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10 February 2017

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Abstract

We study the effects of loans and mortgages securitisation on business cycles by using a large-scale agent-based stock-flow consistent macroeconomic model and simulator, that we enriched by including a financial vehicle corporation (FVC), that buys loans and mortgages from banks and issues ABSs and MBSs, and a mutual fund, that invests both in ABSs and MBSs. Households own the equity of the mutual fund in the form of equity shares. By means of securitisation, banks conduct regulatory capital arbitrage and reduce risk weighted assets in their balance sheet, in order to lend more loans and mortgages. Results show that different levels of securitisation propensity are able to affect credit and business cycles in different manners. On one side, securitisation increases banks lending activity, influencing positively investment and consumption. On the onther side, the increased amount of credit amplifies the negative shocks, due to higher loans write-offs probability, triggered by the boosted leding activity. Firms' bankruptcies impact the equity of banks, affecting their ability to grant new loans to consumption goods producers (CGPs), which need credit for their production activity, and mortgages to households, which are not able to purchase housing units. CGPs soon go bankrupt and households see their capital income reduced. The predominance of one effect on the other depends on the level of securitisation propensity and the time span considered.

Keywords: Securitisation, Business Cycle, Financial Regulation, Agent-Based Macroeconomics
JEL classification: E32, G23, C63

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1. Introduction

This work studies the impact of securitisation on credit and business cycle using a macroeconomic agent-based and stock-flow consistent model. Our aim is to show how securitisation process deeply modifies the balance sheet structure of banks with the effect of boosting lending activity, thus increasing consumption and investment, but also making the banking system less resiliant to endogeous crises, resulting in more credit rationing that trigger firms bankruptcy cascades, worsening economic performance. Increasing the securitisation propensity, the second effect prevails on the first one.

Securitisation consists in the financial practice of pooling illiquid assets, such as mortgages and loans, and transforming them into tradable securities, i.e. mortgage-backed securities (MBSs) and asset-backed securities (ABSs), more liquid than the underlying loans or receivables, which are sold to interested investors. Securitisation allows credit insitutions to remove risky assets from their balance sheets and consequently to overcome regulatory capital requirements and increase their source of funding.

In a broader view, securitisation can be considered as the core of the so-called shadow banking system, defined by the Financial Stability Board as "the system of credit intermediation that involves entities and activities outside the regular banking system" (FSB (2011)). Shadow banking system includes a multitude of actors and several layers of intermediation. Pozsar et al. (2010) describes in details shadows banks and their relationship with the traditional financial system. Shadow banking system has been listed as one of the main causes of the global financial crisis of 2007 - 2009 (Lysandrou and Nesvetailova (2014), Adrian and Shin (2010)), enhancing the efforts to find more efficient regulatory responses (see Gorton and Metrick (2010), Nersisyan and Wray (2010)).

Only few studies propose stock-flow consistent models of the shadow banking system or some of its components, focusing on the securitisation process and its role in influencing financial and real sectors. Fontana and Godin (2013) study the effects of securitisation on banks balance sheet and housing market, showing how securitisation process can lead to inflation balloons on security market driven by demand for deposits by speculative households and sales of mortgage-backed securities in the secondary market. In Bhaduri et al. (2015), authors show how securitisation expands credit and derivative trade leading to economic boom, but also increasing the fragility of the banking system, driven by the internal fragility of the finance sector arising from its growing internal scarcity of liquidity. A stock-flow consistent model that includes securitisation process is developed also by Nikolaidi (2015), pointing out that the combination of risky financial practices with wage stagnation can increase the likelihood of financial instability in a macro system. Moreover Botta et al. (2016), following a post-keynesian stock-flow consistent approach (Lavoie and Godley (2012) and Caverzasi and Godin (2015)), provide a model of shadow banking system analysing its impact on the whole economy from a macroeconomic perspective, showing how banks, before the crisis, were able to increase the issuance of mortgages while apparently keeping their financial position stable, leading to an increase in the financial instability and that securitisation process makes legislations on capital requirement not only ineffective, but also potentially counterproductive.

We study the functioning and the effects of the securitisation mechanism using the EURACE agent-based and stock-flow consistent macroceconomic simulator. We analyse the effects of the securitisation accross the whole credit cycle and the consequent impact on the business cycle. To the best of our knowledge, this is the first work that includes securitisation process in a large-scale agent-based model, characterised by several classes of economic agents that interact through differets markets, namely markets for consumption goods and capital goods, a housing market, a labor market, a credit market and a financial market for stocks and government bonds.

The main advantage of the agent-based approach is that it allows the study of the emergent aggregate statistical regularities in the economy, which are not originated by the behaviour of an "average" individual, but are the result of agents behaviour and interactions. For instance, firms are heterogeneous, among other things, in terms of degree of financial fragility. This type of heterogeneity plays a crucial role in the evolution over time of aggregate variables such as production and unemployment. Moreover, small idiosyncratic shocks at firm-level may generate single firm bankruptcies, which cause credit rationing by banks and so waves of bankruptcies among firms, then inducing large aggregate fluctuations in the economy. This process plays a crucial role when we introduce securitisation, since banks can exploit regulatory capital arbitrage to lend more, increasing the amount of credit in the economy and thus making bankruptcies more likely.

In order to study the securitisation process, EURACE financial sector has been enriched with the implementation of a financial vehicle corporation (FVC) and a mutual fund. The FVC buys loans and mortgages from banks and issues ABSs and MBSs in order to fund its purchases, while mutual fund purchases ABSs and MBSs. Banks decide the amount of credit to securitise endogenously. Being lending activity constrained by a minimum capital requirement, banks can avoid the capital constraints by selling loans or mortgages to the FVC. This is an opportunity to free up their balance sheet from credit and their related risk and, consequently, lend more.

Results show that securitisation mechanism is able to impact the business cycle. In the short run, banks securitise their assets, thus reducing the risk weighted assets and lending more loans and mortgages. Credit increases, as well as the capital income of households that receive the profits of the mutual fund in the form of dividends. Investment and consumption are influenced positively by the new credit triggered by securitisation. However, the increased amount of credit amplifies the negative shock in the medium and long run, due to higher loans write-offs probability, triggered by the boosted leding activity in the short run. Firms' bankruptcies impact the equity of banks, affecting their ability to grant new loans to consumption goods producers (CGPs), which need credit for their production activity, and mortgages to households, which are not able to purchase housing units. CGPs soon go bankrupt and households see their capital income reduced. The amplitude of securitisation impact to the economy depends on the size of the securitisation availment itself. High securitisation propensity triggers an economic boom in the short-run but increases significantly the fragility of the economy in the long run. Low amount of securitisation, instead, can have positive effects both in the short and long run.

The paper is organized as follows. Section 2 provides a summary of emprical and theoretical literature related to securitisation. In section 3, we introduce the baseline EURACE model with a particular emphasis on the single agents' and sectiorial balance sheets based on stock-flow consistency approach. In section 4, securitisation mechanism is described in details and the new EURACE agents, namely financial vehicle corporation (or special purpose vehicle) and mutual fund, are presented. In section 5 we show the results of computational experiments. Section 6 concludes the paper with final remarks.

2. Securitisation in empirical and theoretical literature

In the introduction, we have listed some stock-flow consistent models of securitisation and stated the main advantages given by the agent-based approach in order to catch some relevant effects of securitisation process. However, besides stock-flow consistent modelling approaches, an increasing attention has been paid by several empirical and theoretical studies to the securitisation activity in the last decades. In this section, we provide a survey of literature, focusing on the benefits and costs of securitisation, on the securitisation impact at micro and macro level and on the role of securitisation in the last great financial crisis, explaining how our work fits in this debate.

Securitisation market exploded during the 1980s and kept growing in next decades. In Europe, securitisation market peaked before the last great crisis, with a total of €818 billions in new asset-backed securities issuance in 2008. Demand for these assets plummeted after 2008 because of the deterioration in the rating of the collateral behind the various types of ABSs. At the end of 2016 the outstanding amount of European securitised assets was €1.5 trillion. For comparison, at its peak in 2008, the overall outstanding amount of the ABS market reached more than €2.2 trillion [1]. According to the literature, securitisation has benefits and costs. On one side, banks can use securitisation for conducting regulatory capital arbitrage, by reducing their regulatory capital requirements and lend more (Jones (2000), Ambrose et al. (2005)). Moreover, securitisation represents a useful risk management tool for banks because it provides an additional source of funds and increases banks'

[1] Data Source: Securities Industry and Financial Markets Association (SIFMA)

lending ability (see Loutskina (2011)). On the other side, securitisation enhances systemic risk, by reducing banks' incentives to screen loans ex-ante and monitoring after lending (Keys et al. (2010)). Brunnermeier and Sannikov (2014) study the full equilibrium dynamics of an economy with financial frictions. They find that securitization and financial innovations include tools that, even if designed to better manage risks at individual level, may increase systemic risk. Another source of systemic risk can be, as stated in Wagner (2007), that banks use the liquidity gained by selling and hedging loans using derivative instruments, to take more risk in primary markets, arising banking instability and the externalities associated with banking failures.

Regarding the securitisation impact at micro and macro level, so far the literature on securitisation and structured finance has been mainly focused on micro level. In particular, a lot of attention has been paid to risk-taking and transfer (Instefjord (2005), Chiesa (2008), Acharya et al. (2013)), tranching of derivative securities (Plantin (2004) and DeMarzo (2005)), the role of collaterals for fiscal (Gorton and Ordonez (2013)) and monetary policies (Singh (2013)), as well as the importance of computing margin requirements for risky collateral in the repo market including systemic risk (Lillo and Pirino (2015)).

In the aftermath of the last great crisis, the debate on the role of securitisation has been particularly lively. Demyanyk and Van Hemert (2011) study the negative role of securitisation in the deterioration of loans' quality before the last financial crisis of 2008, providing also evidence that the rise and fall of the subprime mortgage market follows a classic lending boom-bust scenario, in which unsustainable growth leads to the collapse of the market. The study of Gorton and Metrick (2012) shows, using empirical data, that securitisation led higher uncertainty about bank solvency, increasing the repo haircuts making the U.S. banking system insolvent during the last great financial crisis. Di Patti and Sette (2016) analyse italian data and show that the degree to which banks tightened credit supply to nonfinancial firms during crisis is positively related to the share of loans they securitized before the crisis, resulting in lower credit growth, higher interest rates, lower probability of accepting loan applications and inability of firms to fully compensate the negative credit supply shocks. Despite its negative facade, mainly due to the speculative purpose followed by several financial actors before the financial crisis, sustainable securitisation has been indicated as a resource of funding for firms or households (see Segoviano et al. (2013)). Moreover, Bertay et al. (2016) emphasizes the positive correlation of firms' loans securitisation with the economic activity. Among its role as source of funding, a transparent securitisation could also help investors, allowing them to diversify their portfolios in terms of risk and return, leading to lower costs of capital, higher economic growth and a broader distribution of risk (BoE and ECB (2014)). Fujii (2012) suggests regulatory solutions at individual level and extensive reporting requirements of financial institutions in order to mitigate systemic risk.

In this paper, we do not want to focus on the individual banks decisions, but we analyze how securitisation affects business cycle, trying to explain how securitisation can impact economic activity, either in a positive or negative way. The channels linking securitisation and real economy are mainly twofold (see Bertay et al. (2016) and the related literature). The first one is the change in credit volume of the economy, that can result in more consumption for households and more funds for investments for firms. However, excess use of securitisation can lead to bankruptcies and worsen economic permormance. The second one regards the credit quality, i.e. securitisation would help banks to reduce its constrains and allocate capital in the economy in a more efficient way, favoring the flows of capital to most productive firms while sharing the risk among investors. Also in this case, scholars do not completely agree. For instance, Pennacchi (1988) suggests that banks after seucritising are not interested in ensuring the good quality of the borrowers. In our model we focus on the credit volume channel and we do not pay our attention on the quality of the borrowers in banks lending decision.

3. EURACE baseline model

The EURACE agent-based model and simulator represents a fully integrated macroeconomy composed by several agents that act following behavioural rules and interact through various markets. The model was created during 2006-2009 under the FP6 European Funded Project "EURACE" and since then has been developed to date and strongly improved in the last three years under the FP7 European Funded Project "SYMPHONY"(see Teglio et al. (2015), Ozel et al. (2016), Raberto et al. (2016), Ponta et al. (2016)). In the model, agents' decision processes are characterized by bounded rationality and limited capabilities of computation and information gathering; thus, agents' behavior follows adaptive rules derived from the management literature about firms and banks, and from experimental economics literature about the behavior of consumers and financial investors.

Moreover, agents interact in different types of markets, i.e. markets for consumption goods and capital goods, labor market, credit market and financial market for stocks and government bonds. In the Eurace ABM model, markets represent the place where agents interact. Markets are based on a decentralized exchange with pairwise trading and price dispersion, except for financial market where a centralized Walrasian auctioneer operates and a single price is set at the intersection of the demand and supply curves. In decentralized markets, prices are set by agents on the supply side, by considering a mark-up on unit costs. For a detailed description of agents' behaviors about decision making hypotheses in real (consumption goods and labor) markets as well as in credit markets see Raberto et al. (2012); Teglio et al. (2010); Cincotti et al. (2012); Teglio et al. (2015).

The baseline EURACE model includes:

- *Households (HHs)*: they act as consumers and workers. Households buy homogeneous consumption goods from consumption goods producers according to their consumption budget and provide a homogeneous labour force to consumption goods producers. Households can invest in the stock and in the government bond markets. The saving-consumption decision is modelled according to the theory of buffer-stock saving behaviour, which states that households consumption depends on a precautionary saving motive, determined by a target level of wealth to income ratio (Carroll, 2001; Deaton, 1992). Households can invest their savings in the asset market, by buying and selling equity shares or government bonds. Households' portfolio allocation is modeled according to a preference structure designed to take into account the psychological findings emerged in the framework of behavioral finance and in particular of prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Households' behavior in the financial market has been thoroughly described in Raberto et al. (2008) and Teglio et al. (2009).

- *Consumption goods producers (CGPs)*: they employ labour and capital goods to produce a homogeneous consumption good according to their production plan. CGPs act as price setters in the sale markets and supply their output following a short-term profit maximizing behaviour. Prices are set considering a mark-up on unit costs. CGPs are characterized by a short-term profit objective and make production and investment plans where expected future revenues are based on backward-looking expectations determined by past sales and prices. In particular, production plans depend on past sales and the inventory stock, along the lines of the inventory management literature (Hillier and Lieberman, 1986), while sale prices are determined by a mark-up on costs (wages and debt interests), see. e.g. Plott and Sunder (1982); Fabiani et al. (2006). Investment plans depend on the cost of capital goods and the present value[2] of the additional foreseen revenues, but are limited by both by internal[3] and external financing capabilities[4]. CGPs can also borrow money from banks in order to pay production factors and make investments. They are modelled as corporations whose share are public and traded in the stock market. CGPs can also issue new share to finance their activities if rationed in the credit market. If CGPs end with a net worth (equity) below zero they are considered bankrupt. In this case the producer exits the economy, its employees are laid off, shareholders wiped-out, and its debt is partially written off causing a loss for the lending bank as well. However, a new producer of the same type enters the economy after a lag period with the physical capital inherited from the bankrupted one.

- *Capital goods producer (KGP)*: There is just one type of technology for capital goods. Capital

[2]According to empirical surveys (Graham and Harvey, 2001, 2002), the net present value is one of the most popular method used by managers to evaluate investments.

[3]Along the lines of (Fazzari et al., 2008).

[4]The pecking order theory (Myers and Majluf, 1984) is adopted to determine a hierarchy of financial sources for the firm

goods are produced on request and therefore do not generate inventories.

- *Banks (Bs)*: Banks supply loans to CGPs to finance their operations and mortgages to households that want purchase housing units, collect private sector deposits (i.e., the liquidity of all private agents) and may borrow from the central bank if in shortage of liquidity through a standing facility. Lending activity by banks is constrained by a minimum capital requirement and depends also on the evaluation of the balance sheet of the borrower. In the market for loans, CGPs apply for credit first to their preferred bank, then if rationed to another selected bank. If CGPs are rationed by both their preferred bank and by a second bank, they will be forced to cut their dividend payment. It is worth noting that, in line with the working of the banking system in a modern capitalist economy (see e.g. McLeay et al. (2014)), banks lending is not limited by the available liquidity and, whenever a bank grants a loan, a corresponding deposit, entitled to the borrower, is created on the liability side of the bank' balance sheet.

- *Government (G)*: Government is responsible for the fiscal and welfare policies. The income of the government is given by corporate tax, value-added tax, capital income tax (dividends and bond coupons) and labour tax. The tax payments are done by CGPs, KGP, banks and households and the government budget income is calculated as the sum of all tax payments. Taxes are collected on a monthly basis, while tax rates are revised yearly. Regarding government's expenditures, they include wages for households employed in the public sector, that are set as fixed percentage of the total households, unemployment benefits, transfers and repayment of the government debt (bond coupons). The government observes its budget balance (payment account M_G) every month and if $M_G < 0$ the government has a budget deficit which can be financed by issuing new government bonds, that are sold to the households. The Government computes its budget deficit once per month, but enters in the bond market on a daily basis. The reason is that if the Government enters in the bond market only once per month there is insufficient demand for the bonds, so the Government may fail to attain its liquidity target. Thus the monthly budget deficit will be financed by bonds on a monthly basis, but there is a smoothing across the month.

- *Central Bank (CB)*: The central bank is the responsible for the monetary policy. It sets the policy rate, which is the cost of liquidity provided to banks. The short-term nominal interest rate follows the Taylor rule (see Taylor (1993) for a discussion) and is set as:

$$r^{cb} = \pi + a^{\pi}(\pi - \tilde{\pi}) + a^{\upsilon}(\bar{\upsilon} - \upsilon) \tag{1}$$

where π is the yearly inflation rate for a current month, $\tilde{\pi}$ is the desired rate of inflation, υ is the unemployment rate for a current month, and $\bar{\upsilon}$ mimics the natural rate of unemployment, or the full-employment rate (that we exogenously set to 0 for simplicity). This version of the Taylor rule departs from the standard one for its use of the unemployment rate instead of the output. The two measures are strongly interconnected and the unemployment gap is certainly a satisfactory indicator of economic recession. Another role of the central bank is the provision of a standing facility to grant liquidity in infinite supply to commercial banks, when they are in short supply.

EURACE stocks and flows matrices

Each agent is characterized by a double-entry balance sheet with a detailed account of all monetary and real assets as well as monetary liabilities. Monetary and real flows given by agents' behaviours and interactions determine the period by period balance sheet dynamics. A stock-flow model is then created and used to check that all monetary and real flows are accounted for, and that all changes to stock variables are consistent with these flows (see Raberto et al. (2012); Cincotti et al. (2012) for further details). According to the "stock-flow consistency" approach used in Lavoie and Godley (2012) and post-Keynesian stock-flow consistent modeling (see Caverzasi and Godin (2015) for a survey), we present four significant matrices that provide an exhaustive description of the model. Table 1 is the agent class balance sheet, i.e. the asset and liability entries of each particular agent type. Table 2 represents the balance sheet matrix, describing all assets and liabilities for each sector (here a sector has to be seen as a class of agents). Table 3, called transaction flow matrix, shows all the stock and monetary flows among agents. Table 4, called revaluation matrix, reports for each sector the variations in the stock level that are not due to flows but to changes in the stock price.

In matrix 2 a plus (minus) sign corresponds to agents' assets (liabilities) and each column can be read as the aggregated balance sheet of a specific sector (e.g. households). Rows show assets and claims of assets among sectors, thus generally adding up to zero. Exceptions are capital and inventories, which are accumulated by CGPs, and households' equity shares, which are issued by CGPs, KGP and banks and do not add up to zero because of the difference between market price and book value.

In table 3, the current account describes the flows of revenues (plus sign) and payments (minus sign) that agents get and make. Agents are reported in the columns and monetary flows are reported in the rows. The result of agents' sector transactions is the net cash flow. The capital account section of table 3 describes the balance sheets changes related to each sector.

Money creation

The central bank has two channels to introduce new liquidity (or fiat money) into the system:

- Via loans provided to banks when they are in liquidity shortage
- Through quantitative easing operations, i.e., purchase of government bonds from households in the secondary market

In both cases, the economic agents deposit an amount equal to the new fiat money in the banking sector, generating additional liquidity that is deposited at the central bank and, in turn, generates new liquidity of the central bank that is always equal to the amount of fiat money created. This is the reason why in table 2, the difference between fiat money and central bank liquidity is always constant and equal to the initial central bank liquidity. Moreover, money supply in the economy can variate independently from the fiat money created by the central bank, because it endogenously raises every time a bank grants a new loan and it decreases when the loan is paid back. Securitisation process is able to increase the money supply through the market channel, exploiting the possibility of the banks to sell loans and mortgages to FVC that in turn issue ABSs and MBSs, sold to the mutual fund. In this way the risk related to the credit granted by the banks is shared with the mutual fund. Through the capital arbitrage, banks are able to avoid capital requirements and grant more credit, thus increasing the endogenous money supply.

Table 1: Agent class balance sheets

Agent class	Assets	Liabilities
Household *abbrev.*: HH *index*: $h = 1, \ldots, N_{Hous}$	Liquidity: M_h Stock portfolio: $\Sigma_b n_{E_{h,b}} p_{E_b} +$ $\Sigma_f n_{E_{h,f}} p_{E_f} +$ $n_{E_{h,K}} p_{E_K} +$ $n_{E_{h,D}} p_{E_D}$ Gov Bonds: $n_{h,G}\ p_G$ Housing units: X_h	Mortgages: U_h Equity: E_h
Consumption Goods Producer *abbrev.*: CGP *index*: $f = 1, \ldots, N_{Firm}$	Liquidity: M_f Capital goods: K_f Inventories: I_f	Debt: $D_f = \sum_b \ell_{f,b}$ Equity: E_f
Capital Goods Producer *abbrev.*: KGP	Liquidity: M_K	Equity: E_K
Financial Vehicle Corporation *abbrev.*: V	Liquidity: M_V Loans: $\mathcal{L}_V$ Mortgages: U_V	Asset backed securities (ABSs): ABS_V Mortgage backed securities (MBSs): MBS_V Equity: E_V
Mutual Fund *abbrev.*: D	Liquidity: M_D Asset backed securities (ABSs): ABS_D Mortgage backed securities (MBSs): MBS_D	Equity: E_D
Bank *abbrev.*: B *index*: $b = 1, \ldots, N_{Bank}$	Liquidity: M_b Loans: $\mathcal{L}_b = \sum_f \ell_{b,f}$ Mortgages: $U_b = \sum_h U_{b,h}$ $n_{E_{b,V}} p_{E_V}$	Deposits : $\mathcal{D}_b = \sum_h M_{b,h} + \sum_f M_{b,f} + M_{b,K}$ CB standing facility: $D_b = \ell_{b,CB}$ Equity: E_b
Government *abbrev.*: G	Liquidity: M_G	Outstanding government bonds value : $D_G = n_G\ p_G$ Equity: E_G
Central Bank *abbrev.*: CB	Liquidity: M_{CB} Loans to banks: $\mathcal{L}_{CB} = \sum_b \ell_{CB,b}$ Gov Bonds: $n_{CB,G}\ p_G$	Outstanding fiat money: Fiat_{CB} Deposits: $\mathcal{D}_{CB} = \sum_b M_b + M_G$ Equity: E_{CB}

Balance sheets of any agent class characterizing the Eurace economy. Balance sheet entries in the table have a subscript character, that is the index of an agent in the class to which the variable refers. In some cases, we can find two subscript characters, where the second one refers to the index of an agent in another class where there is the balance-sheet counterpart. For instance, D_f refers to the total debt of firm f, i.e. a liability, and $\mathcal{L}_b$ refers to the aggregate loans of bank b, i.e. an asset. $\ell_{f,b}$ (or $\ell_{b,f}$) refer to the loans granted by banks b to firms f. Of course, $\sum_b \mathcal{L}_b = \sum_f \ell_{b,f}$ represents an aggregate balance sheet identity, that is verified along the entire simulation. $n_{E_{h,x}}$ represent the number of outstanding equity shares of agents x held by households h. The market price of the equity shares is given by p_{E_x}. The stock portfolio's value of household h is then computed as: $\sum_x n_{E_{h,x}} p_{E_x}$. Government bonds' number and market price are given by n_G and p_G, respectively.

	Sectors								
	Non-Financial Private Agents			**Financial Private Agents**		**Banks**	**Policy Makers**		
	HHs	**CGPs**	**KGP**	**V**	**D**	**Bs**	**G**	**CB**	Σ
Housing units	$+X_H\ p_X$								$+X_H\ p_X$
Capital		$+K_F\ p_K$							$+K_F\ p_K$
Inventories		$+I_F\ p_c$							$+I_F\ p_c$
Government Bonds	$+n_G^H\ p_G$						$-n_G\ p_G$	$+n_G^{CB}\ p_G$	0
Debt / Credit	–Mortgages	–Loans				+Loans +Mortgages $-\text{Loans}_{CB}$		$+\text{Loans}_{CB}$	0
Securitised Loans				$+\text{Loans}_V$ $+\text{Mortgages}_V$		$-\text{Loans}_V$ $-\text{Mortgages}_V$			0
ABSs , MBSs				$-\text{ABS}_V$ $-\text{MBS}_V$	$+\text{ABS}_D$ $+\text{MBS}_D$				0
Private Liquidity	$+M_H$	$+M_F$	$+M_K$	$+M_V$	$+M_D$	$-D_B$			0
Banks, Government Liquidity						$+M_B$	$+M_G$	$-D_{CB}$	0
CB Liquidity / Fiat Money								$+\text{M}_{CB}$ $-\text{Fiat}_{CB}$	$+\text{M}_{CB,0}$
	$+\Sigma_f n_{E_f} p_{E_f}$	$-E_F$							$+\Sigma_f n_{E_f} p_{E_f} - E_F$
	$+n_{E_k} p_{E_k}$		$-E_K$						$+n_{E_k} p_{E_k} - E_K$
Traded Equity				$-E_V$		$+n_{E_V} p_{E_V}$			$+n_{E_V} p_{E_V} - E_V$
	$+n_{E_D} p_{E_D}$				$-E_D$				$+n_{E_D} p_{E_D} - E_D$
	$+\Sigma_b n_{E_b} p_{E_b}$					$-E_B$			$+\Sigma_b n_{E_b} p_{E_b} - E_B$
Equity	$-E_H$						$-E_G$	$-E_{CB}$	$-E_H - E_G - E_{CB}$
Σ	0	0	0	0	0	0	0	0	0

Table 2: Sectorial balance sheet matrix. Subscripts represent the index of the agent to which the stock refers. Uppercase subscripts are used when the stock refers to a whole sector, whereas lowercase subscripts are used when it refers to a single agent (for instance in the case of sums). Finally, superscript characters are introduced when the balance sheet counterpart is more than one single sector.

		HHs	**CGPs**	**KGP**	**V**	**D**	**Bs**	**G**	**CB**	**CB money creation**	Σ
Current Account	Consumption	−	+								0
	Wages	+	−	−				−			0
	Transfers	+						−			0
	Investment		−	+							0
	Taxes	−	−	−			−	+			0
	Dividends	+	−	−	−	−	−/+				0
	Securitisation Interest				+		−				0
	ABSs/MBSs coupons				−	+					0
	Bond coupons	+						−	+		0
	CB coupons payback							+	−		0
	Banks interests	−	−				+				0
	CB loans interests						−		+		0
	CB interests payback						+		−		0
		=	=	=	=	=	=	=	=		
	Net cash flow	Savings	Profits	Profits	Profits	Profits	Profits	Surplus	Seignoirage		0
Capital Account	Net cash flow	+Savings	+Profits	+Profits	+Profits	+Profits	+Profits	+Surplus	+Seignoirage		0
	Δ Loans / Mortgages	+Δ Mortgages	+Δ Loans				−Δ Loans −Δ Mortgages +Δ Loans$_{CB}$			−Δ Loans$_{CB}$	0
	Δ Issue of new shares / bonds	$-\Sigma_f p_{E_f} \Delta n_{E_f}$ $-p_{E_G} \Delta n_{E_G}$	$+\Sigma_f p_{E_f} \Delta n_{E_f}$					$+p_{E_G} \Delta n_{E_G}$			0
	Δ Securitized loans / mortgages				+Δ Loans$_V$ +Δ Mortgages$_V$		− Δ Loans$_V$ − Δ Mortgages$_V$				0
	Δ Issue of ABSs/MBSs				+ Δ ABS$_V$ + Δ MBS$_V$	−Δ ABS$_D$ − Δ MBS$_D$					0
	Δ Quantitative easing	$+p_{E_G} \Delta n^{QE}_{E_G}$								$-p_{E_G} \Delta n^{QE}_{E_G}$	0
	Δ Private Liquidity & Δ Banks' deposits	$-\Delta M_H$	$-\Delta M_F$	$-\Delta M_K$	$-\Delta M_V$	$-\Delta M_D$	$+\Delta D_B$				0
	Δ Banks/Pub. Liq. & Δ CB deposits						$-\Delta M_B$	$-\Delta M_G$	$+\Delta D_{CB}$		0
	Δ CB Liq. / Δ Fiat Money								$-\Delta M_{CB}$	+Δ Fiat$_{CB}$	0
	Σ	0	0	0	0	0	0	0	0	0	

Table 3: Sectorial transaction flow matrix of agents populating the EURACE economy

		HHs	**CGPs**	**KGP**	**V**	**D**	**Bs**	**G**	**CB**	**Σ**
Equity_{t-1}		$E_{H,t-1}$	$E_{F,t-1}$	$E_{K,t-1}$	$E_{V,t-1}$	$E_{D,t-1}$	$E_{B,t-1}$	$E_{G,t-1}$	$E_{CB,t-1}$	$E_{TOT,t-1}$
Net cash flow		+Savings	+Profits	+Profits	+Profits	+Profits	+Profits	+Surplus	+Seignoirage	0
Revaluations/ Devaluations										
	Housing units	$+\Sigma_h \Delta p_X X_h$								$+\Sigma_h \Delta p_X X_h$
	Capital		$+\Sigma_f \Delta p_K K_f$							$+\Sigma_f \Delta p_K K_f$
	Inventories		$+\Sigma_f \Delta p_c I_f$							$+\Sigma_f \Delta p_c I_f$
		$+\Sigma_f \Delta p_{E_f} n_{E_f}$								$+\Sigma_f \Delta p_{E_f} n_{E_f}$
		$+\Sigma_b \Delta p_{E_b} n_{E_b}$								$+\Sigma_b \Delta p_{E_b} n_{E_b}$
	Equity shares	$+\Delta p_{E_k} n_{E_k}$								$+\Delta p_{E_k} n_{E_k}$
		$+\Delta p_{E_v} n_{E_v}$								$+\Delta p_{E_v} n_{E_v}$
		$+\Delta p_{E_d} n_{E_d}$								$+\Delta p_{E_d} n_{E_d}$
	Bonds	$+\Delta p_G n_G^H$						$-\Delta p_G n_G$	$+\Delta p_G n_G^{CB}$	0
		=	=	=	=	=	=	=	=	=
Equity		$E_{H,t}$	$E_{F,t}$	$E_{K,t}$	$E_{V,t}$	$E_{D,t}$	$E_{B,t}$	$E_{G,t}$	$E_{CB,t}$	$E_{TOT,t}$

Table 4: Sectorial revaluation matrix of agents populating the EURACE economy.

4. Securitisation and money market creation

In order to study the securitisation mechanism, EURACE baseline model has been enriched with the addition of two agents:

- *Financial Vehicle Corporation (FVC)*: It carries out securitisation transactions. The role of FVC is the transformation of banks loans and mortgages in asset-backed securities (ABSs) and mortgage-backed securities (MBSs). In particular, banks sell to the FVC loans and mortgages that they want to put off their balance sheet. In order to fund banks' credit purchase, FVC creates pools of loans and mortgages and issues ABSs and/or MBSs.
- *Mutual fund (D)*: It represents the demand side of ABSs and MBSs. It has an initial provision of liquidity that it uses to support the securitisation mechanism throught securitised assets purchase. Together with the purchase of asset-backed securities and mortgage-backed securities, it receives the right to collect the cash flows related to the securitised credit, i.e. principals and interests. Its equity is owned by households, that receive the profit of the fund in the form of dividends.

Securitisation mechanism empowers banks to sell loans and household mortgages to the financial vehicle corporation (FVC), which can transfer them out of their balance sheet by issuing ABSs and MBSs, sold to the mutual fund. Thus banks are able to free their balance sheets from loans and mortgages and their related risk. The relevance of securitisation process in EURACE is due to the presence in the model of a realistic banks' capital requirement provision that mimics Basel II/III regulations. In particular, the amount of banks' risk weighted assets can not exceed a maximum level with respect to the equity capital, in order to have a sufficient buffer to cushion possible loans and mortgages write-offs. Thus securitisation process can be used by banks for regulatory capital arbitrage. A detailed description of the EURACE credit market and securitisation process follows.

4.1. Credit supply

Let us consider a bank b with equity E_b and risk-weighted portfolio W_b consisting of risk weighted loans $W_{b,\mathcal{L}}$ and mortgages $W_{b,U}$, such that:

$$W_b = W_{b,\mathcal{L}} + W_{b,U}. \tag{2}$$

Suppose that a consumption good producer (CGP) sends a loan request amount λ_f to the bank b. Let us assume that ω_{λ_f} is the risk weight of loan λ_f (i.e. accounts for the financial fragility of the prospective borrower); then we set ω_{λ_f} to depend on the borrower's default probability as follows:

$$\omega_{\lambda_f} = 2.5(\pi_f)^3, \tag{3}$$

where π_f represents the default probability of the borrower based on its leverage, along the lines of the Moodys KMV model (Saunders and Allen, 2010):

$$\pi_f = \frac{D_f + \lambda_f}{D_f + \lambda_f + E_f}. \tag{4}$$

Equation 3 represents a cubic function approximating the so-called Basel II internal ratings approach (see Yeh et al. (2005)). In this way, different credit ratings are assigned to different borrowers and the risks associated to their loans have different weights in banks balance sheet. Bank b is allowed to lend up to the amount $\ell_{bf} \leqslant \lambda_f$ provided that its equity (capital base) is at least a fraction k of $W_b + \omega_{\lambda_f}\ell_{bf}$:

$$W_b + \omega_{\lambda_f}\ell_{bf} \leqslant \alpha E_b, \tag{5}$$

where α is the inverse of k, i.e. $\alpha = 1/k$.

Besides CGP, households can send credit requests to banks. Whenever they enter in the housing market, they can buy house units and, in case their liquidity is lower than the offered price, they ask for a mortgage (see Ozel et al. (2016)). Let us assume that $\widehat{U}_{bh}$ is the mortgage asked by the potential borrower (household h) to the bank b. Bank b can grant the mortgage amount $\widehat{U}_{bh}$ to household h only if its capital requirement is satisfied, following the same condition expressed in equation 5 for loans to CGP:

$$W_b + \omega_{\widehat{U}_h}\widehat{U}_{bh} \leqslant \alpha E_b. \tag{6}$$

Differently from CGP loans, risk weight of household mortgages $\omega_{\widehat{U}_h}$ is assumed constant and equal to 0.5.

However, a flow control measure, namely debt-service-to-income (DSTI), checks incomes and debt payments of the household for the upcoming quarter. In particular, banks can provide mortgages only if the total mortgage payments of the applicant are lower than a DSTI ratio of his income, i.e.

$$R_{U_h} + R_{\widehat{U}_h} \leqslant DSTI(Z_l + Z_e) \tag{7}$$

where $R_{U_h} + R_{\widehat{U}_h}$ is the quarterly payments (principal and interests) related to both present mortgages U_h of household h and the new mortgage $\widehat{U}_h$. $Z_l + Z_e$ is the sum of quarterly labor and capital income after taxes.

4.2. Securitisation mechanism

As stated in the equations 5 and 6, bank's lending activity is limited by the ratio of its risk-weighted assets and equity, according to the regulatory capital requirements. The ceiling of risk-weighted assets for the bank is given by α times its equity capital, i.e. αE_b. Thus, from a regulatory prespective, the bank is constrained by the following rule: $W_b \leq \alpha E_b$. Introducing the securitisation mechanism, the bank can put off its balance sheet the amount of risk-weighted assets that exceeds the ceiling. Moreover, we want to add a behavioural rule, by considering different thresholds, computed quarterly as a fraction of the ceiling. Therefore, we introduce an exogenous securitisation propensity parameter μ. According to μ, the bank's threshold is given by $(1-\mu)\alpha E_b$. The higher the value of μ, the lower will be the threshold of the bank, resulting in more securitisation. In fact, whenever bank's risk-weighted assets exceed the threshold, the bank computes the amount S_b of risk weighted assets that it want to sell to the FVC as:

$$\begin{cases} S_b = W_b - (1-\mu)\alpha E_b & \text{if} \quad W_b > (1-\mu)\alpha E_b \\ S_b = 0 & \text{if} \quad W_b \leq (1-\mu)\alpha E_b \end{cases}$$

We define $\mathcal{L}_b$ and U_b as the amount of loans and mortgages in bank b balance sheet. The fraction of loans ($\mathcal{L}_{S_b}$) and/or mortgages (U_{S_b}) that the bank will securitise and sell to the FVC is computed as the ratio between S_b and the bank's risk-weighted assets and is uniformly distributed among bank's loans and/or mortgages. In particular, we consider three settings, depending on the type of credit securitised:

1. *Loans Securitisation (LS)*: Only loans are sold to FVC and securitised:

$$\begin{cases} \mathcal{L}_{S_b} = \left(\frac{S_b}{W_{b,\mathcal{L}}}\right)\mathcal{L}_b & \text{if} \quad W_{b,\mathcal{L}} > S_b \\ \mathcal{L}_{S_b} = \mathcal{L}_b & \text{if} \quad W_{b,\mathcal{L}} \leq S_b \end{cases}$$

2. *Mortgages Securitisation (MS)*: Only mortgages are sold to FVC and securitised:

$$\begin{cases} \mathcal{U}_{S_b} = \left(\frac{S_b}{W_{b,\mathcal{U}}}\right)\mathcal{U}_b & \text{if} \quad W_{b,\mathcal{U}} > S_b \\ \mathcal{U}_{S_b} = \mathcal{U}_b & \text{if} \quad W_{b,\mathcal{U}} \leq S_b \end{cases}$$

3. *Total Securitisation (TS)*: Both loans and mortgages are sold to FVC and securitised:

$$\mathcal{L}_{S_b} = \left(\frac{S_b}{W_b}\right)\mathcal{L}_b$$

$$U_{S_b} = \left(\frac{S_b}{W_b}\right)U_b$$

FVC funds the purchase of loans and mortgages by issuing asset-backed securities (ABSs) and/or mortgage-backed securities (MBSs). The securitised assets are then sold to the mutual fund. This process allows the bank to free its balance sheet from an amount of risk weighted asstes equal to S_b, decreasing the amount of W_b and allowing the bank to lend more, according to equations 5 and 6.

Thus new money can be created in the system by a process that does not involve only the banking sector but also the financial market through the mutual fund.

Securitization process does not involve only the credit transfer, but also the payment of the related flows. When the bank securitises credit, it computes the ratio between securitised loans (mortgages) and total loans (mortgages), i.e. $\phi_l = \frac{\mathcal{L}_{S_b}}{\mathcal{L}_b}$ and $\phi_m = \frac{U_{S_b}}{U_b}$. They represent the fractions of loans or mortgages securitised over the total loans or mortgages held by the bank b. But they also represent the fraction of interests and principals that the bank will pay to the FVC until the credit involved in the securitisation is fully paid back by the borrower (or written-off in case of borrower's bankruptcy). In turn, the FVC pays interests and principals to the mutual fund. Thus, by purchasing ABSs and MBSs, the mutual fund grants itself the right to receive the flows of payments of securitised credit. The equity of the mutual fund is owned by households to whom it pays all the interests in form of dividends.

5. Computational experiments

The results are based on Monte Carlo computational experiments, i.e. simulations were run using different seeds of the pseudorandom number generator for each scenario. We consider three different settings for securitisation, as explained in section 4:

- Loans Securitisation(LS): Only loans are securitised
- Mortgages Securitisation(MS): Only mortgages are securitised
- Total Securitisation(TS): Both loans and mortgages are securitised

Moreover, we consider four values of μ (0, 15%, 30%, 45%), thus we have a total of 12 scenarios. Simulations run for a time span of fifteen years and twenty seeds per scenario have been used, for a total of 240 simulations. We present results using time trajectories, boxplots and averages. Trajectories are presented only for one seed and for TS scenario; they provide a clear comparison of the different scenarios accross time. Furthermore, for statistical robustness, a set of boxplots is presented. They show, for three settings of securitisation (LS, MS, TS) and four values of μ (0, 15%, 30%, 45%), the distribution of economic and financial variables over the twenty seeds used to initialize the pseudo-random number generator. Boxplots report time averages and we have considered three time spans, each of them starting from year three and lasting until the end of year 5, year 10 and year 15. Therefore, time spans include 2, 8 and 13 years, respectively. In the boxplots, the top of the rectangle indicates the third quartile, the horizontal line inside the rectangle indicates the median, and the bottom of the rectangle indicates the first quartile. The vertical line that extends to the top of the rectangle indicates the maximum value, and another vertical line that extends to the bottom of the rectangle indicates the minimum value. The points inside the boxplots represent the yearly averages. Finally, simulations run for a time span of fifteen years, but for the first three years banks are not allowed to sell credit to FVC, thus there are three years of common transition phase, which we do not consider in the analysis. Simulation can diverge at the beginning of year 4, when banks can sell credit to FVC and thus the distinction among securitisation scenarios is enabled. In this way, we have a second twelve-years period, which is different for each scenario but originates from the same initial conditions. In the description of results, we refer to credit as the sum of loans and mortgages. In-BS credit represents the credit accounted in banks' balance sheet, while off-BS credit is the credit securitised and put off banks' balance sheet. Finally total credit represents the sum of in-BS credit and off-BS credit.

5.1. Regulatory capital arbitrage

Figure 1 shows in details the difference between in-BS and off-BS credit. The top panel refers to in-BS credit. It is evident that higher values of μ lead banks to sell more loans and mortgages and thus the amount of credit in their balance sheet increases less. Credit sold by banks is purchased by the FVC, transformed in ABSs and MBSs, that correspond to off-BS loans and mortgages, and sold to the mutual fund (middle panel). The sum of credits in-BS and off-BS sheet represents the total credit in the economy, shown in the bottom panel.

Figure 2 shows the ratio between off-BS credit over the total credit. The toothed patterns are determined by the timing of securitisation activation. Every quarter, banks sell credit to the FVC, increasing the amount of off-BS credit as well as its ratio with respect to the total credit. Among two quarters, the payments of credit installments decrease the amount of off-balance sheet credit, with the result of a lower value of the ratio. Higher values of securitisation propensity μ raise the amount of off-BS credit. It is worth pointing out that, as explained in section 4, also for μ equal to 0 banks can sell credit (figure 2), but they rarely do it, because their risk-weighted assets are usually lower than the ceiling. Boxplots in figure 8 show the ratio of off-BS credit and total credit also for the LS and MS settings, but the ratio is lower with respect to TS setting because only loans or mortgages are securitised, thus their amount over the total credit does not reach the same level of TS, due to the possibility that the amount of loans and mortgages in bank's balance sheet is not enough to fulfill the securitisation requests in LS and MS scenarios, expecially in the long run.

The amount of off-BS credit has a direct impact on the banks' regulatory capital. Regulatory capital refers to the capital that the banks must hold because of regulatory requirements. In our setting, the value of k is 10%, where k reppresent the capital adeguacy ratio (see equations 5 and 6). This entails that the ratio between equity and risk weighted assets shall be at least 10%, i.e. banks can lend an amount of money equivalent to maximum 10 units of equity, that results in a value of α equal to 10 in equations 5 and 6, being $\alpha = 1/k$. In our results, we do not show the ratio between equity and risk weighted assets, but the ratio between equity and credit not weighted for the risk, in order to have a more intuitive measurement of credit.

Figure 3 shows the ratio between banks' equity and in-BS credit as well as the ratio between banks' equity and the total credit. All scenarios present an equity to in-BS credit ratio equal or higher than the ratio between equity and total credit. This is straightforward since total credit is the sum of in-BS and off-BS credit. It is worth noting that, with the securitisation enabled, even if banks formally satisfy the regulatory requirements, the systemic risk exposure of the economy is different.

In fact, figure 3 highlights that the equity to total credit ratio far exceeds the limits that banks should be subject to. This means that the regulatory capital requirements work (see figure 10), but banks, through securitisation, are able to avoid the requirements and increase the credit in the economy, consequently arising the probability of bankruptcies and the systemic risk. Figures 10 and 11 give us more informations regarding the different scenarios. Even if the ratio computed in figure 10 has different values for TS, LS and MS settings, given by different behaviour of equity and credit, it is important to notice that the ratio is higher than 0.1, ecxept from the scenario with μ=45% at year 15, due to large number of bankruptcies that impact banks' equity (see boxplots in figure 20). Boxplot 11, istead, shows that the real risk exposure of economy, as measured by the ratio between banks' equity and total credit, exceed the one allowed by regulatory capital requirements in a more consistent way for higher lever of μ and higher time spans. Our results show that banks can use securitisation for regulatory capital arbitrage, in order to create more credit. The use of securitization to avoid regulatory capital requirements is supported by the literature (Gimnez Roche and Lermyte (2016), Ambrose et al. (2005), Efing (2015)). Morevover, the reduction of regulatory capital requirements on capital and the consequent capacity of banks to supply new loans can change according to business cycle condition, as we show in the following subsections.

5.2. Credit cycle

Boxplots in figures 12, 13 and 14 show the growth rates of loans, mortgages and total credit, respectively. We analyzed three time horizons, i.e. from year 3 until the end of year 5, 10 and 15, that we consider as short run, medium run and long run time periods. Boxplots indicate that loans, mortgages and credit increase more consistently for high values of μ in the short run. In the medium and long run, this is not true for the μ=45% scenario. Boxplot 14 confirms that at year 10 and 15, the growth rate of total credit is higher only for μ= 15% and 30%, while too much securitisation, i.e. μ=45%, leads to a lower growth rate at year 15. Looking at year-5 analysis, TS setting shows higher credit growth rates for increasing values of μ. That states that in the first years of economic growth (see boxplots in figures 16, 17 and 19) without bankruptcies (see boxplot in figure 20), securitisation improves the economy through the higher amount of loans and mortgages lent by banks. LS and MS settings also are characterized by higher growth rates for increasing level of securitisation, but do not reach the level of TS.

Moreover, LS shows higher growth rates compared to MS. We argue that the main reason is due to the different risk weight assigned to CGPs loans and household mortgages. As pointed out in section 4.2, banks compute the amount of credit to securitise according to the risk-weighted assets that they want to remove from their balance sheet. Banks compute the risk weight of new loans taking into account the balance sheet's debt and equity of CGPs (see equation 4), while risk-weighted mortgages are computed as the half of the mortgages value. Being the risk weight of loans usually higher than 0.5, mortgages to be securitised in the MS setting may be higher than loans in the LS one. This is relevant because there is a limit on the securitisation volume, given by the amount of credit in bank's balance sheet. In particular, applying the share of securitisation only on loans or mortgages may have the effect that banks could not securitise the amount required because not provided with a sufficient amount of loans or mortgages. The consequence is that, in the long run, banks have lower possibility to lend due to Basel II/III regulation and no possibility to securitise. The effect is a credit crunch and a high number of illiquidity bankruptcies [5].

In this work we do not focus on the effects of securitisation on the housing market and on the demand of ABSs and MBSs. We want to show the effects of different securitisation settings on banks' balance sheet. In this respect, MS and LS differ only in terms of amount of securitised assets. This amount can be relevant because, given the same value S_b, mortgages to be securitised in MS are usually higher than the loans in LS, for the reason explained above. In both cases, banks increase less their equity (according to μ) when securitisation mechanism starts, because they use the channel of FVC to lend more (see figure 15). But in the TS and LS settings, banks can bear this situation because they keep using securitisation channel, increasing the amount of off-BS credit, as shown in figure 8. In the MS case, instead, banks can not securitise as much as they need because it is possible that there are not enough mortgages in bank's balance sheet, expecially in the medium and long run. This leads an higher number of bankruptcies (figure 20) and worst economic performances (figures 16, 17, 18, 19). We refer to bankruptcies only for consumption good producers, as we have not considered a resolution mechanism in case of bank's bankrutpcy. This is not a limitation for our analysis, since negative bank's equity simply results in a credit freeze while bank try to rise its equity. A resolution mechanism would burden on taxpayers and depositors, thus reinforcing the negative economic spiral that we observe in case of high securitisation propensity and confirming our results. Anyhow, boxplot 15 shows that banks' equity on average is positive across our simulations.

Business cycle

EURACE model is able to reproduce endogenous business cycles and endogenous crises, see for instance Raberto et al. (2012). Figure 5 shows real consumption, real investment and bankrupties. Real consumption is characterised by a growth trend in the long run and recessions of different intensity followed by recoveries. During a boom period, with high growth rate and nearly full employment, the pressure on wages increments the unit costs and togheter with an high aggregated demand causes an increase in the inflation, as shown in figure 6. Consequently, the central bank, that sets the policy rate following a Taylor rule, that targets the consumption good price, raises the interest rate. Starting from year 4, securitisation is active and figure 5 shows that in the short run, i.e. at the end of year 5, securitisation propensity influences positively both consumption and investment. In figures 16, 17, 18, 19, focusing on TS, we can see that at the end of year 5, all the yearly growth rates benefit from higher values of μ.

[5]The model foresees two cases for bankruptcies, namely illiquidity and insolvency. Illiquidity bankruptcy occurs when CGP liquidity is not even suffcient to meet compulsory payments, i.e. debt service and taxes. Insolvency bankruptcy is triggered whenever the equity of CGP becomes negative and therefore involves also loan and equity write-off for lending bank (see Teglio et al. (2015) for details)

It is worth noting that the impact of securitisation to the business cycle is mainly twofold:

- Throught the credit cycle, securitisation affects the amount of loans and mortgages lent to the CGPs and households, influencing investment and consumption.
- Throught banks' and mutual fund's profit and their paid dividends to households, increasing their capital income.

During boom periods, CGPs increase their costs because higher CB rate increases interest rate payments. CGPs become more fragile (see figure 7) and crises occur when insolvency bankruptcies of CGPs are large enough to hurt banks equity. This leads to an equity contraction that causes a credit crunch that affects CGPs possibilities to refinance their debt, hitting economic activity through bankruptcy chains. Through securitisation activity, banks are able to sell credit to the FVC and thus avoid the constrains of capital requirements. This leads an increase of credit in the short run (see figures 12, 13 and 14), due to less banks' credit rationing. The consequence is an increase of economic activity, but also higher probability of bankruptcies. In fact, figure 5 shows that, starting from year 8, several bankruptcies occur for the μ=45% scenario. The consequence is a decrease in investments and thus a brake on growth.

Boxplots 16, 17, 18, 19, 20 show the main economic outputs for 3 time spans and three different settings: TS, LS and MS. TS scenario shows that in the short and medium-run, i.e. year 5 and 10, real investment level, real consumption and GDP yearly growth rates increase for higher values of securitisation propensity μ. Results are different in the long run, when the systemic risk arised by the increased amount of credit lent triggers more bankruptcies that hit banks' equity and their lending activity, resulting in more severe downturns, expecially when securitisation propensity μ is high. However, according to our computational experiments, the best economic performances are achieved by the setting with μ=15%. A low level of securitisation, according to our simulations, is the best compromise between growth and financial fragility.

The presented results highlight the relevace of securitisation process for the business cycle and the possible effects of shadow banking system on the real economy, in line with other studies on this topic. For instance, Altunbas et al. (2009) show how banks increase their lending activity using securitisation for regulatory capital arbitrage and point out, using empirical analysis, that this effect is maximised during economic expansions. We show this aspect since in our results the credit expansion is higher during the first years, where economic is growing and no crises occurs. Moreover, we show that the during economic downturns securitisation impacts negatively the busines cycle, expecially for high values of securitisation propensity. Also Peersman and Wagner (2015) analyse lending, securitisation and risk-taking shocks and find that securitisation has relevent effects on U.S. business cycle. Furthermore, Bertay et al. (2016) show the credit composition channel of securitisation, stating that coutries with more securitisation on business loans have higher economic growth, as opposed to household mortgages. Although we focus on the credit volume channel, we show that securitisation can result in more investments and thus trigger economic activity, expecially when only firm loans are securitised.

In addition to the related literature, we show that securitisation can have positive or negative effects on business cycle depending on the securitisation propensity and economic conditions. If securitisation propensity is low, it can help lending activity without overly exposing the economy, resulting in less severe economic recessions. An increase in the securitisation propensity, instead, amplifies the economic performance during growing periods, but leads to deeper economic downturns.

6. Concluding remarks

This work focuses on the study of securitisation impact on credit and business cycles usign an agent based- stock flow consistent model. For this purpose, EURACE agent-based macroeconomic simulator has been enhanced with the addition of the securitisation mechanism and new agents, namely financial vehicle corporation (FVC) and mutual fund (D).

Through securitisation, banks are able to sell loans and mortgages to FVC, that pool them and issues asset backed securities (ABSs) and mortgage backed securities (MBSs), sold to the mutual fund. A securitisation propensity (μ) has been introduced in order to study the effects of different degrees of securitisation. Quarterly, depeding on its value, banks determine the amount of risk-weighted assets to securitise. Securitisation mechanism impacts the structure of banks' balance sheet and influences the credit cycle, due to banks ability to overcome Basel II/III capital requirements.

Computational experiments' results show that in the short-run securitisation triggers a boom to the growth, but increases significantly the fragility of the economy in the long-run. The best economic performance in the short-run is given by the highest values of μ. This is not confirmed in a time span of 10 years, where scenarios with the highest μ are affected negatively by the fragility of the banking sector. In the long-run, the best scenario is given by μ=15%, that also shows better results for all simulations' time spans compared to the baseline scenario (μ=0), suggesting that a restrained securitisation can be a benefit for the economy. Higher levels of securitisation propensity, instead, cause severe crises in the long-run due to the increased financial fragility given by banks' excessive use of securitisation, leading to bankruptcies of CGPs and wealth losses of households.

Figures

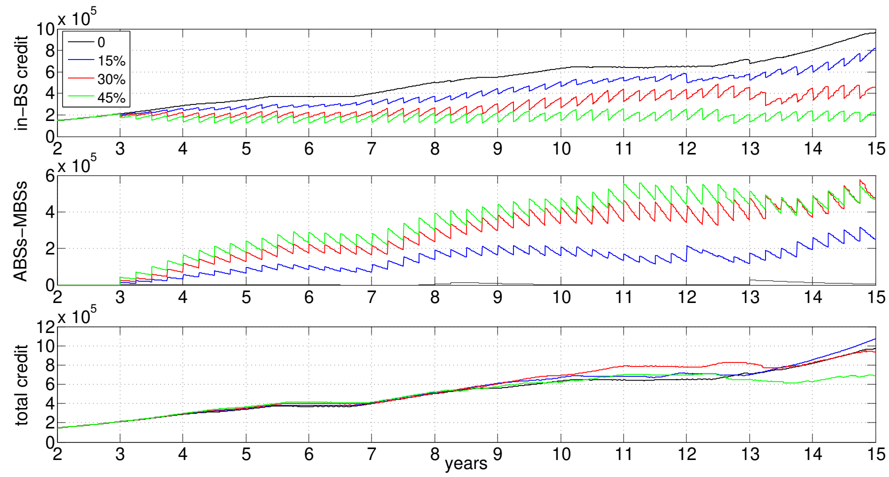

Figure 1: in-BS credit (top panel), ABSs and MBSs in mutual funds balance sheet (middle panel) and total credit (bottom panel). Four values of μ are shown: 0, 15%, 30%, 45%.

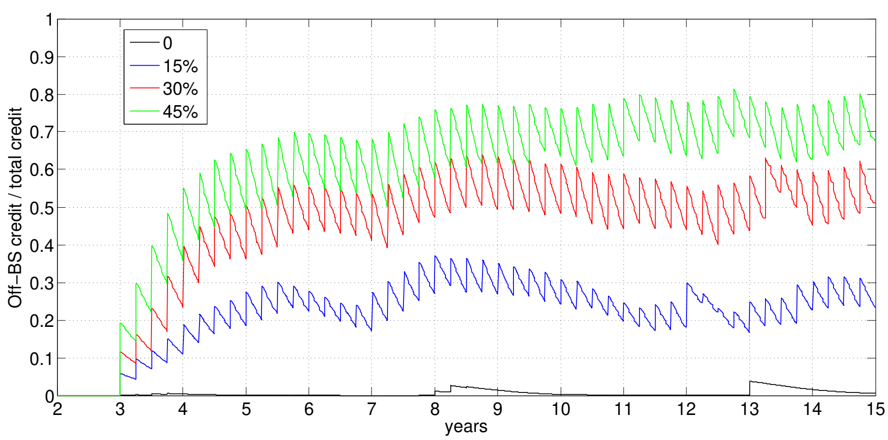

Figure 2: Off-BS credit to total credit ratio. Four values of μ are shown: 0, 15%, 30%, 45%.

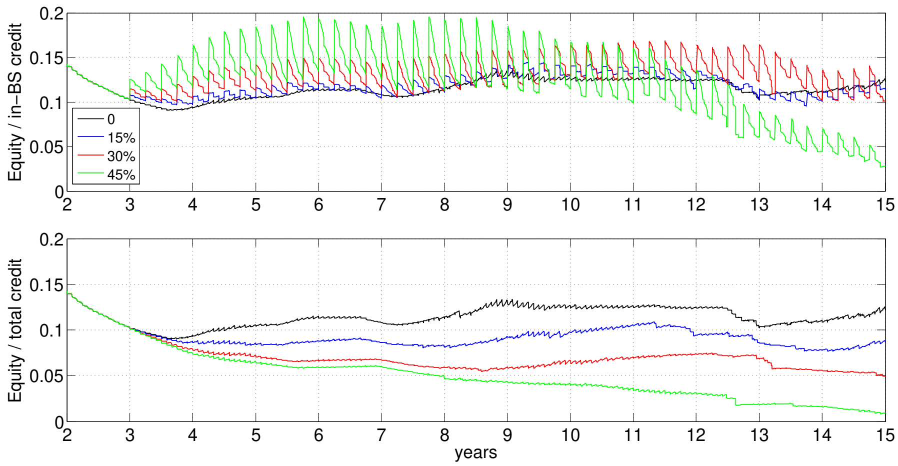

Figure 3: Equity to in-BS credit ratio (top panel) and equity to total credit ratio (bottom panel). Four values of μ are shown: 0, 15%, 30%, 45%.

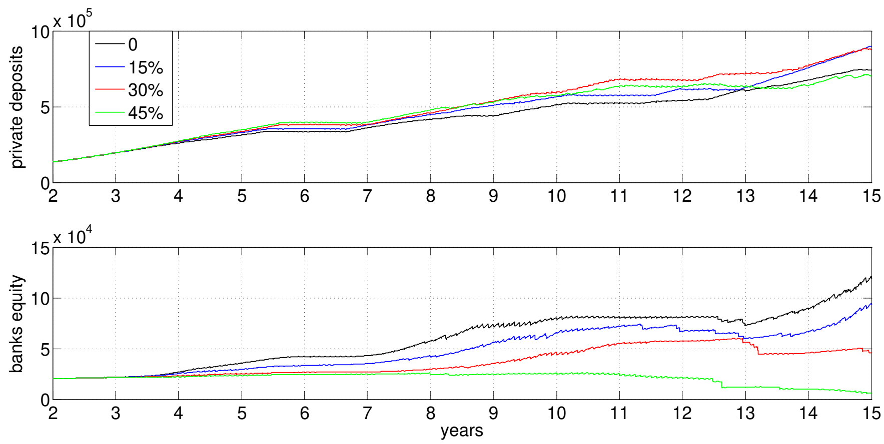

Figure 4: Private sector deposits (top panel) and banks' equity level (bottom panel). Four values of μ are shown: 0, 15%, 30%, 45%.

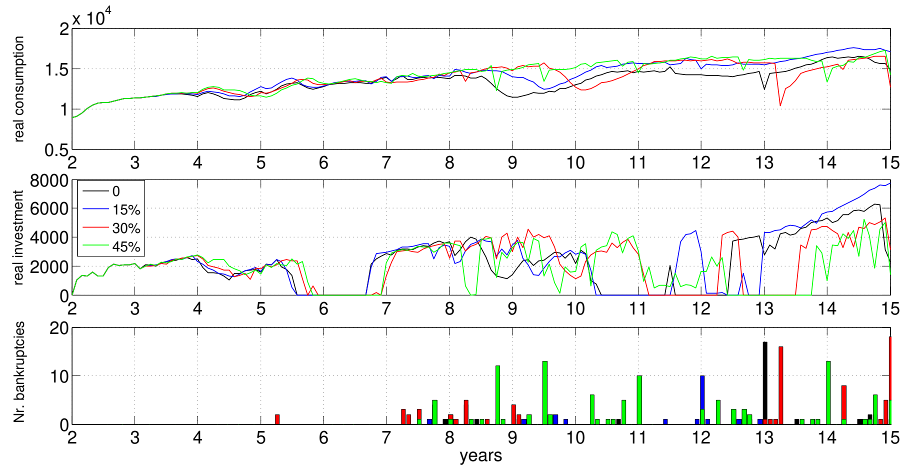

Figure 5: Real consumption level (top panel), real investments (middle panel) and number of bankruptcies (bottom panel). Four values of μ are shown: 0, 15%, 30%, 45%.

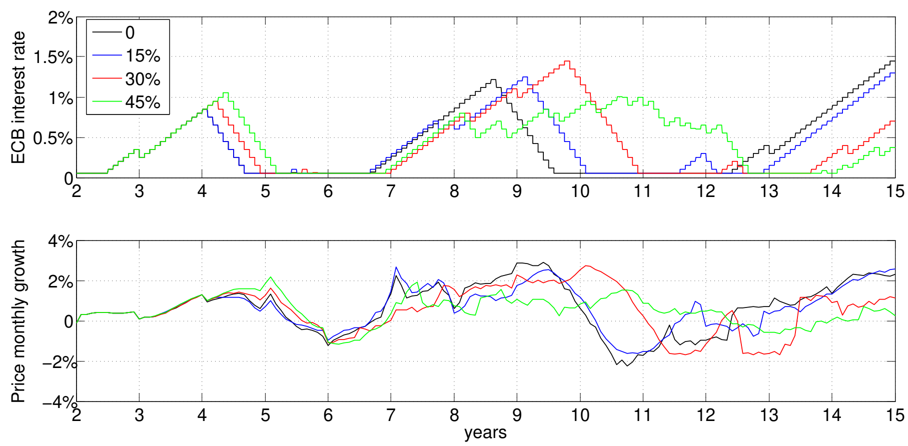

Figure 6: CB policy rate (top panel) and inflation (bottom panel). Four values of μ are shown: 0, 15%, 30%, 45%.

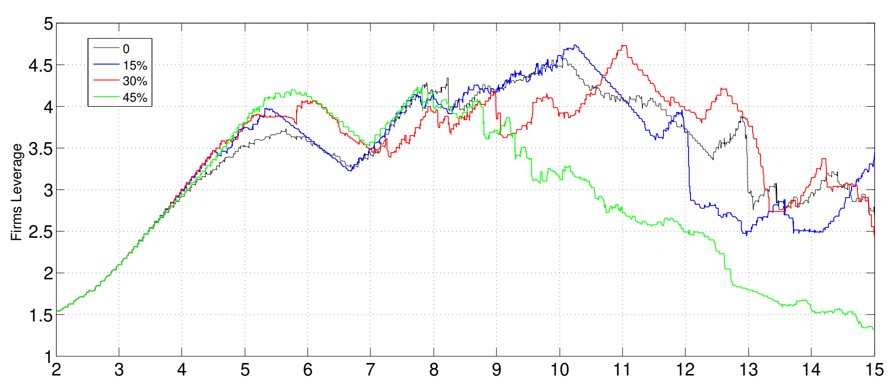

Figure 7: Firm leverage (debt to equity ratio). Four values of μ are shown: 0, 15%, 30%, 45%.

Boxplots

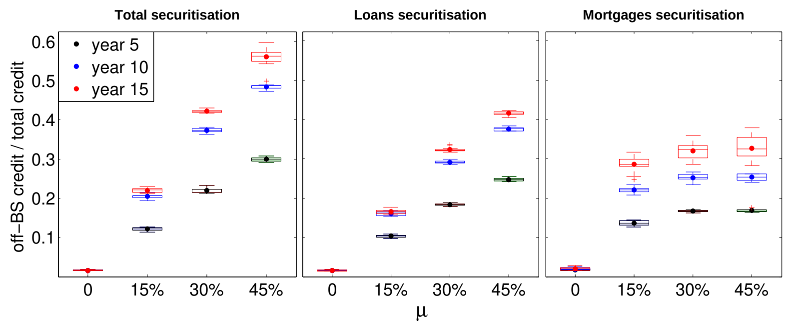

Figure 8: Boxplots and means of off-BS credit to total credit ratio, for three different time spans (5, 10, 15 years), three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

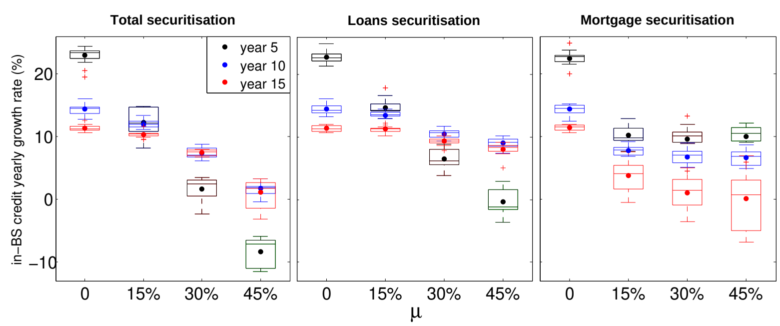

Figure 9: Boxplots and means of in-BS credit yearly growth rate, for three different time spans (5, 10, 15 years), three typologies of securitization (TS, LS and MS) and four values of μ (0,15%,30%,45%)

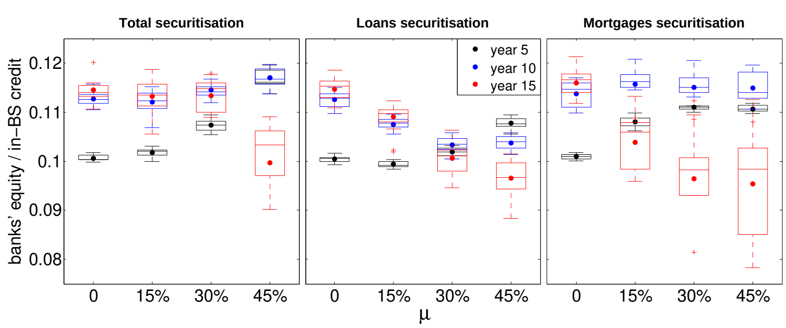

Figure 10: Boxplots and means of banks' equity to in-BS credit ratio, for three different time spans (5, 10, 15 years), three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

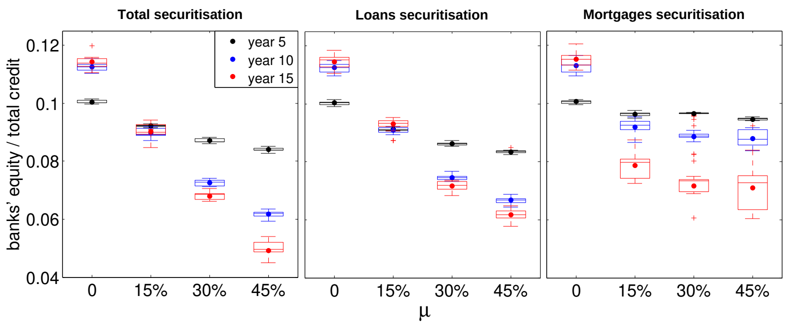

Figure 11: Boxplots and means of banks' equity to total credit ratio, for three different time spans (5, 10, 15 years), three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

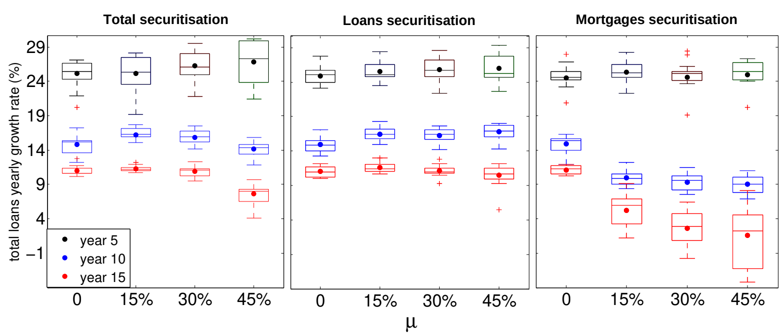

Figure 12: Boxplots and means of total loans yearly growth rate, for three different time spans (5, 10, 15 years), three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

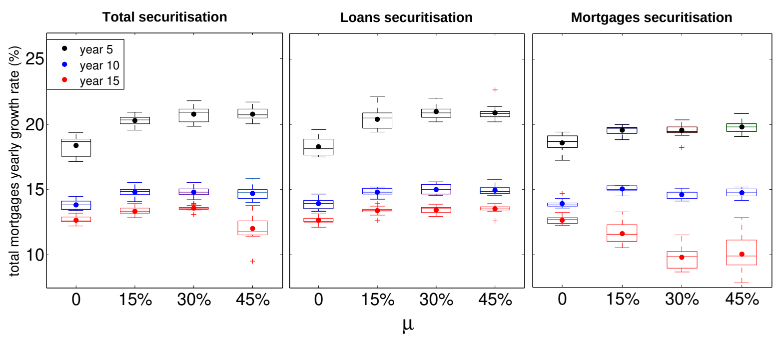

Figure 13: Boxplots and means of total mortgages yearly growth rate, for three different time spans (5, 10, 15 years), three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

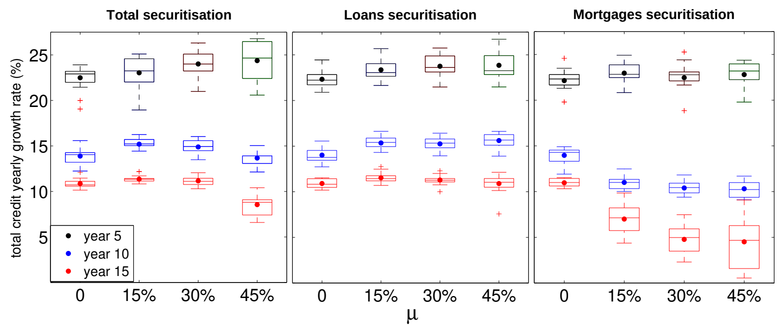

Figure 14: Boxplots and means of total credit yearly growth rate, for three different time spans (5, 10, 15 years), three typology of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

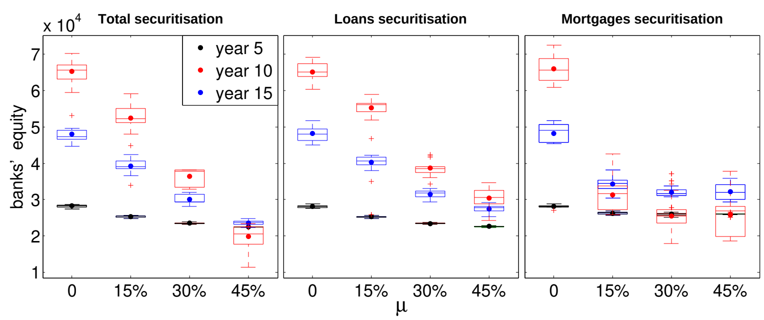

Figure 15: Boxplots and means of banks' equity, for three different time spans (5, 10, 15 years, three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

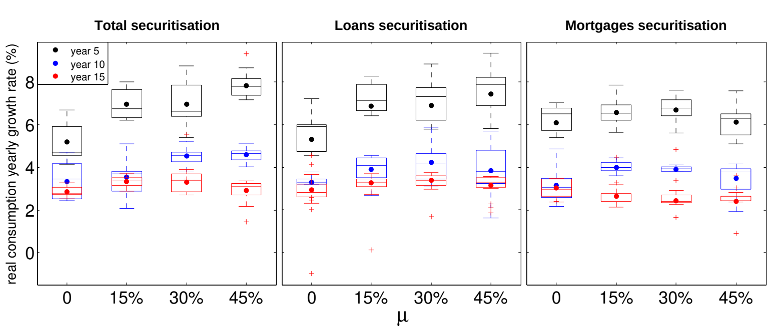

Figure 16: Boxplots and means of real consumption yearly growth rate, for three different time spans (5, 10, 15 years), three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

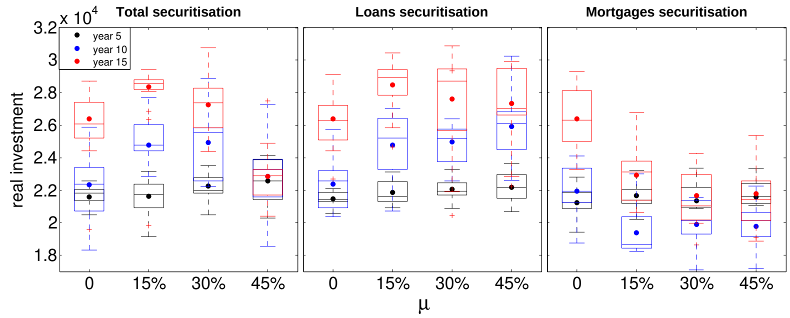

Figure 17: Boxplots and means of real investment, for three different time spans (5, 10, 15 years, three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

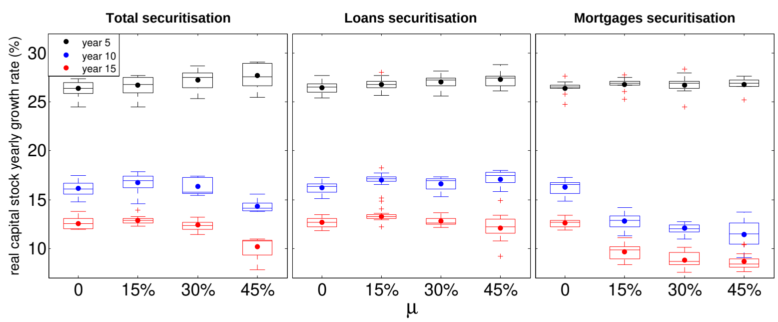

Figure 18: Boxplots and means of capital stock yearly growth rate, for three different time spans (5, 10, 15 years, three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

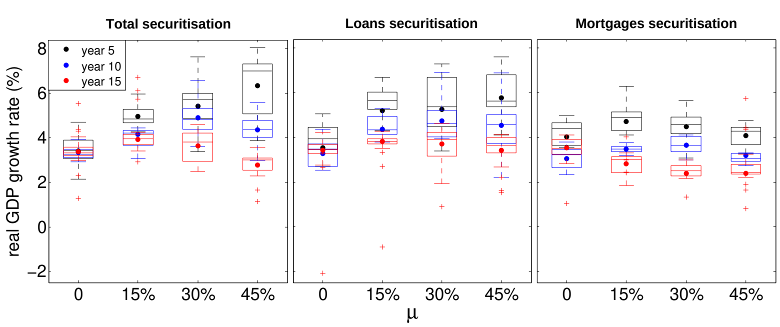

Figure 19: Boxplots and means of real GDP yearly growth rate, for three different time spans (5, 10, 15 years, three typology of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

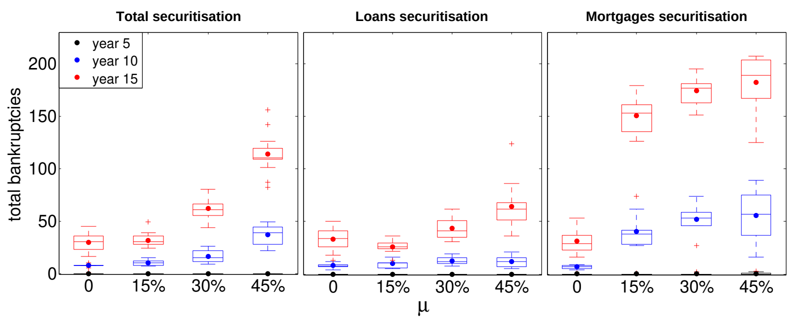

Figure 20: Boxplots and means of bankruptcies, for three different time span (5, 10, 15 years, three typologies of securitisation (TS, LS and MS) and four values of μ (0,15%,30%,45%)

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