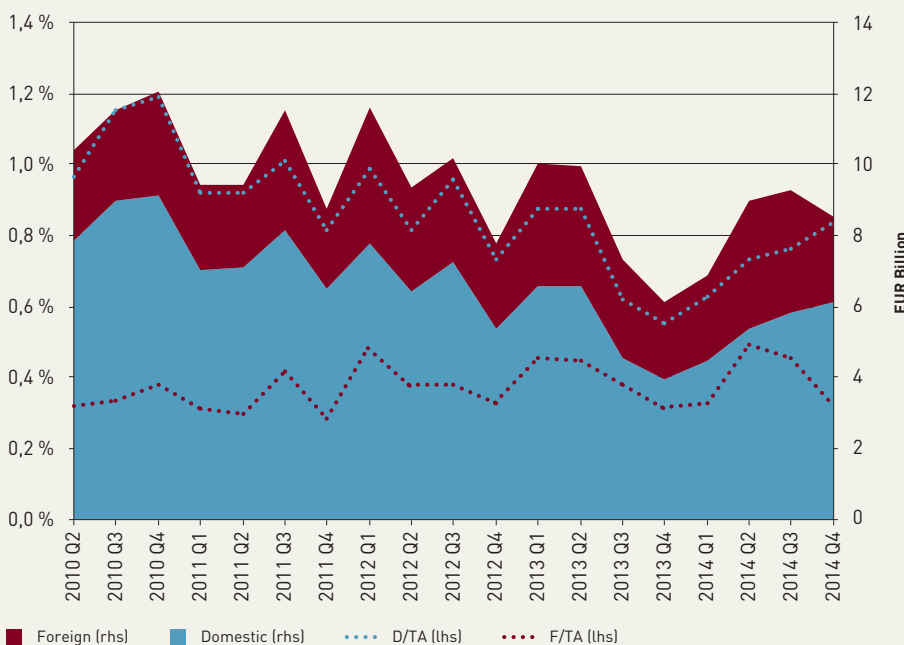
Source: BCL

Chart 8
Luxembourg bank exposures to OPC and market-based financing entities by asset types (2014Q4)



Source: BCL

Chart 9
Ratio of bank investments in OIFs to Luxembourg banking assets



Source: BCL

4.2 Banking sector investments in OIFs

- **Trending down, but strong increase in 2014**

Luxembourg bank investments in OIFs account for a considerable share of total market-based financing entities investments (approximately 46%). A closer look at historical developments reveals a declining trend of domestic bank exposures toward OIFs – total exposure toward the OIF sector has diminished from 10.4 billion euros in 2010Q2 to 8.5 billion euros in 2014Q4. However, the exposures to domestic OIFs have marked an increase in most recent quarters, as observed on Chart 9, whereas exposures toward foreign OIFs decreased to a certain extent (demonstrated by dashed lines in Chart 9 – signifying the ratio: *total domestic/foreign exposures to OIFs vs. total domestic banking sector assets*).

Charts 10 and 11 display the exposures of individual banks to OIFs, relative to (i) total assets and (ii) total equity¹⁹. The exposures to the OIF industry are not highly concentrated. Banks display

¹⁹ *Total equity reference stands for total own funds, but is considered to be an accounting item rather than a regulatory item. This approach was adopted in order to include branches in the analysis when individual bank exposure to market-based financing entity is measured up against its total equity. Namely, branches are not bound to report their regulatory capital; hence some of the banks would have been left out of the analysis if the regulatory own funds definition would have been applied. However, Chart 18 includes also the CET 1 in addition to total equity and total assets as a measure of risk when considering individual bank exposures to market-based financing entities.*

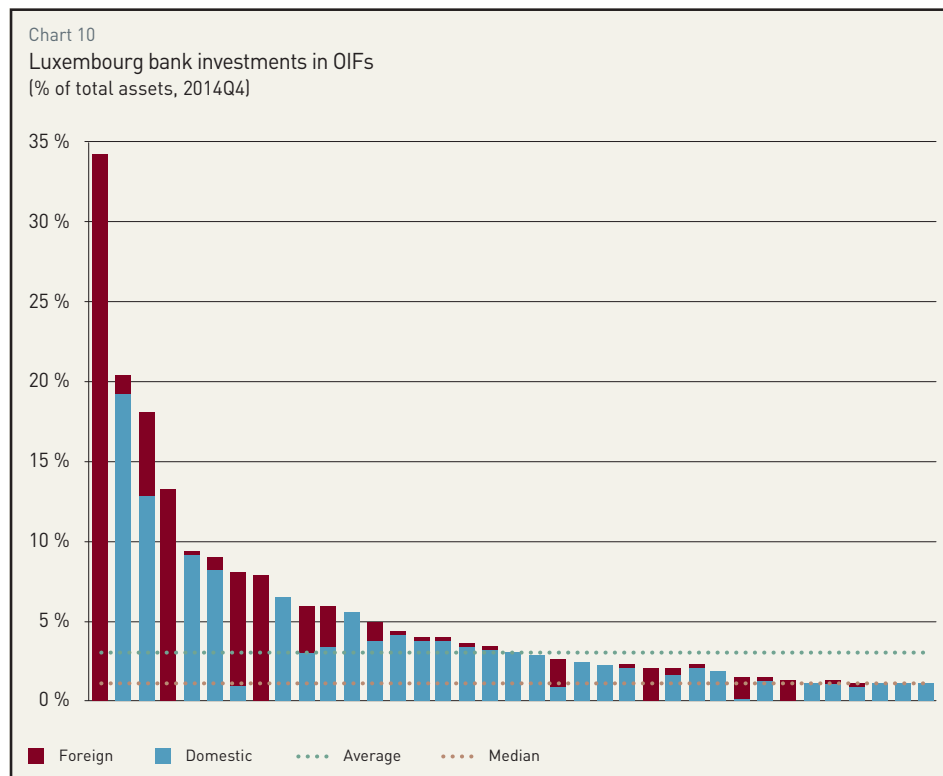
relatively modest investments to the OIF industry in terms of the proportions of their total asset size. Approximately half of banks within the domestic banking system had exposures toward the OIF industry, but only 12 banks surpassed the threshold of 5% in total OIF exposures to total balance sheet size.

Eighteen banks have exposures to OIFs greater than 50% of their total equity; half of those banks have exposures to OIFs which surpassed their total equity. The average and median values of the distribution are 41% and 12%, respectively.

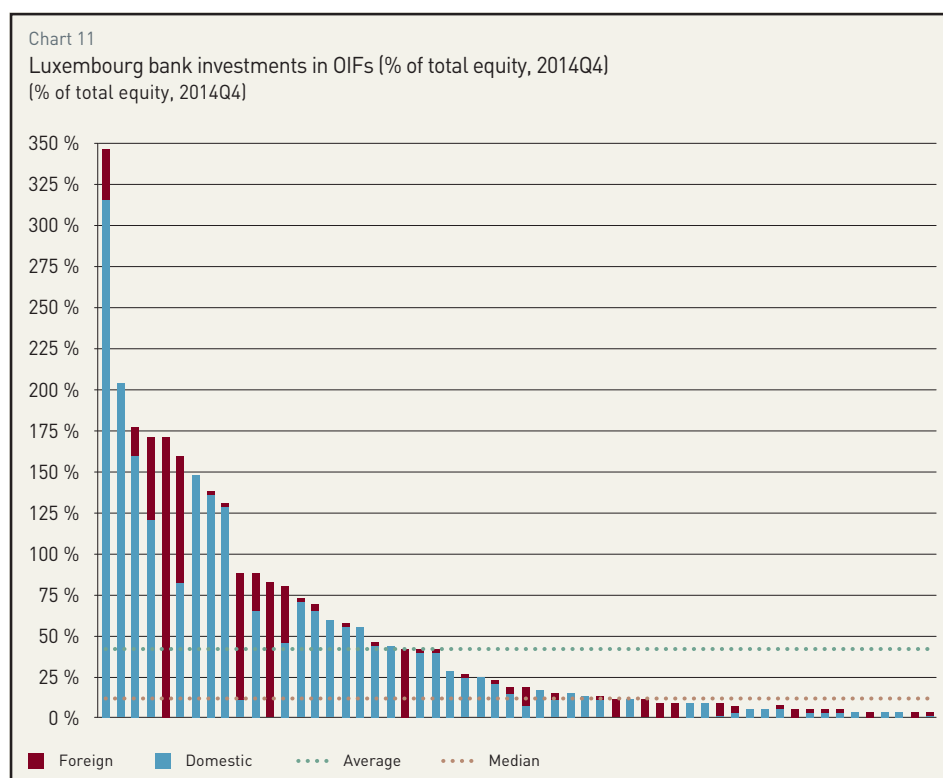
4.3 Banking sector investments in MMFs

- **Insignificant except for one bank**

Similar to the domestic banking sector investments in the OIFs, the investments in MMFs share a longer-term declining trend. However, similar to OIFs, there was a significant increase in exposures in 2014Q4. As opposed to the latest increase in OIF exposures, which were mainly from domestic OIFs, domestic banks have increased their exposures to MMFs based abroad. Nevertheless, exposures to MMFs tend to be rather marginal, especially after subtracting the exceptionally large exposure of a single bank (2.0 billion euros investment in foreign MMF quoted shares) from the existing composition of domestic banking sector MMF exposures. The investments in MMFs make up about 0.3% of domestic

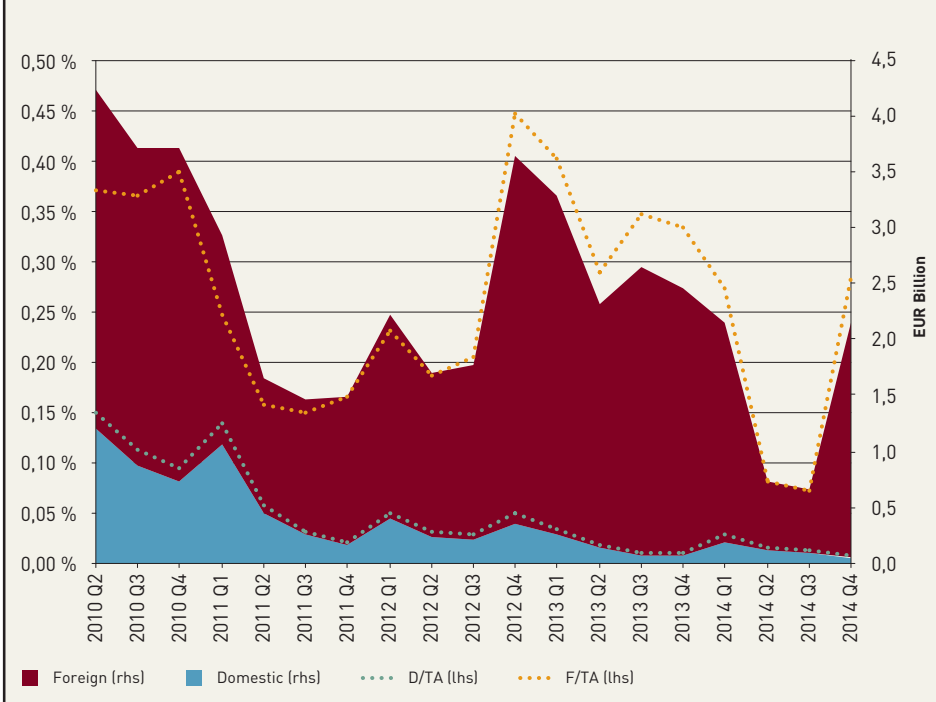


Source: BCL



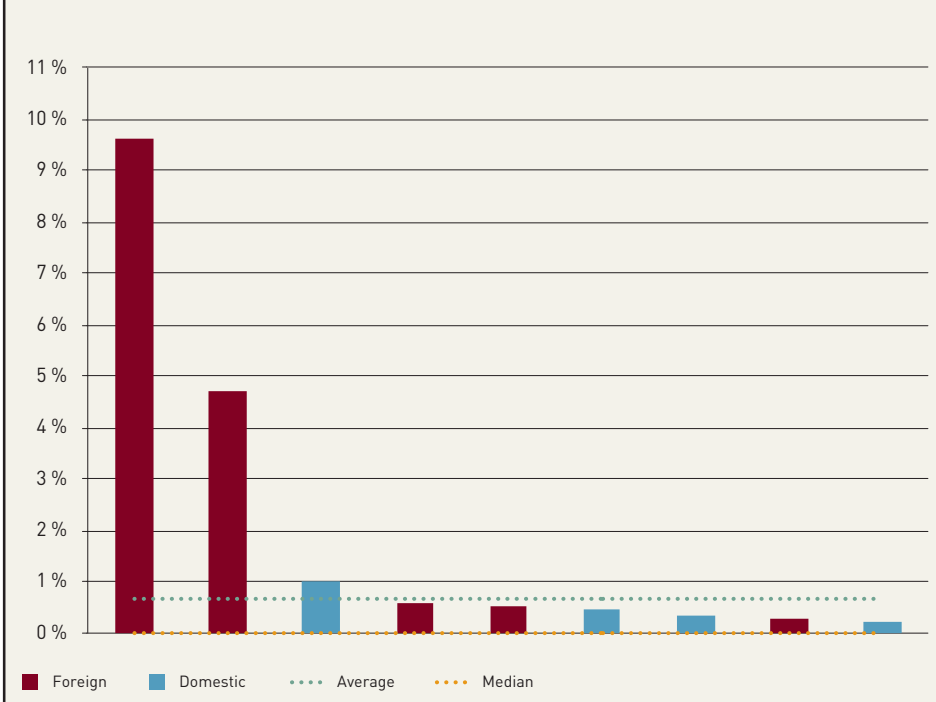
Source: BCL

Chart 12
Ratio of bank investments in MMFs to Luxembourg banking assets



Source: BCL

Chart 13
Luxembourg bank investments in MMFs (% of total assets, 2014Q4)



Source: BCL

banking sector balance sheets, which amounted to 2.1 billion euros in 2014Q4 (2010Q2: about 4 billion euros).

The exposures to MMFs do not reach the levels observed with bank exposures to the OIFs, as compared to the total balance sheet size of individual banks. Only one bank is exposed to MMFs above the 5% threshold of its total balance sheet size. The majority of the largest five banks' exposures toward MMFs are to a foreign entity.

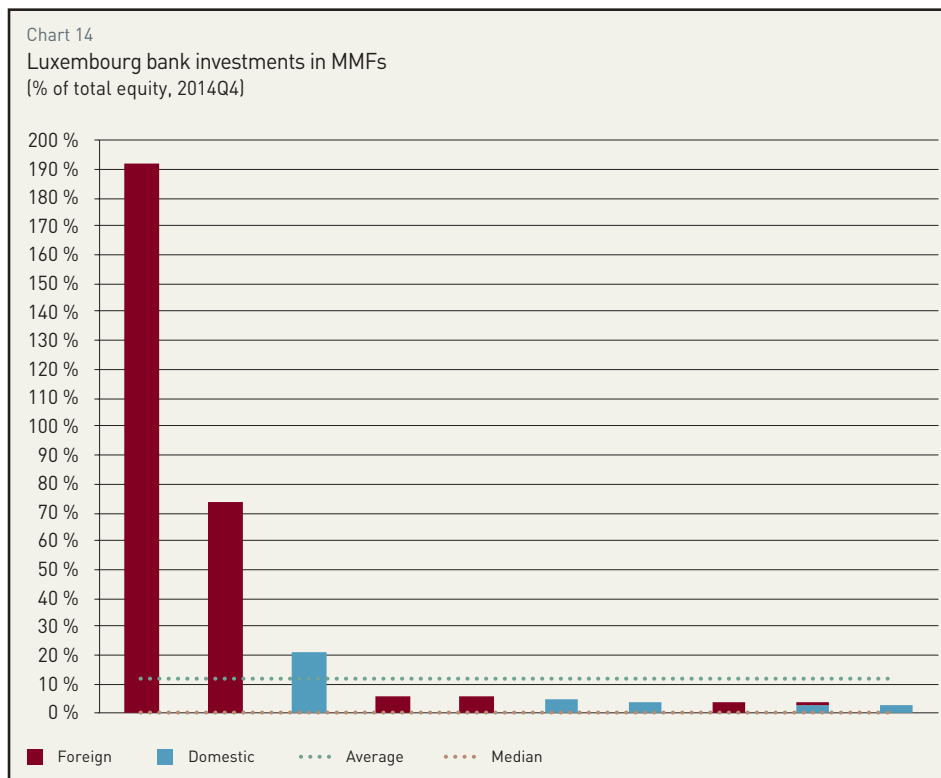
Two banks have exposures to the MMF industry which are greater than 50% of their total equity. The divergence of the four banks' exposures to MMFs, as compared to the rest of the banks within the group, is also emphasised by the average and median values of the distribution. Namely, the median value (0.1%) is much lower than the average value (12%), implying that a few outliers drive the mean value up from an overall low level of exposures vis-à-vis the MMF sector.

4.4 Banking sector investments in securitisation vehicles

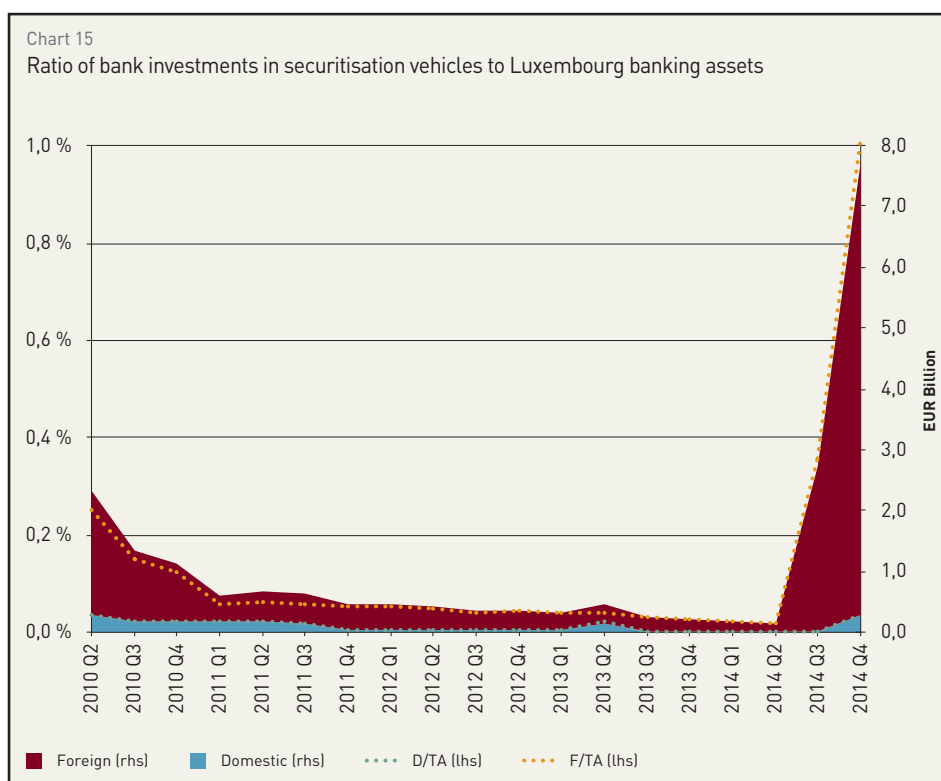
From looking at Chart 15, the first impression might be that exposures to securitisation vehicles have taken a substantial upswing since 2014 Q3. However, this might only partially be the case. A bank specialised in securitised investments was introduced in the reporting framework in 2014 Q3, which significantly changed the landscape in Chart 15. With the exception of this significant bank, exposures to securitised vehicles remained relatively stable even in the last quarter of 2014. The significant bank contributed to about 53% of total securitisation investments by the domestic banking sector. Total asset exposure to securitised vehicles accounted for approximately 1% of total domestic banking sector assets.

The distribution of Luxembourg banking sector investments in securitisation vehicles varies substantially – Chart 16 displays a specialised bank with investments in securitised assets representing slightly above 80% of its total assets. The rest of the domestic banking system has only marginal exposures to securitisation vehicles – about 18% of domestic credit institutions invested in securitised assets in 2014Q4.

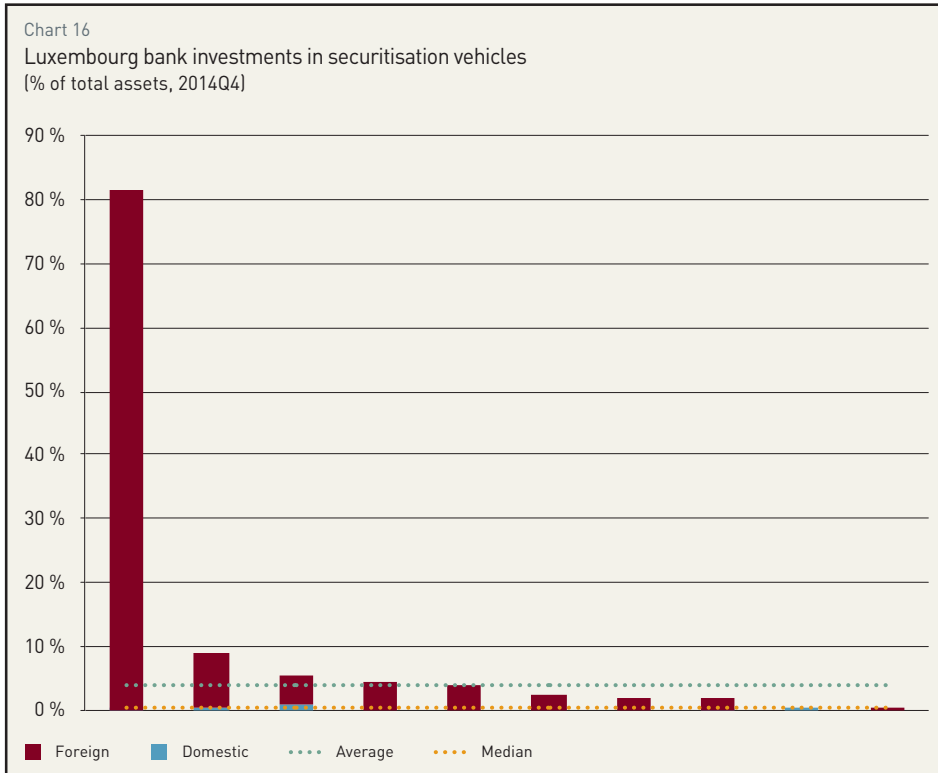
Five domestic banks had exposures to securitisation vehicles which surpassed their total equity



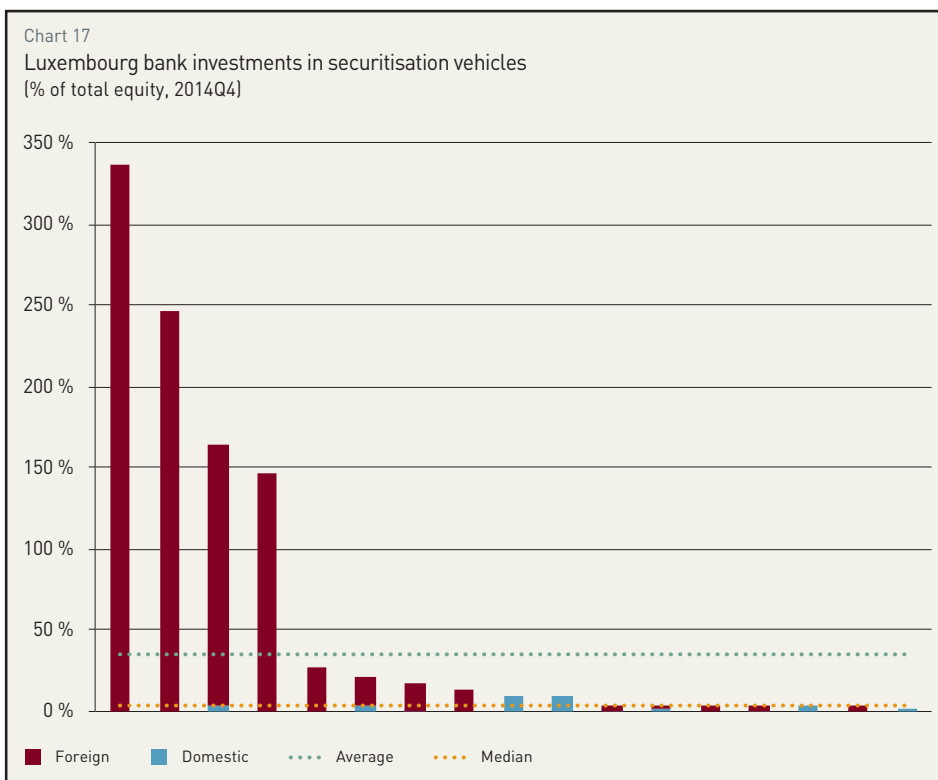
Source: BCL



Source: BCL



Source: BCL



Source: BCL

levels in 2014Q4²⁰. The banks with significant exposures to securitisation vehicles, displayed in Chart 17, are either branches or credit institutions with specialised business models that significantly differ from the business strategies of commercial banks.

4.5 Combined banking sector exposures to market-based financing entities

The charts in Section 4 above display a rather limited view of the concentration of potential risks stemming from the exposure to market-based financing entities. This is because the charts in Section 4 show individual bank exposures to OIFs, MMF, and securitisation vehicles separately, whereas Chart 18 considers them together. In addition, we include *common equity tier 1 (CET 1)* as an additional element to the already existing measures of risk²¹ to provide a more comprehensive risk perspective.

Chart 18 below includes three graphs based on clusters from the network analysis in Charts 4 and 5: (a) domestically oriented banks, (b) foreign branches, and (c) the rest of the domestic banking sector.²² The y-axis on the graphs in Chart 18 represents the ratio of investments in market-based financing entities to

20 One bank is not included in the graph because its securitisation vehicle exposure to total equity ratio amounted to 37,660%, which would have distorted the graph below.
 21 Total assets and total equity.
 22 The aforementioned bank is not included in the graph to avoid distorting the graph below.

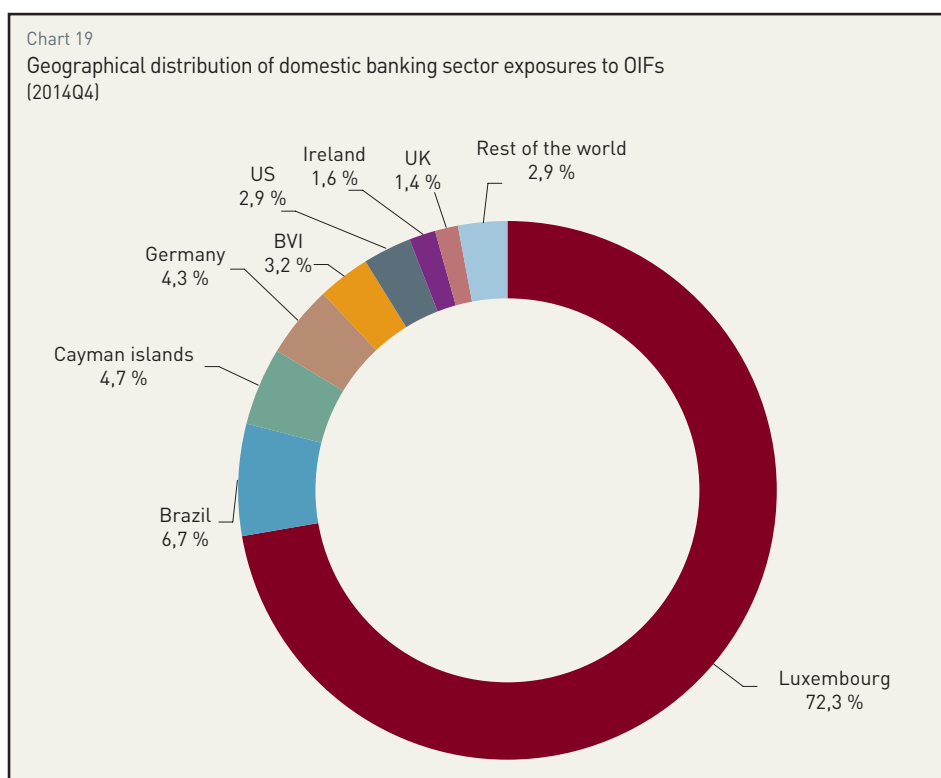
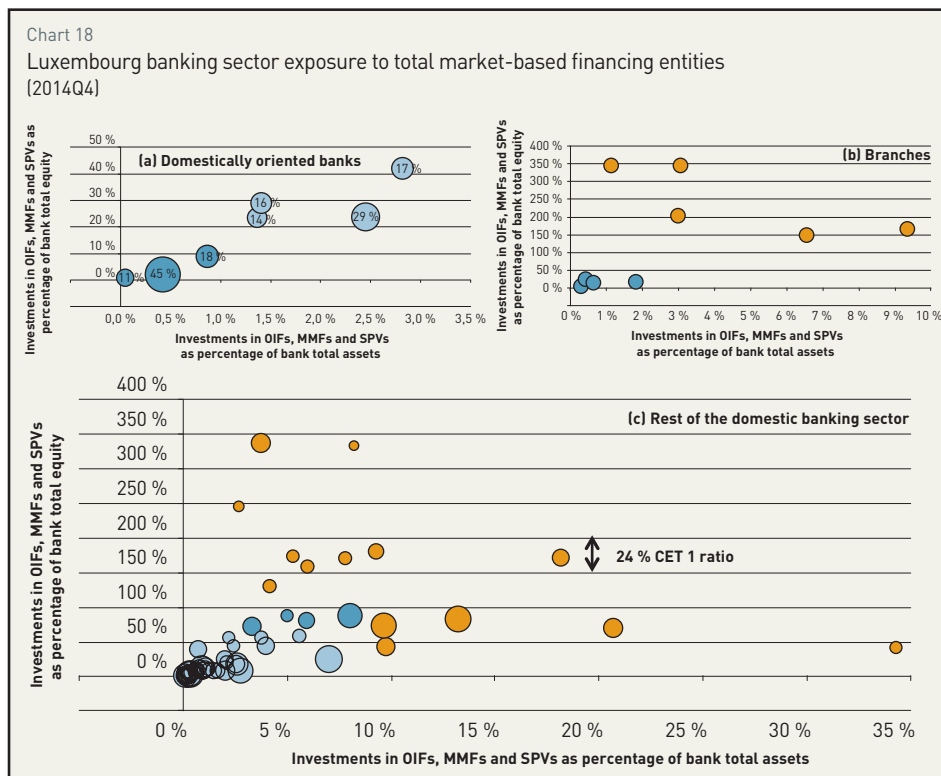
total equity of the bank. The x-axis represents the ratio of investments in market-based financing entities to their total assets. The volume of a bubble represents the CET 1 ratio²³ of a bank. The banks which exceeded the thresholds of (i) 100% for total market-based financing entities exposure to bank total equity and (ii) 10% for total market-based financing entities exposure to bank total assets are considered to exhibit more risk and are highlighted in orange.

The observations from Chart 18 lead us to conclude that (i) banks with exposures to market-based financing entities are generally well capitalised, (ii) domestically oriented banks are exposed to market-based financing entities only to a limited extent compared to branches and the rest of the domestic banking sector, and (iii) some of the outliers – with substantial exposures to market-based financing entities and relatively low CET 1 ratio levels – within the group of banks representing the rest of the domestic banking sector warrant closer monitoring.

4.6 Geographical breakdown of banking sector investments

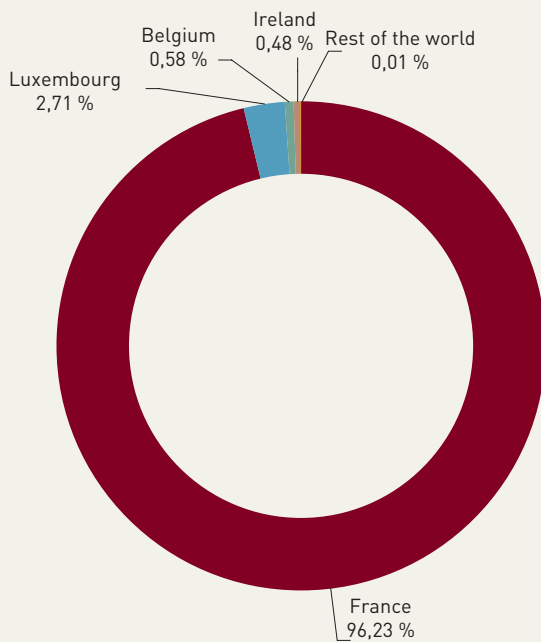
The subsection below displays a precise geographical allocation of Luxembourg banking sector funds toward the market-based financing entities.

23 The bubbles within the graph representing domestically oriented banks include the CET 1 ratio values for each domestically oriented bank displayed in the graph.



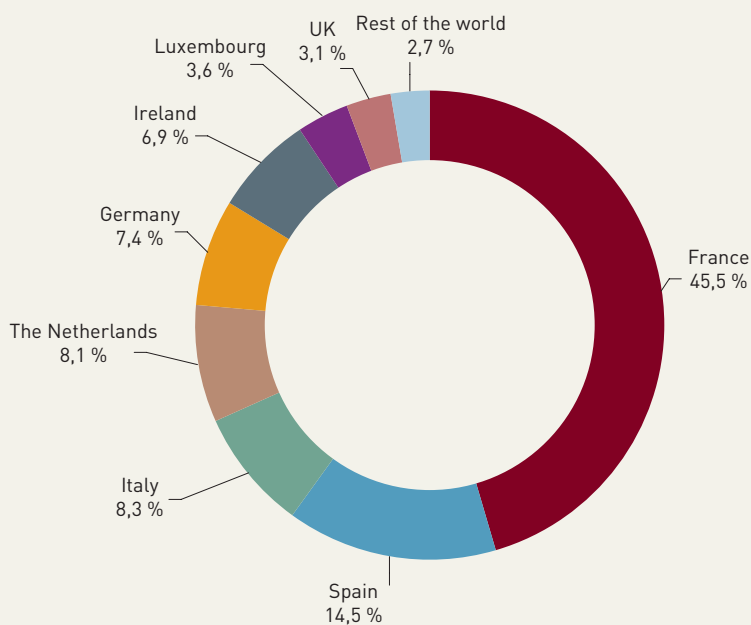
Source: BCL

Chart 20
Geographical distribution of domestic banking sector exposures to MMFs
(2014Q4)



Source: BCL

Chart 21
Geographical distribution of domestic banking sector exposures to securitization vehicles
(2014Q4)



Source: BCL

- **OIFs' home bias with some exotic preferences**

Investments in domestic OIF entities prevail and EU exposure constitutes slightly above 80% of total investments in OIFs. The most prevalent overseas exposures are Brazil (about 7%), Cayman Islands (about 5%), British Virgin Islands (BVI) and US (about 3% each).

- **The MMF path leads to France**

The Luxembourg banking sector investments in MMFs do not share the same home bias tendency as observed previously with the investments toward OIFs. Domestic MMFs hold a mere 3% share of the total MMF fund distribution. The major MMF investment destination is France, notably due to an already mentioned significant exposure of a single Luxembourg bank.

- **The EU preference of securitisation vehicles**

Similarly to Luxembourg banking sector fund distribution to MMFs, France is a major investment destination toward securitization vehicle entities as well. As demonstrated in Chart 16, a single bank exposure signifies a large proportion of the combined exposure to France. Approximately 90% of Luxembourg banking sector investments in securitised debt instruments are issued by entities based within the boundaries of continental Europe.

5. FUNDING FROM THE MARKET-BASED FINANCING ENTITIES

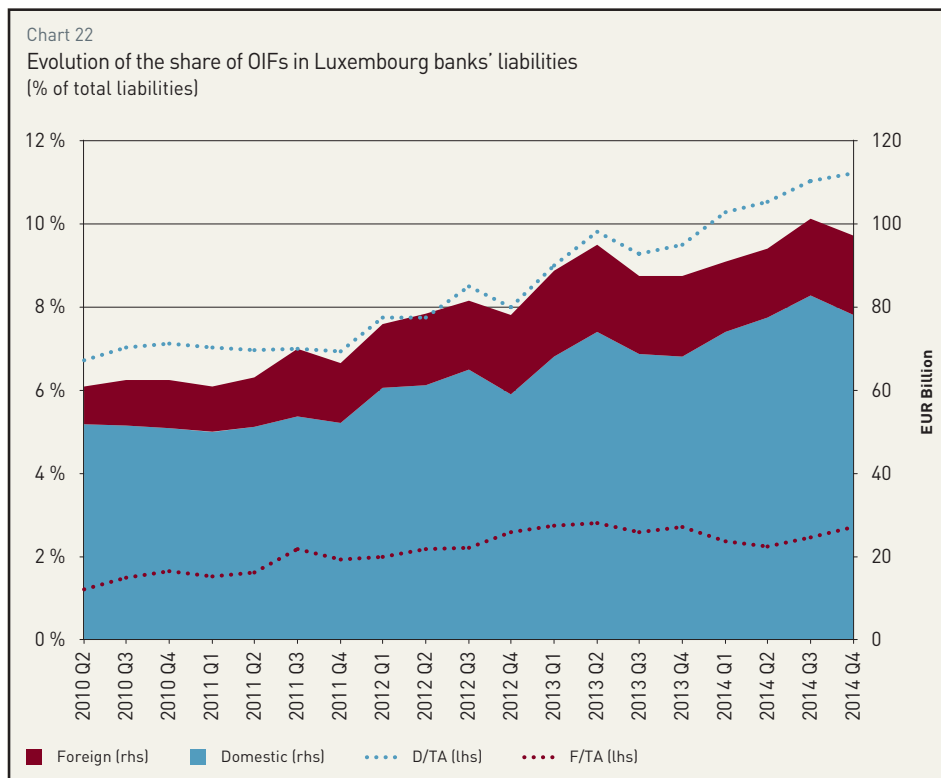
Given the importance of funding sources for the domestic banks and potential risks originating from emerging market economies, this section focuses on the funding of the domestic banking sector stemming from OIF, MMF and securitisation vehicles sectors. For each of them, we analyse the distribution within the banking sector, the geographical origins, the types of liabilities and the maturities.

5.1 Funding from other investment funds

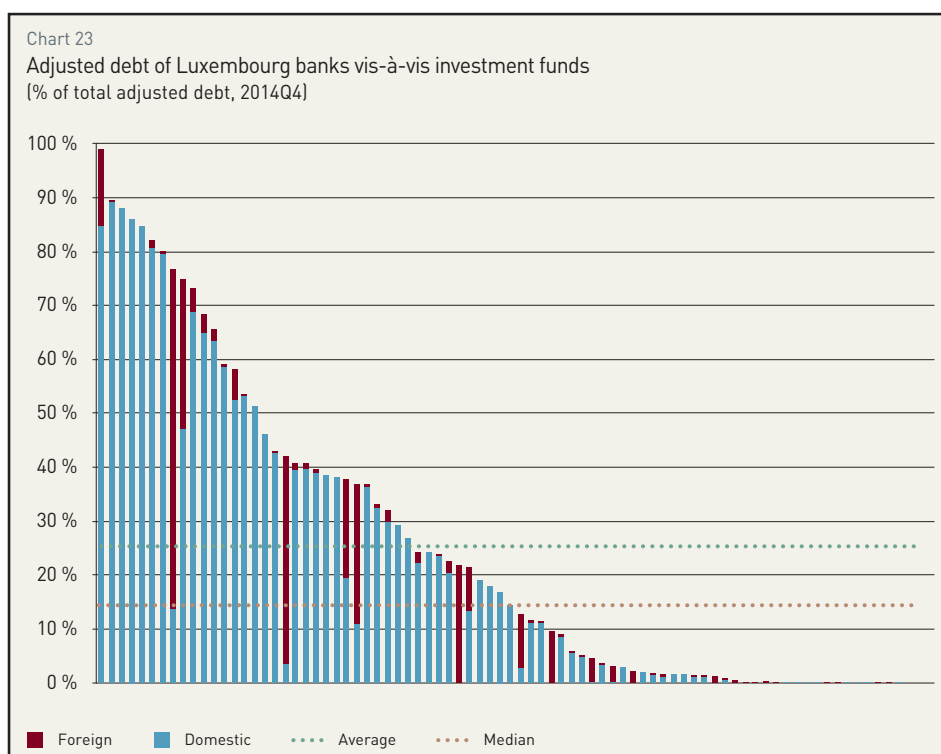
5.1.1 The growing importance of funding from OIFs

Although the share of OIFs is still relatively small compared to the share of other banking institutions in total funding, the OIFs have increased their contribution in the past few years from 8% in June 2010 to 14% in December 2014. It has to be noted that most of the increase results from domestic funds. This suggests a growing reliance of Luxembourg banks on funding provided by those institutions.

At the individual level, 81 banks (out of 148 banks within the domestic banking system) report liabilities vis-à-vis OIFs. Many of them are predominantly reliant on OIF funding. In the majority of cases domestic OIFs represent most of the total OIF funding. Nevertheless, some banks still exhibit a high level of liabilities



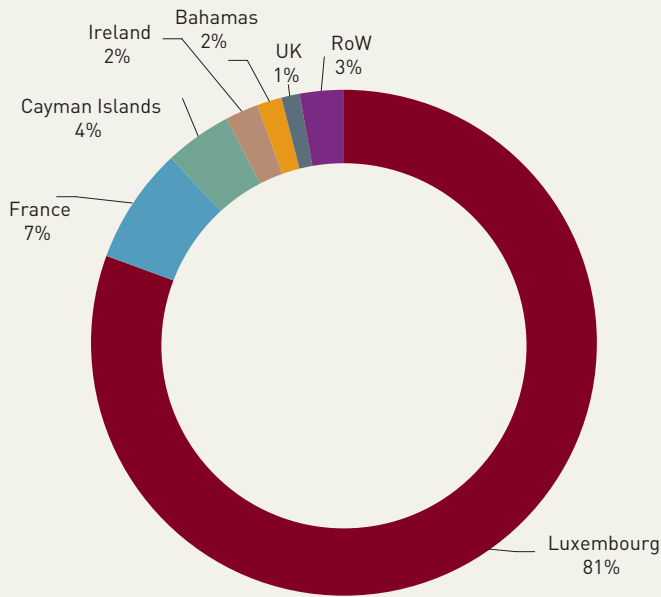
Source: BCL



Source: BCL

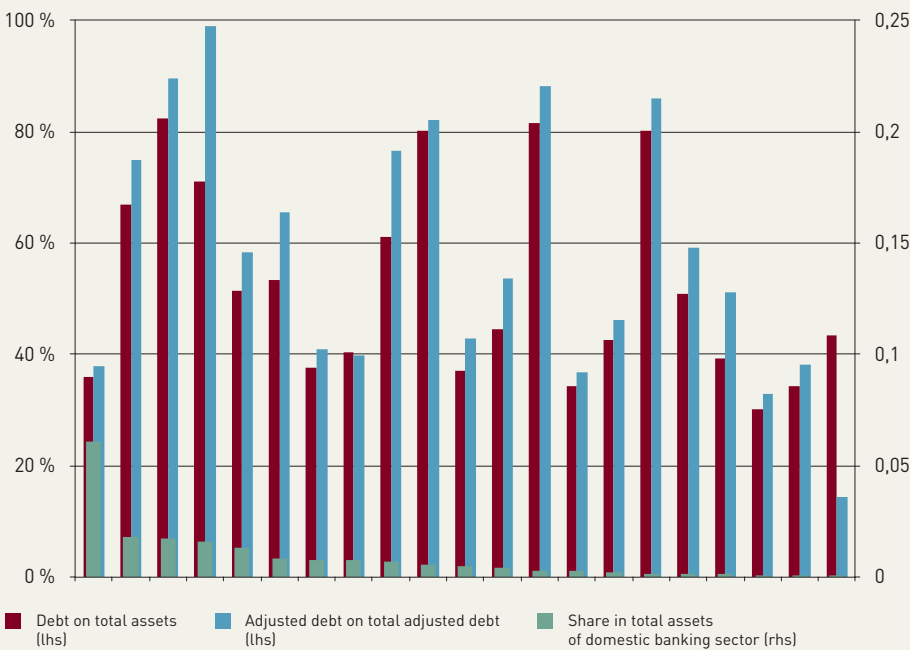
Note: Adjusted debt is the difference between total debt and deposits received from affiliates.

Chart 24
Geographical distribution of domestic banking sector's debt vis-à-vis OIFs (2014Q1)



Source: BCL

Chart 25
Debt of Luxembourg banks (non-branches) vis-à-vis investment funds (2014Q1)



Source: BCL

vis-à-vis foreign funds. The geographical distribution of foreign bank liabilities is studied in more detail subsequently. Out of the 81 banks receiving funds from the OIF sector, there are 33 banks which report marginal OIF funding below 5% of total adjusted external funding. For banks with a ratio above 30%, a more detailed analysis is provided below.

5.1.2 The predominance of domestic OIFs

The Chart below illustrates the predominance of domestic OIFs which represent 81% of total OIF funding. In addition, many French funds (7% of total debt) invest in the Luxembourg banking sector, followed by entities from Cayman Islands and Ireland (respectively 4% and 2%). The funding from other parts of the world accounts for only 6% of the total debt of banks.

5.1.3 Identifying banks highly reliant upon the OIFs funding

There are 28 banks receiving more than 30% of their funding from OIFs. Those banks account for 21% of total assets of domestic banking sector. Seven of them are branches of foreign banks and represent about 3% of total assets of all banks. Among banks which are not classified as branches, eleven banks account for more than 0.5% of total assets of the domestic banking sector, including one accounting for more than 5% of total domestic assets of Luxembourg banks.

5.1.4 High liquidity of deposits

Long-term funding from OIFs appears to be very limited. The liabilities reported under “no breakdown” are almost exclusively *Overnight deposits* (see Table below).²⁴ Indeed, the share of *Short sale of securities* is extremely marginal. The affiliates tend to provide more stable funding. However, deposits received from related entities are consolidated to determine the adjusted debt. The table below shows that most of the funding stemming from OIFs is highly liquid and could be withdrawn fast in case OIFs would need them.

Table 1:

Types of liabilities vis-à-vis investment funds by maturities (2014Q4)

	OVERNIGHT DEPOSITS	DEPOSITS WITH AGREED MATURITY	DEPOSITS REDEEMABLE AT NOTICE	SALE AND REPURCHASE AGREEMENTS	SHORT SALE OF SECURITIES	TOTAL DEBT	DEPOSITS RECEIVED FROM AFFILIATES	TOTAL ADJUSTED DEBT
No breakdown	100%				0%	82 837	1%	82 221
Up to 1 year		16%	6%	27%		12 065	1%	11 713
[1 year; 2 years]		40%	10%			4	16%	2
[2 years; 5 years]		50%	0%			81		81
Over 5 years		50%				22		22
Total	82 836	4 086	1 479	6 605	0	95 007	969	94 038

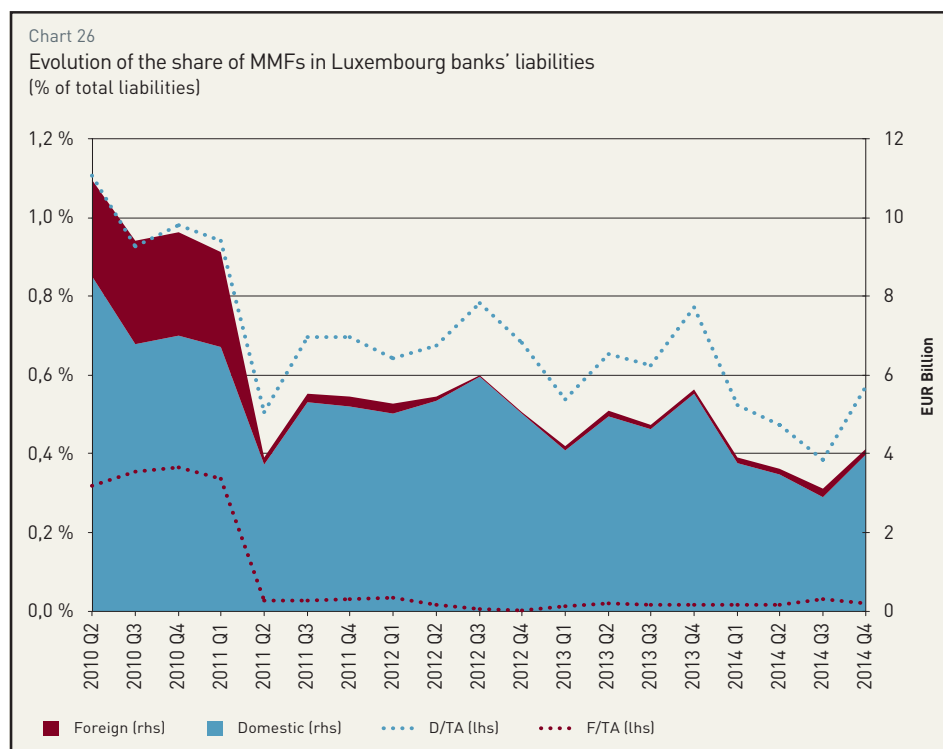
Source: BCL

Note: Values are either expressed as percentages of total debt for a given maturity or in million euros.

5.2 Funding from money market funds

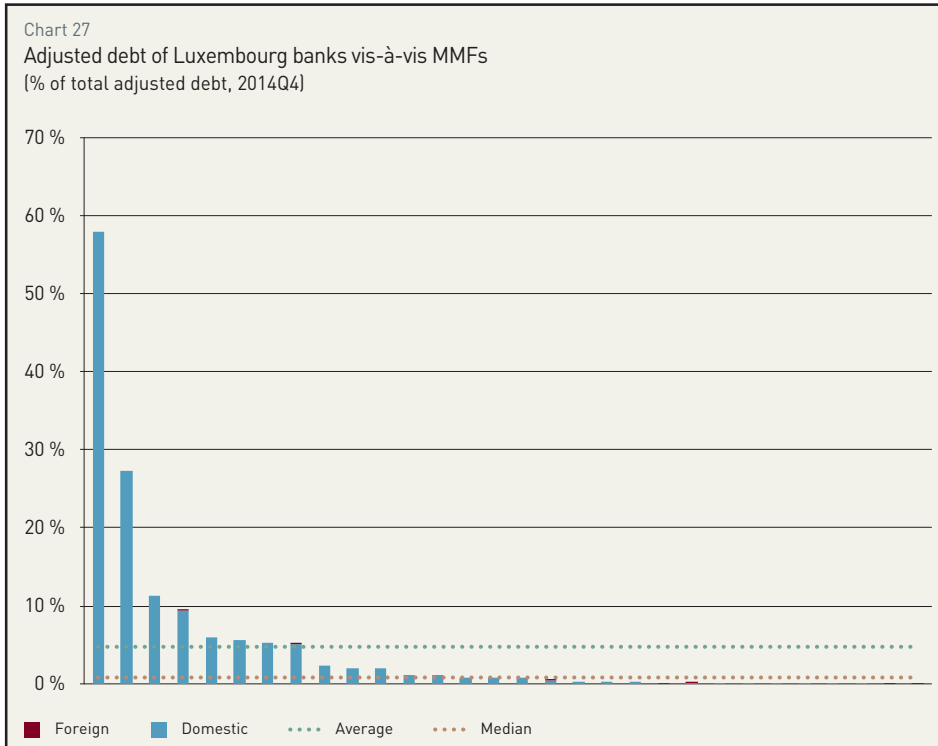
Money market funds have not contributed substantially to the funding of Luxembourg banks in the past few years. In fact, the share of their contribution has even decreased somewhat since 2011. Concomitantly, we notice that foreign MMF funding has almost disappeared from banks' liabilities. Overall, the contribution of MMFs to domestic bank funding seems to be marginal as it represents less than 0.6% of total bank liabilities.

The figures at the individual bank level show that only a few banks rely on MMF funding and in only one case their shares outweigh



Source: BCL

²⁴ *Overnight deposits are convertible into currency and/or transferable on demand by cheque, banker's order, debit entry or similar means, without significant delay, restriction or penalty.*



Source: BCL

Note: Adjusted debt is the difference between total debt and deposits received from affiliates.

30% of total external adjusted debt. Individual figures confirm the aggregated numbers as marginal foreign MMF contribution can be observed. Most of foreign MMF funding is of Irish origin and directed at one domestic bank.

Similarly to the case of OIFs, liabilities with no breakdown are almost exclusively overnight deposits. Total debt reported vis-à-vis MMFs essentially takes the form of short-term debt or overnight deposits. It has to be noted that deposits received from affiliates result only from funds provided by domestic MMFs to two banks.

Table 2:

Types of liabilities vis-à-vis MMFs by maturities (2014Q4)

	OVERNIGHT DEPOSITS	DEPOSITS WITH AGREED MATURITY	DEPOSITS REDEEMABLE AT NOTICE	SALE AND REPURCHASE AGREEMENTS	SHORT SALE OF SECURITIES	TOTAL DEBT	DEPOSITS RECEIVED FROM AFFILIATES	TOTAL ADJUSTED DEBT
No breakdown	100%				0%	3 347	6%	3 149
Up to 1 year		100%				584		584
]1 year; 2 years]		100%				1		1
]2 years; 5 years]						0		0
Over 5 years		100%				128		128
Total	3 347	713				4 061	198	3 862

Source: BCL

Note: Values are either expressed as percentages of total debt for a given maturity or in millions of Euros.

5.3 Funding from securitisation vehicles

From Chart 28, we can observe that funding of banks by securitisation vehicles has decreased since 2010 and accounted for around 0.4% of their total liabilities in 2014Q4. Recently, foreign counterparties have played a growing role in bank funding and domestic and foreign securitisation vehicles now bring the same amount of funding to domestic bank (1.3 billion euros).

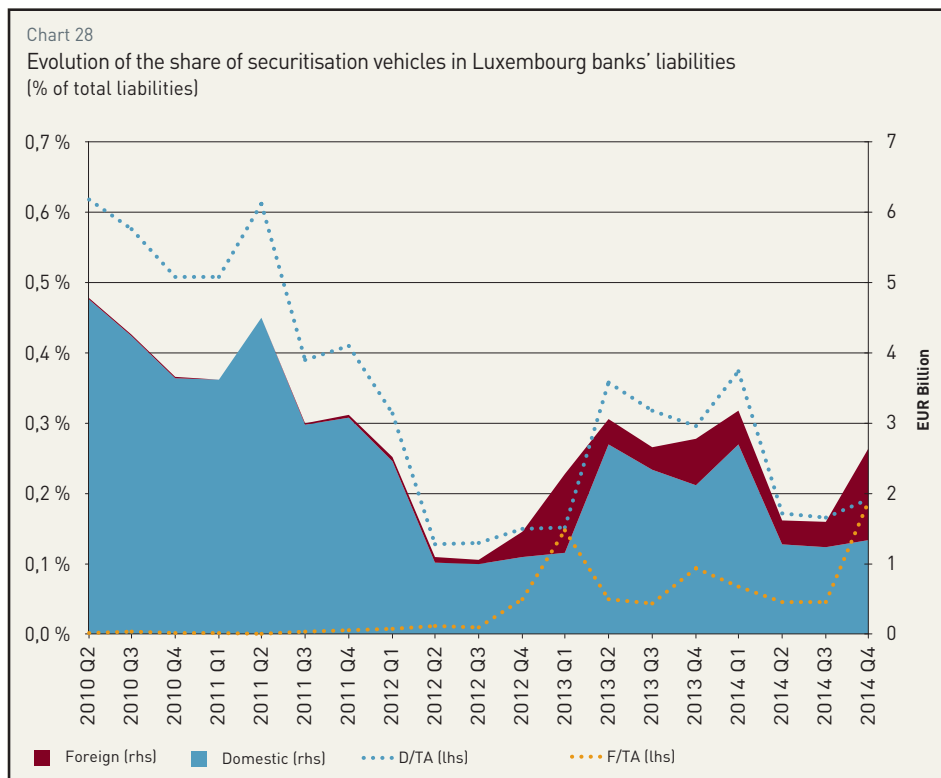
After the adjustment for deposits received from affiliates, individual debts exhibit low levels that do not outweigh 10% of total adjusted debt. Therefore, funding risk stemming from securitisation vehicles can be regarded as relatively marginal for Luxembourg banks.

6. EXPOSURE OF LUXEMBOURG FUND INDUSTRY TOWARD BANKS

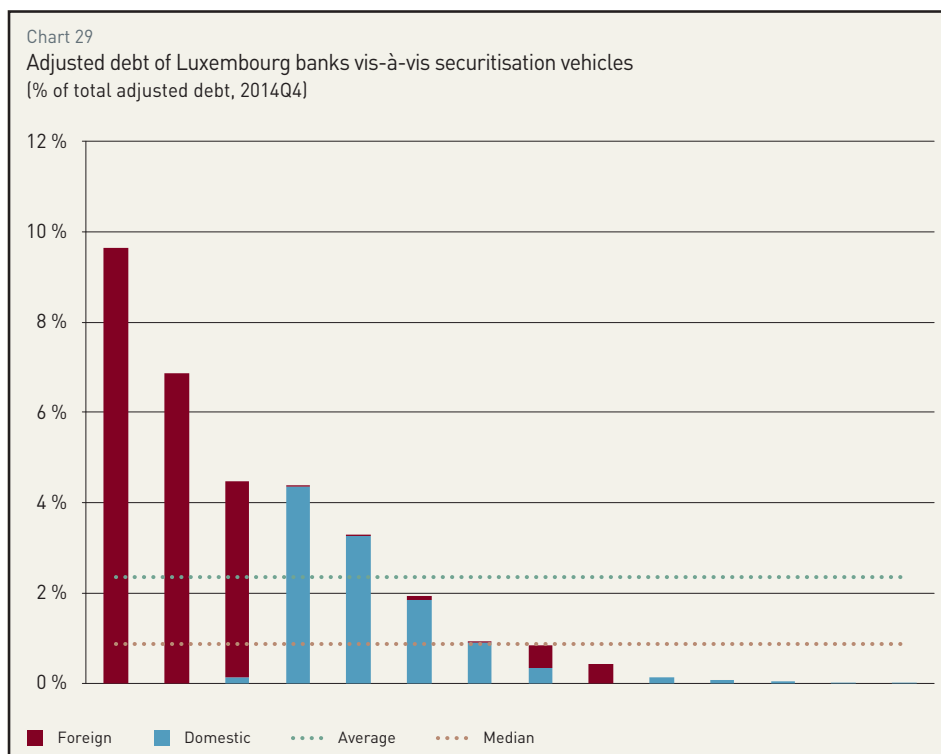
In this section we analyse the interconnectedness between banks and OIFs from a fund's perspective and evaluate any potential funding or credit risks for the domestic fund industry. In particular, spillover risks from banks to the investment fund sector are examined. Subsequently, we observe whether variations in OIFs' total assets impact their bank deposits.

6.1 MFIs as a major counterpart for MMFs on the asset side when foreign entities are included

The bank funding liquidity problems have the potential to propagate quickly to the rest of the financial sector. Indeed, when banks struggle with funding, it becomes difficult to issue loans. Therefore, other financial institutions that rely heavily on bank funding may face funding risk when banks encounter such difficulties in the first place. In order to determine whether bank funding difficulties could spread to the fund industry, we analyse the evolution of the shares of banks in total liabilities of funds. The level



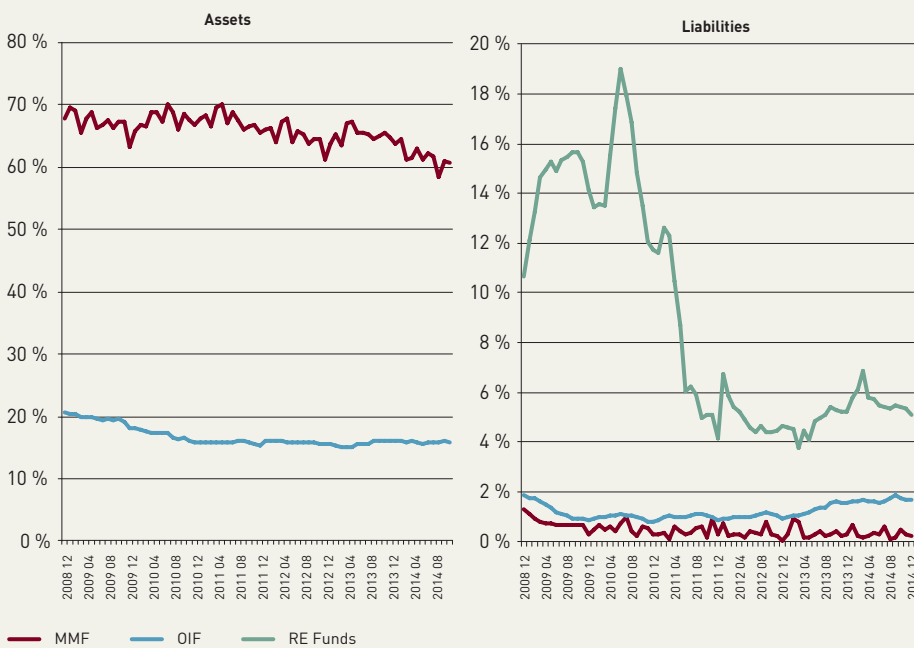
Source: BCL



Source: BCL

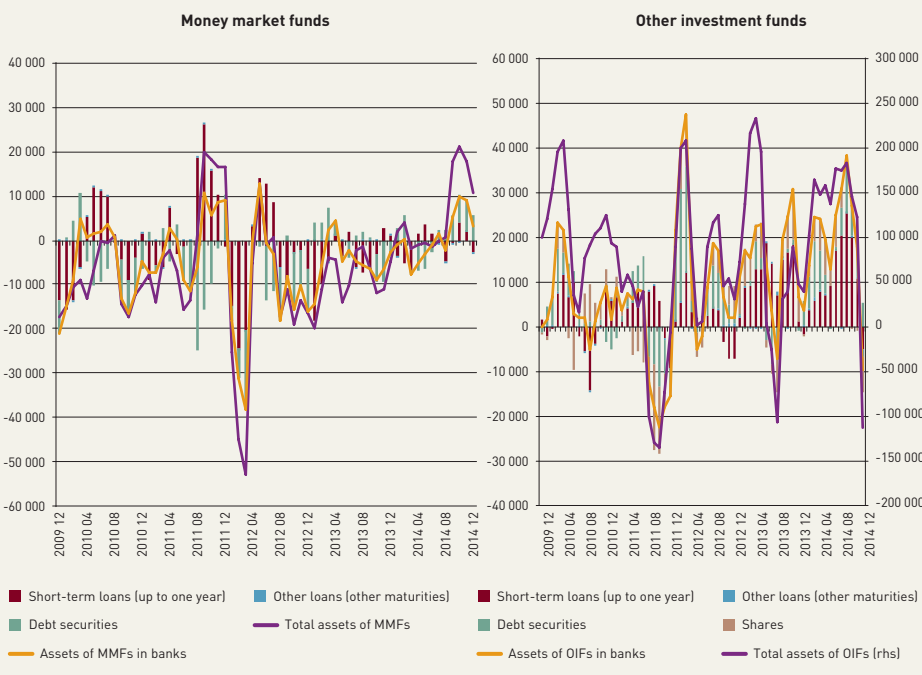
Note: Adjusted debt is the difference between total debt and deposits received from affiliates.

Chart 30
Shares of MFIs in funds total assets and liabilities
(% of total assets/liabilities)



Source: BCL

Chart 31
Variation of Luxembourg investment funds' total assets and variation of assets held in credit institutions
(quarterly change, EUR million)



Source: BCL

of OIFs/MMFs asset exposures to the banking sector is also depicted so as to determine whether the fund industry is exposed to credit risk stemming from banks. In this subsection national statistics on domestic OPCs are used which permits a decomposition of exposures of domestic funds by type of fund vis-à-vis both domestic and foreign credit institutions (ratios for each type of investment fund are reported in the dashboard presented in the next section).

The share of banks in MMFs assets is very high, consistently observed at a level between 57% and 70% of total assets since 2010, but it is gradually decreasing since 2013. OIFs invest less in credit institutions. The shares of banks in OIF total assets range from 8% for hedge funds to 20% for bond funds. Those levels are consistent with the observed euro zone characteristics where the share of MFIs in total funds was slightly higher than 15% in 2014 Q1 while the share of MFIs in MMFs assets evolved between 65% and 75% of total assets over the same period.²⁵ On the liability side, OIFs/MMFs rely for less than 2% of their funding on MFIs, except for the real estate funds for which the level is higher but also remains rather limited.

From Chart 31, we observe that the net asset variation of MMFs is closely related to the stock of assets held in credit institutions. Most of the MMF asset variation results from exposures to banks

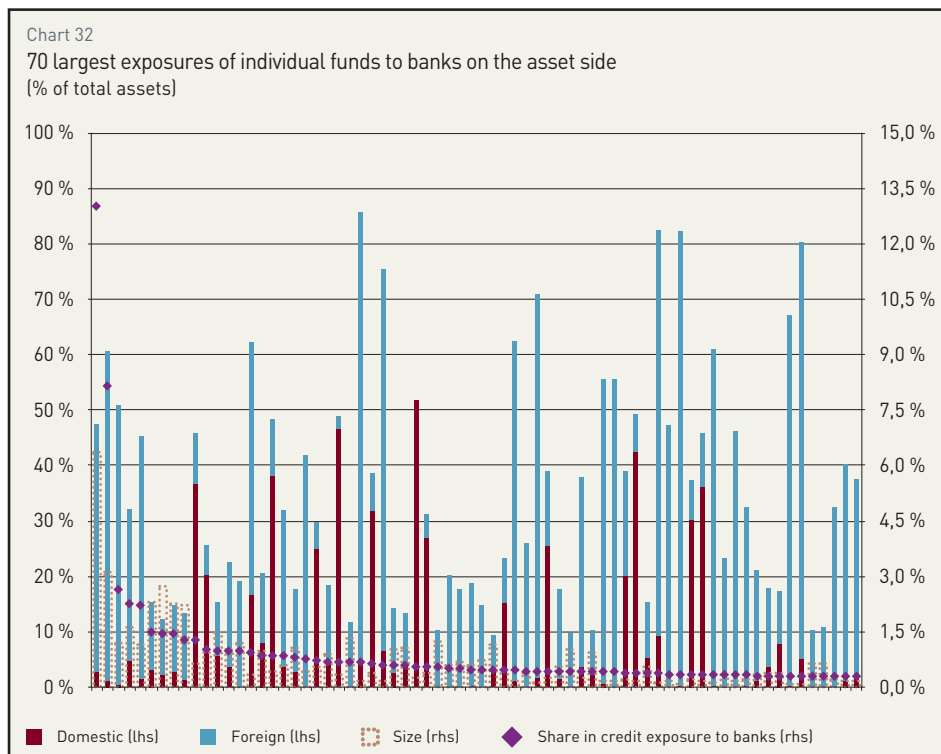
25 ESMA (21014), Report on Trends, Risks, and Vulnerabilities, No. 2, 2014.

and a large share of it from loans with maturity below one year. As regards the OIFs, exposures to banks contribute to a much lesser extent to total assets fluctuations. However, short-term loans appear to play a leading role in variations of OIFs' exposures to banks. In particular, we observe that OIFs have significantly increased their short-term loans to banks in 2013 and 2014.

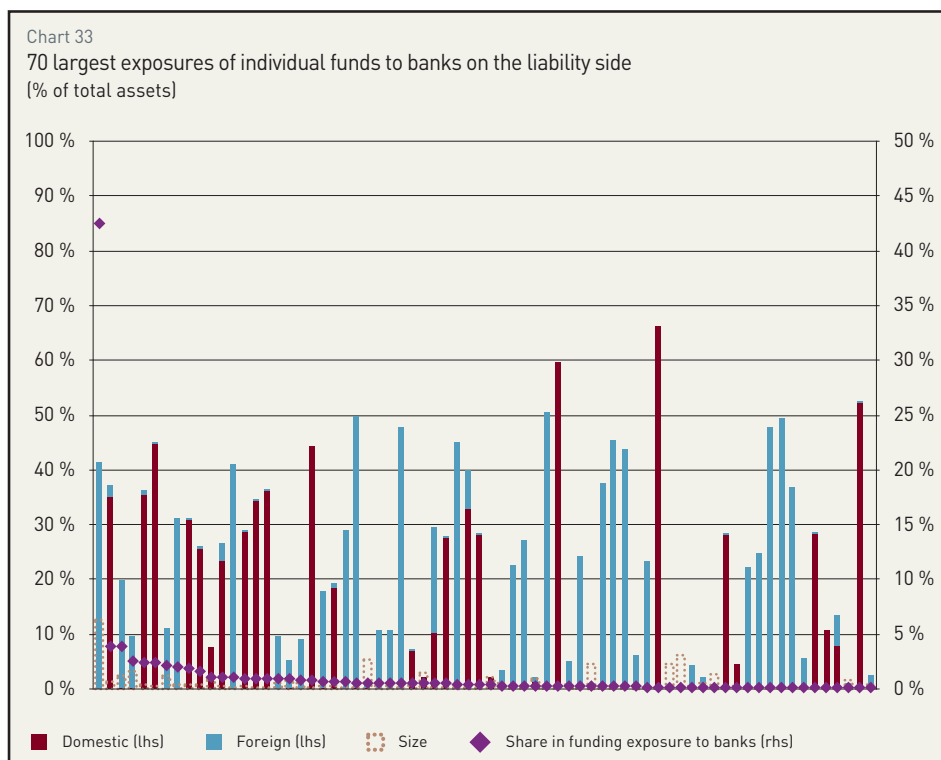
6.2 Individual fund exposures to the banking sector

In this subsection we study the exposures of OIFs/MMFs to banks at the individual level using a database of more than 3650 funds and 13200 fund units which hold total assets of more than 3 trillion euros. The analysis focuses on the top 70 exposures of domestic funds to the banking sector both on the liability and asset sides. Exposures are deemed to be "high" when the ratio outweighs the level of 25% for a fund representing more than 0.5% of total assets of domestic fund industry and more than 0.5% of total exposures to banks.

The 70 funds with the largest credit exposures to banks account for 66% of assets held by OIFs/MMFs in banks. Funds having a credit risk exposure above 25% represent 64% of the fund industry. However, most of them are small funds – only 9 funds which represent a 16% share of the industry – are regarded as having "high" exposures to banks. The exposures to domestic banks remain generally low for individual funds shown in Chart 32, except for 11 banks.

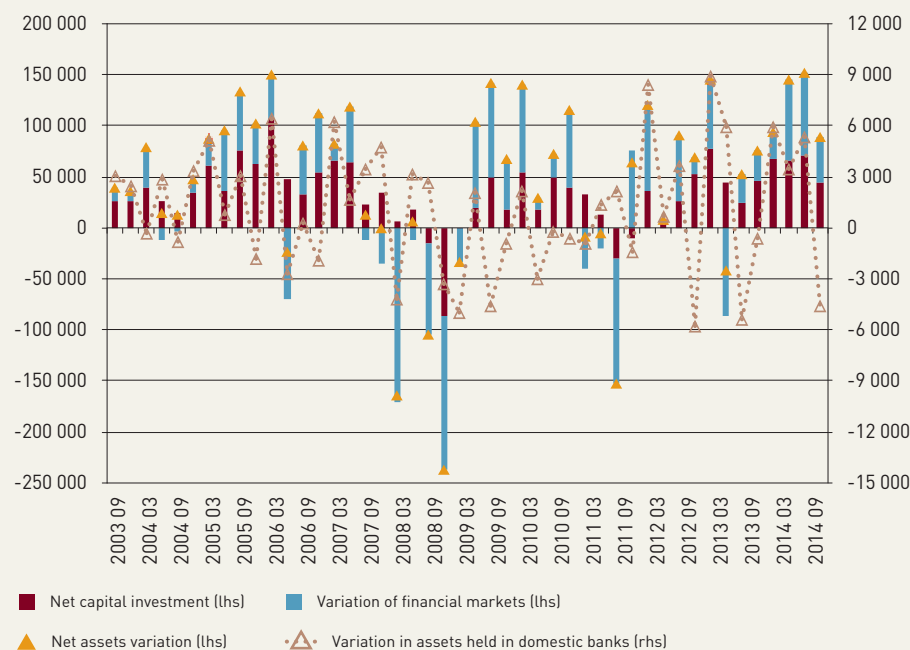


Source: BCL
Note: this figure includes exposures in financial derivatives.



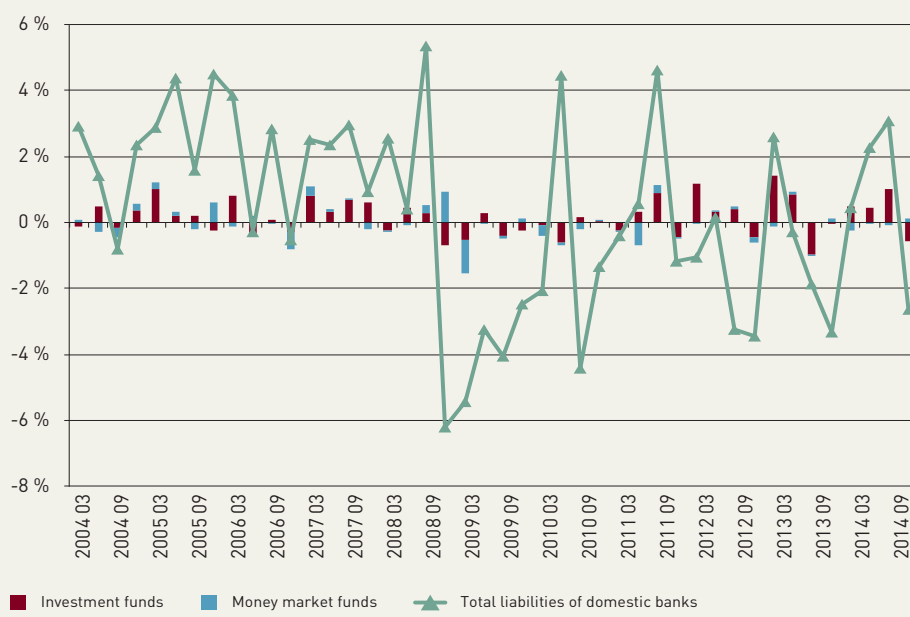
Source: BCL
Note: this figure includes exposures in financial derivatives.

Chart 34
Variation of Luxembourg OIFs' total assets and variation of assets held in domestic banks
(quarterly change, EUR million)



Source: BCL

Chart 35
Contribution of Investment funds and Money market funds to the variation of domestic banks' total liabilities
(% of total liabilities variation)



Source: BCL

The fund industry is less exposed to the banking sector on the liability side. The 70 largest bank-linked exposures cover 91% of all OIFs/MMFs' exposures to banks. Funding risk is considered to be high – above 25% of total assets – for 112 funds, but only 2 of them are bigger than 0.5% of the fund sector's total asset. In 17 cases, the funding ratio vis-à-vis domestic banks is higher than 25%, though none of those exposures is considered to be "high" according to the criteria stated above.

6.3 The sharp reduction in OIF total assets in 2008 was followed by a decrease in OIF deposits in domestic banks

Chart 34 below displays the variations of OIF (i) net assets and (ii) assets in domestic banks. We observe that following the crisis in 2008, domestic OIFs withdrew deposits from Luxembourg banks. However, the scale of deposits in domestic banks was not sufficient to cover losses associated with the financial downturn. On the bank side, such an outflow of OIF deposits only contributed to reducing the aggregated balance sheet of domestic banks by 1.3% between September 2008 and September 2010 compared to a total reduction of 21.5% over the period. Although at the aggregated level, the withdrawal of OIFs from domestic banks does not seem to have impacted bank funding by much, OIF runs have the potential to affect individual banks which substantially rely on OIF short-term funding, although the risk for Luxembourg remains low.

6.4 Since the collapse of Lehman Brothers OIFs contribute more to the variations of banks' liabilities

OIFs and MMFs may contribute significantly to the variation of banks' total liabilities. The correlation coefficients of OIFs with domestic banks' total liabilities and MMFs with domestic banks' total liabilities were at 0.27 and 0.64, respectively (see chart below). By contrast, the correlation with the contribution of OIFs has become much stronger (0.52) after 2008, while MMFs are now negatively correlated with the growth rate of domestic banks' total liabilities. Therefore, OIFs are now playing a stronger role in funding domestic banks. On the one hand, the share of OIFs in bank funding has increased over the past few years, while on the other hand, the OIFs have contributed more to the variations of banks' liabilities since the 2008 crisis.

7. INDICATOR FRAMEWORK FOR MONITORING INTERCONNECTEDNESS

Activity and connections established between the banks and OIFs/MMFs require constant monitoring in order to follow their evolution over time and to detect any potential emergence of risk in the early stages. Such a monitoring approach is a key aspect of macro-prudential policy which is to reinforce the resilience of the financial system overall so as to support the provision of long-term stable funding to the real economy. The development of indicators is essential to guide the use of macro-prudential policy and take decisions as regards the activation/de-activation and the calibration of possible macro-prudential instruments.

The interconnectedness between banks and OIFs/MMFs can be measured using a wide range of indicators. Following the work carried out by the Financial Stability Board (FSB)²⁶, interconnectedness between banks and OIFs/MMFs can be measured by a credit risk indicator and a funding risk indicator. First, credit risk is measured by the ratio of assets of *i* to *j* on total asset of *i*:

$$CR_{i,j} = \frac{A_{i,j}}{TA_i}$$

where *i* and *j* are either banks or investment funds, $CR_{i,j}$ stands for credit risk for *i* vis-à-vis *j*, $A_{i,j}$ is the assets of *i* to *j*, and TA_i is the total assets of *i*. This indicator allows determining the extent of potential losses stemming from failures in one sector. Alternatively, we substitute total equity (TE) to total assets (TA) to evaluate the exposure in the light of the capacity of banks to cover potential losses resulting from a particular sector with their own funds.

Second, the funding risk is the ratio of total liabilities of *i* to *j* on the total assets of *i*:

$$FR_{i,j} = \frac{L_{i,j}}{Ta_i}$$

Where *i* and *j* are either banks or investment funds; $FR_{i,j}$ stands for funding risk for *i* vis-à-vis *j*; $L_{x,y}$ is the liabilities of *i* to *j*; and TA_i is the total assets of *i*. A similar indicator is also calculated using only short-term liabilities (overnight deposits or deposits with a maturity of less than one year) so as to determine whether liabilities can be withdrawn quickly, if needed. The higher the ratio, the more an institution is susceptible to liquidity shortages.

26 FSB (2014), « Global Shadow Banking Monitoring Report 2013 », 14 November 2014.

Finally, the size of a group of institutions is determined as follows:

$$Size_i = \frac{TA_i}{\sum_j^N TA_j}$$

In the assessment of interconnectedness risk between banks and OIFs/MMFs, we distinguish two set of indicators. The first group of indicators aims to capture interconnectedness from the domestic banks' point of view whereas the second one describes the exposures of domestic OIFs/MMFs to banks. The banking sector is decomposed into domestic banks, foreign subsidiaries and foreign branches in order to distinguish banks which follow under national regulation from those outside its scope. Finally, we show indicators for the group of 9 banks whose activities are domestically oriented. The objective is to determine the extent to which banks contributing to the funding of the real economy could be affected by negative shocks in the OIFs/MMFs sector.

Table 3:

Indicators on exposures of domestic banks to OIFs

	CREDIT RISK TA	CREDIT RISK TE	FUNDING RISK TA	SHORT TERM FUNDING RISK TA	SIZE (% OF TA)
All banks	1%	15%	14%	14%	17%
Domestic banks	1%	7%	4%	4%	2%
Foreign subsidiaries	2%	18%	16%	16%	12%
Foreign branches	0%	11%	15%	15%	2%
Domestically oriented	0%	2%	2%	2%	2%
	100%	100%	100%	100%	100%

Table 4:

Indicators on exposures of domestic banks to MMFs

	CREDIT RISK TA	CREDIT RISK TE	FUNDING RISK TA	SHORT TERM FUNDING RISK TA	SIZE (% OF TA)
All banks	0%	4%	1%	1%	17%
Domestic banks	0%	1%	0%	0%	2%
Foreign subsidiaries	0%	5%	1%	0%	12%
Foreign branches	0%	0%	2%	2%	2%
Domestically oriented	0%	0%	0%	0%	2%
	100%	100%	100%	100%	100%

Table 5:

Indicators on exposures of domestic banks to securitisation vehicles

	CREDIT RISK TA	CREDIT RISK TE	FUNDING RISK TA	SHORT TERM FUNDING RISK TA	SIZE (% OF TA)
All banks	1%	14%	0%	0%	17%
Domestic banks	0%	3%	0%	0%	2%
Foreign subsidiaries	1%	15%	0%	0%	12%
Foreign branches	1%	45%	1%	1%	2%
Domestically oriented	0%	3%	0%	0%	2%
	100%	100%	100%	100%	100%

Table 6:

Indicators on exposures of IFs and MMFs to banks

	ALL BANKS		DOMESTIC BANKS		SIZE (% OF TA)
	CREDIT RISK TA	FUNDING RISK TA	CREDIT RISK TA	FUNDING RISK TA	
All funds	19%	2%	4%	0%	80%
Equity funds	12%	1%	3%	0%	24%
Bond funds	20%	2%	3%	0%	27%
Mixed funds	16%	2%	5%	1%	19%
RE funds	10%	5%	10%	2%	1%
Hedge funds	8%	2%	4%	1%	1%
Other funds	17%	4%	6%	1%	2%
MMFs	57%	0%	4%	0%	5%
	100%	100%	100%	100%	100%

8. CONCLUSIONS


In this work we have analysed the interconnections between the domestic banking sector and market-based financing entities in Luxembourg.

The network analysis demonstrates that the exposure of domestically oriented banks toward the market-based financing entities within Luxembourg and abroad is rather limited. On the other hand, the analysis also reveals that domestic market-based financing entities are substantially more interconnected with the foreign banking sector than with domestic banks, suggesting that they remain susceptible to risks originating outside the Luxembourg banking sector.

As consistently emphasised throughout the analysis, domestic bank exposures to market-based financing entities are rather low in terms of proportion to the domestic banking sector's total assets. The exposures to OIFs seem to be on a declining trend; however we could observe a rise in activity in 2014Q4, especially in terms of exposures to domestic OIFs. Moreover, several domestic banks have considerable exposures toward the OIF sector, measured in relative terms vs. total assets or vs. total equity. In particular, the domestic banking sector has most significant ties with the bond funds as shown by the network analysis.

The exposure to bond funds in a current protracted low interest rate environment can be concerning to some extent given the rising macro risks on the back of increasing divergences between international monetary policy stances. This upward shift in interest rates could have an impact on the fund industry, in particular the bond funds, since bonds carry the highest price sensitivity to the expected yield curve swings in the current environment. Therefore, bond funds could be exposed to some risks in the event of sudden asset price shocks. The network analysis in Section 3 shows that the domestic bond and mixed funds are primarily exposed to the foreign banking sector on both sides of the balance sheet. Nevertheless, bond/mixed funds exposures toward the domestic banking sector are not negligible. Therefore, a more granular analysis on individual bond/mixed fund connections with the bank entities is warranted.

The asset exposures of the domestic banking sector to MMFs and securitisation vehicles remain relatively marginal with the exception of one bank in each of the above mentioned market-based financing entities' exposures. There is a single bank which has substantial exposure to either MMFs or securitisation vehicles. Nevertheless, neither of the two banks pose any systemic risk to the domestic banking industry given their exclusive ties to the foreign banking sector.



On the liability side, the share of OIFs in total funding of domestic banks has increased by more than 75% since 2010. The share of MMFs has declined over the same period and is now rather marginal. Domestic OIFs account for a predominant part of bank liabilities vis-à-vis OIFs (81%) and the main foreign counterpart is France (7%). OIFs mostly provide banks with short-term liquid funding which may be more susceptible to withdrawals. In the event of a large redemption of shares, managers would tend to close the most liquid position first in order to cover liquidity shortages. From that point of view, the holding of liquid assets by OIFs can be beneficial in terms of stability since it improves their ability to absorb shocks. The withdrawal of OIF funding in banks can also result from a loss of confidence in banks or if funds have to liquidate their assets in order to recover losses in case of market distress. For Luxembourg, we noted above that domestic OIFs reduced their deposits in banks following the 2008 crisis and that net capital investment had a limited impact on the stock of assets held in domestic banks.

The 28 banks receiving more than 30% of their funding from OIFs, including 7 branches, account for 21% of total assets of domestic banking sector. Among the banks not classified as branches, which are regulated by Luxembourg authorities, only 11 banks account for more than 0.5% of total assets of the domestic banking sector.

Liquidity is a central issue for the resilience of financial institutions in times of stress and for the provision of long-term stable funding to support the real economy. Although not suggested by the analysis here, there might be potential systemic consequences for the stability of the financial system in case banks' normal funding and refinancing channels fail. In such a case, macro-prudential measures may be implemented in order to prevent liquidity stress. In particular, Article 105 of the CRD IV foresees that authorities can impose specific requirements to mitigate the liquidity risk to which an institution can be exposed.

In the case of banks relying on OIF funding, a more thorough assessment should be carried out in order to determine whether these institutions maintain adequate levels of liquidity buffers as regards the potential withdrawal of funding stemming from OIFs. For instance, the behaviour of liquidity ratios of domestic banks in a scenario of a run on the bank from the OIFs should be further analysed so as to determine if individual banks may face a sudden withdrawal of a substantial amount of OIFs' deposits.