The Aftermath of the Financial Crisis: The Effect of Deleveraging on the Real Economy

Laura Bottazzi and Anastasia Girshina

***Abstract*—This paper seeks to explain the mechanism of transmission of failures from the financial sector to the real economy. We consider the tightening of firms' financial conditions as an engine of such a transmission. In order to investigate this mechanism we construct a dynamic stochastic general equilibrium model focusing on the production side of the economy as a channel of the transition of the crisis. The debt cutting is modeled as a negative shock to the lending mechanism through an increase in the level of collateral required by financial institutions in order to provide a loan. We conclude that deleveraging might be one of the main reasons for the drop in both consumption and investment during the recent financial crisis.**

***Keywords*—De-leveraging, financial crisis, real economy, recession**

I. Introduction

THE Great Depression followed the worst financial crisis in the history of the United States and of many other countries. The Great Recession followed the second-worst stock market crash in 2008. There have been many discussions among economists on the reasons that led to such severe collapses. As a consequence, a vast range of models seeking to explain the mechanism of transmission of failures from the financial sector to the real economy has been developed.

First of all, economists stressed the regularities and the common features in the behavior of the main economic indicators during the different types of economic crises occurred in the last century. As it is shown in Hall [1], similar patterns in the behavior of the unemployment rate during crisis can be observed. Defining slumps as periods when the employed fraction of the labor force aged 25 through 54 is less than 95.5 percent Hall observes that the most serious collapses in the US economic history had followed financial crises.

In the case of the slump that began at the end of 2007 and became severer after the crisis of September 2008, the mechanism of the development of the crisis is rather clear: years of stable and rising home prices made levered positions in real-estate-related assets appear quite safe. Regulators permitted the increase in leverage, especially to investment banks and other financial entities, to be free from government guarantees. Credit became available to households, which were denied access under previous standards. The result was an increase in homebuilding and sales for consumer durables, along with the buildup of consumer debt. A totally unexpected decline in home prices conveyed the financial crisis and it led to the thin capitalization of financial intermediaries which responded with the tightening of lending standards and with the increase of the interest rate charged to borrowers. The result has been a long and deep slump. Unemployment has been a leading symptom of the poor performance of the economy. It lingered at a level around 10 percent three years after the beginning of the crisis.

Another clear indicator of the state of the economy has been the drop in the level of output. It is interesting, though, to look at the four components of the real GDP, as shown in Fig. 1: they didn't have the same dynamics after the second quarter of 2008. Indeed, net export and government purchases were barely affected by the crisis. The biggest drop, instead, was experienced by the consumption of nondurables and services and, more importantly, by the fourth component: investment, defined as the sum of consumer durables, business and residential investment.

It is a standard practice to finance investments through the financial market. Indeed, business heavily relies on it when financing investments in plants, equipment and inventories. Residential investment almost totally depends on the financial market, since both homebuilders and homebuyers finance the construction and the purchase of the houses with bank loans. The same happens to car purchases as almost all the car-buyers take out loans to buy a new car. Therefore, precisely this component of real GDP- investment -is the one strongly linked to the financial market.

Given that investment highly depends on the borrowing from the financial market - both through bank loans and on the bond markets - we find it interesting to think about some unexpected shocks to the lending mechanism as a possible source of the drop in investments.

Furthermore, as it is shown by Jermann and Quadrini in [2], not only the sharp economic downturn of 2008-09 was caused by a tightening of the firms' financing conditions, but also those occurred in the period 1990-91 and in 2001 were strongly influenced by changes in the credit conditions. Using the financial data from the Flow of Funds Accounts of the Federal Reserve, Jermann and Quadrini [2] show that equity payouts are negatively correlated with debt repurchases and that debt repurchases increase during or around recessions. Consequently recessions lead firms to restructure their financial positions by cutting debt and reducing the payments made to shareholders.

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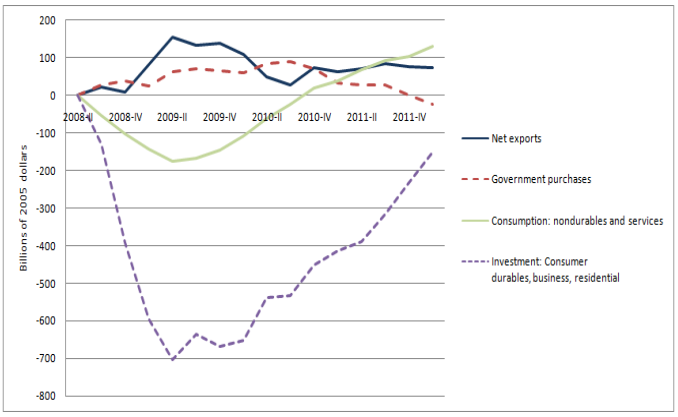

Fig. 1. Changes from the Second Quarter of 2008 in Four Components of Real GDP
Source: U.S. National Income and Product Accounts, Table 1.1.6.

Although most of the literature addresses the problem of the deleveraging of the household's sector and the effect on household consumption, we find it interesting to investigate the effect of the failures of the financial sector looking at the firm's deleveraging.

In order to do this, we construct a dynamic stochastic general equilibrium model with two sectors: households and firms. In the paper we consider a simple model with identical consumers[1] and a firm capital investment decision financed by a loan. The shock to the lending mechanism is modeled as a change in the level of collateral required by financial institutions in order to provide the loan.

The paper is organized as follows. First, we give a short overview of the recent literature on this topic. Then, we look at how investment models have made capital endogenous and have modeled credit constraint. Finally, we construct our own DSGE model with endogenous capital and a credit constraint and we calibrate a version of it with identical consumers.

II. Literature Review

The literature that considers *deleveraging* as the main channel through which shocks on the financial markets affect the real economy take two main perspectives :

- *Deleveraging from the side of households.* In this case demand shocks lead to the impossibility of smoothing consumption. The major effect observed is on the consumption of durables.
- *Deleveraging from the side of firms*. In this case the main real effect is the drop in investments.

Interestingly, both effects can be observed in Fig. 1.

There are several major papers addressing the deleveraging channel of the real effects of financial crisis.

Hall [1], [4] concentrates his analysis on such drivers of the crisis as financial frictions and agency costs. Three are the main forces that drove the economy in the real crisis:

1. the buildup of excess stocks of housing and consumer durables;
2. the expansion of consumer debt that financed the buildup*;*
3. the financial frictions that resulted from the decline in real-estate prices.

His findings are in line with those of Bernanke and Gilchrist [5]. A large decrease in the values of the asset holdings of financial institutions led to a worsening of agency problems and to a widening in the credit spreads. The diminished ability to finance the purchase of capital goods resulted in a drop in all types of investment - plants, equipment, inventories, residential constructions, and consumer durables. The situation was worsened, as shown in Hall [4], by the increase of BAA corporate bond rate that exacerbated the collapse of investment.

Philippon and Midrigan [6] provide evidence that in U.S. output and employment had declined more in regions where household leverage had increased more during the credit boom. They conclude, that a decline in home equity borrowing tightens the cash-in-advance constraint, thus triggering a recession.

From another perspective Eggertsson [7] analyzes a new-Keynesian dynamic stochastic general equilibrium (DSGE) model where he can develop, the so-called, paradox of thrift. This paradox is a situation in which an increase in interest rates drives savings up and slowdown economy. The paper investigates the problem of the lack of demand and therefore tries to explore possible spending stimulating policies. Particularly, he concentrates on taxes reduction (payroll tax, capital tax, sales tax). The results obtained in this paper are due to the hypothesis of zero-bounded interest rates: cutting taxes instead of being expansionary ends up being contractionary. At the aggregate level cutting the payroll tax leads to the decrease of employment in equilibrium (paradox of toil) and cutting capital taxes leads to the decrease of savings in equilibrium - paradox of thrift in the model with capital. Eggertsson [8], instead, considers a DSGE model with labor and, therefore, can only concentrate on the paradox of toil. There is no capital in the model he develops.

Another paper exploring the paradox of thrift is Christiano [9]. He elaborates on the model of Eggertsson and Woodford [10] and [11], predicting a downward spiral in investments in case of zero-bound environment. A shift to the right of the supply of savings, i.e. its increase, is modeled as a shock to the discount rate. In Eggertsson and Woodford [11] and Eggertsson and Woodford [10] with no capital (to which Christiano in [9] refers as to an inelastic investment case) the shock to the discount rate leads to the drop in the level of consumption in the effort to increase saving. But since investments (and therefore, savings) cannot change in equilibrium, by construction, and real interest rate is zero-bounded, a shock leads to the drop in output and employment. If investment is introduced (the investment-elastic case in the paper), the consequent reduction of interest rate is enough to offset the rise in investments and no downward spiral follows.

Yet another paper addressing the question of deleveraging

[1] Eggertsson and Krugman [3] consider two types of consumers: borrowers and savers. The model here developed could be extended to the case of heterogeneous consumers.

is Eggertsson and Krugman [3]. They investigate three paradoxes emerging in the environment of zero-bounded interest rates. The first two were already described above. They are the "paradox of thrift" and the "paradox of toil". Under the last one more willingness to work ends up reducing the amount of work being done. The third is the "paradox of flexibility": when the economy is under a large deleveraging shock, flexible prices make matters worse. Indeed, falling prices do not help to raise demand. Instead, they only raise the real value of debt and depress spending by debtors (Fisher effect [12]). In this situation for a slump to be avoided, someone must spend to compensate for the fact that debtors are spending less. A zero-nominal interest rate may not be low enough to induce the needed spending. Even though the shock lands the economy in a paradox of topsy-turvy, in which saving is vice, increased productivity can reduce output, and flexible wages increase unemployment, expansionary fiscal policy should be effective. The rise in government spending not only won't depress private spending, but it will also lead to an increased spending on the part of the consumers.

As regards the literature that considers the existence of credit constraints and their effects on firms' investment decisions some contributions need to be cited. Some of them are discussed in Bernanke and Gilchrist [5], Curdia and Woodford [13], Aiyagari [14], Kiyotaki and Moore [15], Brunnermeier and Sannikov [16], Gertler and Kiyotaki [17], Khan and Thomas [18], Buera and Moll [19], Del Negro and Kiyotaki [20], Cagetti and Bassetto [21], Goldberg [22].

Nevertheless, the papers that greatly influenced our modeling strategy are the following three.

Aghion and Banerjee [23], consider credit constrained firms operating in open economy and credit constraints are modeled in the framework of entry barriers. It is assumed that entrepreneurs are subject to borrowing constraint and that the maximum amount they can borrow is:

$$d_t \leq \mu_t \omega_t \quad (1)$$

where ω_t is firms' cash flow (or their wealth) and μ_t is a credit multiplier which could be either constant throughout the model or can depend on the real and/or on the nominal interest rate.

In Guerrieri and Lorenzoni [24] firms borrowing constraints are modelled as:

$$b_{i,t+1} \leq -\varphi_k k_{t+1} \quad (2)$$

Firms have to provide collateral, and φ_k is the fraction of capital required as a collateral. When prices decrease banks increase this fraction, which reduces firms ability to borrow. Reduction in the firms borrowing, in its turn, reduces investments, which reduces capital and, again, decreases borrowing. This process generates a spiral.

Using a different approach Jermann and Quadrini [2] consider firms that finance investments by issuing equity and/or debt. Debt is subject to an enforcement constraint, which depends on firm's lifetime profitability. Since firms can default, this enforcement constraint is exactly the source of financial frictions.

We now turn to our model.

III. The Benchmark Model with Identical Consumers

In this section we consider a simple model with identical consumers and we investigate the effect of deleveraging on the production side of the economy[2]. To study the behavior under the "paradox of thrift" [3] we introduce investments in the Eggertsson and Krugman [3] model.

The representative consumer maximizes his utility function:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t (u(C_t - \upsilon(h_t))) \quad (3)$$

subject to the resource constraint

$$B_t = (1 + i_{t-1})B_{t-1} + P_t W_t h_t - P_t C_t + T_t \quad (4)$$

We assume there exists a continuum of goods represented by the interval [0,1]. C_t is the consumption index given by $C_t \equiv [\int_0^1 c_t(j)^{(\theta-1)/\theta} dj]^{(\theta/(\theta-1))}$ where $c_t(j)$ is the quantity of good j consumed by the household in period t. P_t is the corresponding aggregate price index $P_t \equiv [\int_0^1 p(j) dj^{(1-\theta)}]^{(1/(1-\theta))}$ with $p_t(j)$ being the price of good j.

Household decides how to allocate its consumption expenditures among different goods. It, hence, maximizes the consumption index C_t for any given level of expenditures $\int_0^1 P_t(j)C_t(j)dj$. The solution to this maximization problem yields demand equations of good j $C_t(j) = \left(\frac{p_t(j)}{P_t}\right)^{-\epsilon} C_t$ for all j.

In the budget constraint W_t is the real wage rate and h_t denotes hours the household works. $P_t C_t$ are total consumption expenditures. B_t represents purchases of one-period bonds with nominal interest rate i_t, and T_t is the lump-sum component of income.

The sequence of period budget constraint satisfies the solvency condition $\lim_{T\to\infty} \mathbb{E}_t\ (B_t) \geq 0$ for all t.

To construct firms' problem we assume there is a continuum of firms and each firm produces a differentiated good $j \in [0,1]$. All firms face identical technology represented by a Cobb-Douglas production function (7). The demand for good j (6) is identical for every firm and is derived from the households' maximization problem. Further, we assume that only fraction $1 - \lambda$ of firms can change their prices freely in any period.

What is important for our model is that we assume that firms can invest (I_t) and therefore, we include capital stock (K_t) in the model. Thus, firms problem is to maximize profits subject to capital accumulation constraint (8):

[2] Given the presence of the capital in the model there are several ways to show the paradox of thrift. For example, we can do it by increasing the return on investments, or, following Eggertsson [7] by decreasing the tax rate on dividends.

[3] There are several ways to model endogeneous capital and investments. Among the papers that explore the models with endogenous capital are Eggertsson [7], Christiano [9], Koo [25], Kiyotaki and Moore [15], Krugman [26] and [27], McKinsey [28], Aghion and Scarpetta [29].

$$\max E_t \sum_{t=0}^{\infty} \varphi^t [p_t(j)y_t(j) - W_t P_t h_t(j) - P_t I_t(j)] \quad (5)$$

$$y_t^s(j) = Y_t \left(\frac{p_t(j)}{P_t}\right)^{-\theta} \quad (6)$$

$$y_t^d(j) = K_t(j)^{\gamma} h_t(j)^{1-\gamma} \quad (7)$$

$$k_{t+1} = (1-\delta)k_t + I_t \quad (8)$$

We assume that firms can invest only by borrowing.

$$I_t \leq d_t \quad (9)$$

To borrow firms have to provide collateral which is an exogenous fraction of its capital. This fraction is the source of the shock in the model.

$$d_t \leq \xi_t k_t \quad (10)$$

We assume that the shock to the level of collateral ξ follows AR(1) process:

$$\xi_{t+1} = \varphi_{\xi} \xi_t + \varsigma_{t+1} \quad (11)$$

where ς_t is an i.i.d. shock with zero mean and standard deviation σ.

Government expenditures are G_t and are aggregated according to a Dixit- Stigliz aggregator [30]. Government finances expenditures by collecting taxes T_t. Monetary policy is modeled as the choice of i_t, which follows a Taylor rule:

$$i_t = \max(0, r_t^n + \varphi_{\pi}\pi_t) \quad (12)$$

where $\varphi_{\pi} > 1$ and r_t^n is the natural rate of interest.

IV. Solution and Calibration of the Model

To analyze the effect of the increase of the collateral required by banks to supply a loan to firms on the level of investments we use numerical simulations.

In order to perform such simulation of the model we choose preferences characterized by isoelastic utility function separable in consumption and leisure.

$$U(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + \psi \frac{(1-h)^{1-\eta}}{1-\eta} \quad (13)$$

Given this specification of the utility function and assuming that in steady state prices are stable we log-linearize the first order conditions of the optimization problem around the steady state to obtain a system of equations. We solve the system and compute impulse-response functions using the MATLAB routine Gensys written by Christopher Sims.

To perform calibration we have used the following data sources:

1. Flow of Funds Accounts on consumer debt (Federal Reserve board)
2. National Income and Product Accounts (NIPA)
3. Survey on Consumer Finances (SCF)
4. Federal Reserve board for business loans
5. Survey of Professional forecasters (Philadelphia Federal Reserve Bank)

Using this data we can calibrate our model and analyze the impulse-response functions using benchmark parameters from Table 1. Following Hall [4], the economy has a single production sector with two inputs: labor and capital. It uses a Cobb-Douglas function, with a labor elasticity of 0.646. The utility function is calibrated in such a way that intertemporal elasticity of substitution is 0.5. Frisch elasticity of labor supply is set to 1.9. The rate of depreciation of capital is set to 0.0188 which corresponds to 7.5% of annual rate of depreciation of capital and fits NIPA Fixed Asset Tables. The parameter on leisure in the utility is chosen so that average hours worked for employed worker are 40% of their time endowment. The model has no economic growth, no uncertainty, and it is a closed economy. Steady-state value of output is normalized to 1. Table 1. reports calibrated values of core parameters.

TABLE I. Benchmark Calibration of the Parameters

Notation	Description	Value	Source/Target
	Preferences and technology		
γ	Share of labor in the production function	0.646	NIPA Income Share
β	Intertemporal discount factor	0.9825	Jermann, Quadrini [2]
σ	Intertemporal elasticity of substitution	0.5	Hall [4]
η	Frisch Elasticity of labor supply	1.9	Hall [4]
ψ	Coefficient on leisure in utility	12.48	Guerrieri, Lorenzoni [24]
θ	Elasticity of substitution between varieties of goods	6	Schmitt-Grohé, Uribe [31]
δ	Capital depreciation rate	0.0188	NIPA Fixed Asset Tables
	Fiscal and monetary policy		
ϕ_{Π}	Monetary policy response to inflation	1.5	Falagiarda, Marzo [32]
λ	Percentage of firms not changing their price	0.36	Woodford [33]
i	Net nominal interest rate	0.0163	Guerrieri, Lorenzoni [24]

By calibrating the model according to these parameters, we obtain the impulse – response functions shown in Fig. 2.

Fig. 2 exhibits a clear drop in capital, employment and output. The calibration results fit nicely with the graph of Fig. 1. And, not surprisingly, we see the drop in consumption.

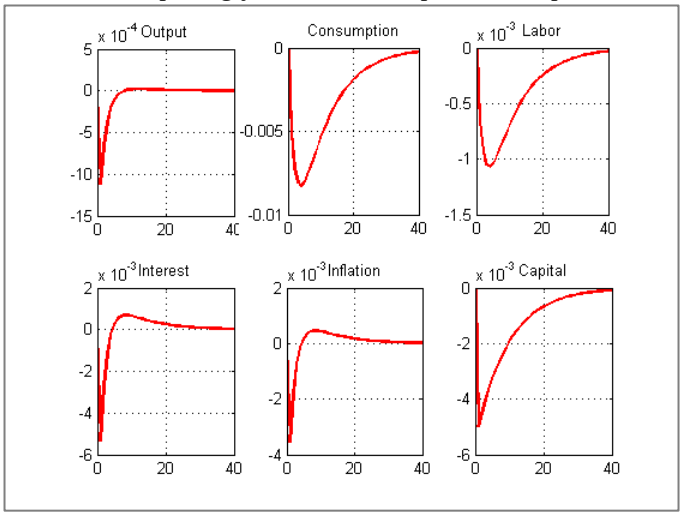

Fig. 2. Shock to the level of collateral

Our findings also go in line with a variety of empirical papers. Among these papers is Mian and Sufi [34]. They estimated that a negative aggregate demand shock driven by

household deleveraging is responsible for a large fraction of the decline in U.S. employment from 2007 to 2009. Therefore, they conclude that a high level of household debt and the associated deleveraging process are the main reasons for historically high unemployment in the U.S. economy. They also find that employment losses in the non-tradable sector are higher in high leverage U.S. counties, while losses in the tradable sector are uniformly distributed across all counties.

V. Concluding remarks

Household debt in the United States reached unprecedented levels before the onset of the recession. Economic literature strongly supports the view that the onset of the recession was driven by a series of shocks that required deleveraging of both households and firms.

As we have stated at the beginning of this paper, the main objective was to investigate the mechanism of the transition of the crisis from the financial sector to the real economy. After performing an accurate empirical analysis we conclude that firms' deleveraging process might have been one of the main reasons for the drop in both consumption and investments. In this paper we concentrate our attention on the drop in investments and on the deleveraging experienced by firms.

To perform the analyses, we have modeled an economy with household and firms, where firms are credit constrained. Indeed, by solving this model with the MATLAB routine Gensys we were able to observe both the drop in the level of investment and, as a consequence, the drop in the output that is documented in Fig. 1.

By including the capital in the model we were able to observe how the increase in the level of the collateral required by banks has led to the drop in investments, and, therefore, to the sharp reduction in the level of output.

There are several policy implications which can be drawn from the model. Firstly, an increase in spending is required to avoid a slump. Secondly, an expansionary fiscal policy should be effective: an increase in government spending would lead to the increased spending on the part of liquidity-constrained debtors. The process of recovery will depend on debtors paying down their liabilities. And, as it is pointed out in Eggertsson and Krugman [3], this process corresponds very closely to Koo's notion of a protracted "balance sheet recession".

This work provides a possibility for future research. As we have solved and calibrated only the model with identical consumers, there is room for solving the extended model with heterogeneous consumers: savers and borrowers.

Moreover, as it is shown in Hall [1], not only the drop in prices along with drop in the production of consumer durable, home-building, business structures can be observed, but also there were negative changes in both goods imported and exported. To study this effect could be a very interesting extension of the model, especially in the light of the China's slowdown.

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Laura Bottazzi is a full professor of Economics at the University of Bologna. She is research fellow of IGIER, Bocconi University, of the Fondation Banque de France and RCEA. She obtained a PhD in Economics from the Massachusetts Institute of Technology (MIT) in 1992. Prof. Bottazzi has taught at the Tinbergen Institute and has held visiting positions at the London School of Economics (1997), University College of London (1998), MIT (2001), the National Bureau of Economic Research (2002) and the World Bank (2003).

Anastasia Girshina is a PhD Candidate in Economics at the Ca' Foscari University of Venice. She obtained her MSc in Economics Degree from the University of Bologna, Italy in 2012. Dr. Girshina has held Teaching Assistant positions for graduate and undergraduate level courses for Professors Andrea Ichino and Gianluca Fiorentini in 2011.