Two-Way Causality Between Firm's Capital Structure and Business Cycles:

A Macro-Finance DSGE Model

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4. Moreover, the majority of papers that study capital structure in finance literature use a partial equilibrium approach which is not adequate for studying the two-way causality between the firm and the business cycles.
5. For modelling correctly this two-way causality, we need to use general equilibrium models. Furthermore, there are a few papers about the empirical causality from capital structure to business cycles (e.g. Korajczyk and Levy, 2003; Hackbarth et al., 2006; Daskalakis et al., 2017).

What do I do in this proposal?

I develop a macro-finance DSGE model to study how firm's capital structure influences the business cycle, and the *feedback effect* of how the business cycle affects the capital structure decision. This two-causality is studied into a model which embeds the trade-off theory of firm's capital structure in a DSGE model.

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2. In order to evaluate the conclusions of this theoretical model, I estimate the dynamic panel data model which relates the capital structure variables with business cycle variables. I use CRSP and Compustat databases for gathering data related to capital structure of firms which belong to S&P 500 index. I use the Stock and Watson database for macroeconomic data.

Literature review

1. This proposal is related to a strand of papers that embeds **corporate finance issues in macroeconomic models** to study how the firm's financial decisions could affect the real side of the economy (Carlstrom and Fuerst, 1997; Kiyotaki and Moore, 1997; Amdur, 2009; Covas and Den Haan, 2012; Brunnermeier et al, 2013; Brunnermeier and Sannikov, 2014; Katagiri, 2014, De Fiore and Uhlig, 2015; Begenau and Salomao, 2016).

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2. This paper is related to **dynamic investment models literature** (Strebulaev and Whited, 2012; Jermann and Quadrini, 2012). These kinds of models are useful to study the relationship between the firm's financing decisions and the real sector of the economy because the investment and financing decisions are both endogenous.

Model: Overview

The model is based on a dynamic stochastic general equilibrium (DSGE) model in which the decision of the firm's capital structure is endogenous. The economy consists of **three types of agents**: firms, households, and government.

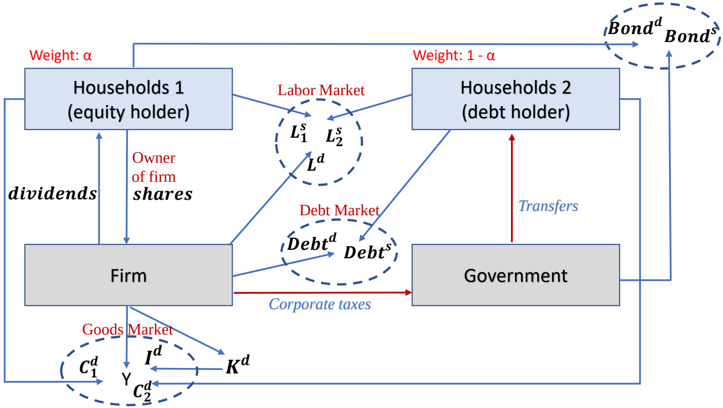

Figure: Overview of the Model

Model: Household 1 (α)

I assume that existence of a continuum of households represented by the interval $[0,1]$. A small fraction $\alpha \in [0,1]$ of these households are firm owners.

Optimization problem:

$$\max_{\{c_{1,t},h_{1,t},\tilde{b}_t,s_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t (log(c_{1,t}) + \beta_h log(1-h_{1,t})) \tag{1}$$

$$c_{1,t} + \frac{1}{1+\tilde{r}_t}\tilde{b}_t + p_t s_t = \tilde{b}_{t-1} + (p_t + d_t)s_{t-1} + w_t h_{1,t} \tag{2}$$

FOC:

$$\frac{1}{c_{1,t}} = \frac{\beta_h}{(1-h_{1,t})w_t} \tag{3}$$

labor supply

$$\frac{1}{c_{1,t}} = \beta E_t \frac{1+\tilde{r}_t}{c_{1,t+1}} \tag{4}$$

Euler equation for consumption

$$\frac{p_t}{c_{1,t}} = \beta E_t \frac{p_{t+1}+d_{t+1}}{c_{1,t+1}} \tag{5}$$

Euler equation for shares

Model: Household 2 $(1 - alpha)$

A big fraction $1 - \alpha \in [0, 1]$ of total households are **not** firm owners.

Optimization problem:

$$\max_{\{c_{2,t}, h_{2,t}, b_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t (log(c_{2,t}) + \beta_h log(1 - h_{2,t})) \quad (6)$$

$$c_{2,t} + p_t^{b,c} b_t = b_{t-1} + tr_t + w_t h_{2,t} \quad (7)$$

FOC:

$$\frac{1}{c_{2,t}} = \frac{\beta_h}{(1 - h_{2,t}) w_t} \quad (8)$$

Labor supply

$$\frac{p_t^{b,c}}{c_{2,t}} = \beta E_t \frac{1}{c_{2,t+1}} \quad (9)$$

Euler equation for consumption

Model: Firms I

1. I assume the firm's technology follows a Cobb-Douglas representation $y_t = a_t k_{t-1}^{\theta_k} h_t^{\theta_h}$ with decreasing return to scale ($\theta_k + \theta_h < 1$). With this assumption, the budget set of the owner of the firm can be affected by the firm's profit.
2. The firm's productivity a_t follows AR(1), that is, $a_t = \rho_a a_{t-1} + \mu_{a,t}$, in which the productivity shock $\mu_{a,t}$ follows a normal distribution $N(0, \sigma_a^2)$.
3. The firm's capital structure is composed of equity s_t and debt b_t. I assume the firm issues equity only one time, but the equity's price varies over time. So, I normalize s_t to one.
4. The accumulation of the capital is represented by $k_t = (1-\delta)k_{t-1}\nu_t + i_t$, in which I specify a capital shock ν_t which follows AR(1): $\nu_t = \rho_\nu \nu_{t-1} + \mu_{\nu,t}$ with $\mu_{\nu,t} \backsim N(0, \sigma_\nu^2)$. This capital shock allows us to study the real effects of firm's capital structure when the value of firm's assets suffers a negative shock.
5. Adjustment cost of capital $ac_t = \frac{\phi}{2}(k_t - k_{t-1})^2$. This assumption gives more realistic impulse-response functions.

Model: Firms II

The element $-(1-t_c)b_{t-1}$ (in d_t equation) represents the tax-shield which comes from debt. Finally, the firm maximizes the dividends d_t subject to technology, capital accumulation equation, and adjustment cost of capital.

Optimization problem:

$$\max_{\{h_t,b_t,k_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} \left[\frac{1}{1+r_j}\right] d_t \tag{10}$$

$$d_t = (1-t_c)(y_t + p_t^{b,f} b_t - (i_t + b_{t-1} + ac_t + w_t h_t)) \tag{11}$$

FOC:

$$\theta_h \frac{y_t}{h_t} = w_t \tag{12}$$

Labor demand

$$p_t^{b,f} = E_t\left(\frac{1}{1+r_t}\right) \tag{13}$$

Optimal equation for debt

$$1 + \phi(k_t - k_{t-1}) = \frac{1}{1+r_t} E_t[\theta_k \frac{y_{t+1}}{k_t} + (1-\delta)\nu_{t+1} + \phi(k_{t+1} - k_t)] \tag{14}$$

Optimal equation for the investment

Equilibrium conditions

1. In the labor market, the aggregate labor demand is compound of the labor demand of the two representative households. So, in equilibrium we have: $h_t = \alpha h_{1,t} + (1-\alpha) h_{2,t}$.
2. In the same way for the consumption, we have: $c_t = \alpha c_{1,t} + (1-\alpha) c_{2,t}$.
3. Furthermore, the equilibrium in the goods market is represented by $y_t = c_t + i_t$.
4. Additionally, the net supply of government bond is zero ($\widetilde{b}_t = 0$), and the firm's equity is equal to one ($s_t = 1$).
5. Finally, the corporate taxes are transferred to the households who are not owners of the firm. This means that $tr_t = t_c(y_t + p_t^{b,f} b_t - (i_t + b_{t-1} + ac_t + w_t h_t))$

Long-run equilibrium and calibration

1. In order to find the policy function of the model, it is necessary to specify the long-run equilibrium (or the steady state). To do that, I consider that $x_t = x_{t+j} = x_{ss}$ for all $j = 1, 2, 3....$,and for all variables. In this setting, the expectation operator does not have a role.
2. Calibration:
    - **discount factor** $\beta = 0.99675$ (it allows us to obtain an interest risk free rate in steady state equals 1.3%)
    - **the weight of leisure** in utility function $\beta_h = 2$ (King et. al., 1988)
    - **adjustment cost of capital** parameter $\phi = 0.025$ (Mendoza, 1991)
    - the parameter of **capital** in production function $\theta_k = 0.65$ (Hennessy and Whited, 2007; Begenau and Salomao, 2016) and the parameter of **labor** in production function $\theta_h = 0.2$
    - the **depreciation rate** $\delta = 0.025$ is based on NIPA depreciation (10% annually)
    - Graham (2000) suggests the corporate tax rate t_c should be 0.3
    - For preliminary results: standard deviation of **productivity shock and capital shock** are 0.0072 (Long and Plosser, 1983), and the **autoregressive coefficient** for both shocks (ρ_a and ρ_ν) is 0.7
    - the **proportion of households** who are owners of the firm is equal to 0.1 (α). I chose this small value to depict the idea that only a few households have firm's shares.

Solution technique

Perturbation Method (for current model)

The model described above can be summarized in a set of nonlinear stochastic equations. In order to solve this system, I use the Taylor approximation technique described by Uhlig (1997). The result is a set of policy functions and law of motion of state variables.

Value Function Iteration with Grid (for extended model)

Since the extensions of this DSGE model consider some no continuous function, then the value function will be no continuous too. In this case I cannot apply perturbation method because the main assumption of this method is continuity. As a result, I will use other technique called "Value Function Iteration with Grid".

Preliminary results (simulation)

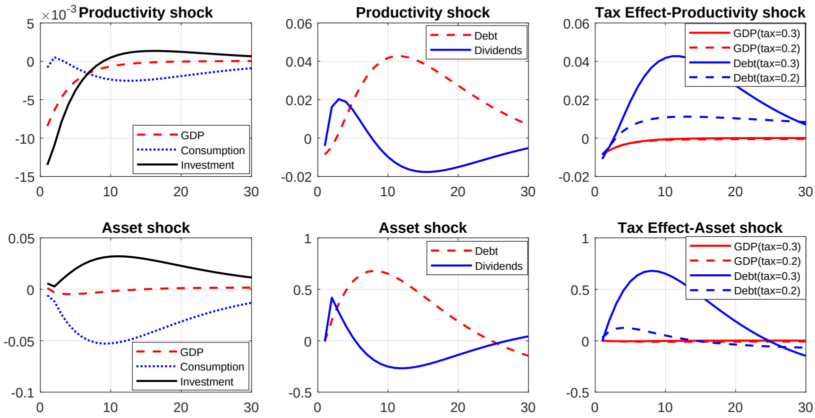

Figure: Impulse-Response Functions: productivity and asset (capital) shock

Econometric analysis

The previous DSGE model suggests important relationships between capital structure variables and business cycle variables (from policy functios). These relationships will be tested in a dynamic panel data model which is defined as follows.

$$y_{i,t} = \gamma \sum_{j=1}^{n} y_{i,t-j} + x'_{i,t}\beta + \alpha_i^* + \lambda_t + \epsilon_{i,t}$$

- For $i = 1, .., N$ and $t = 1, .., T$. α_i^* and λ_t are the (unobserved) individual and time-specific effects, and $\epsilon_{i,t}$ the error (idiosyncratic) term with $E(\epsilon_{i,t}) = 0$, and $E(\epsilon_{i,t}\epsilon_{j,s}) = \sigma_\epsilon^2$ if $j = i$ and $t = s$, and $E(\epsilon_{i,t}\epsilon_{j,s}) = 0$ otherwise.
- In order to estimate this model, I will use CRSP and Compustat databases for getting data related to firms' capital structure and Stock and Watson database for macroeconomic data. In particular, I will use data related to firms belonging to S&P 500 index.

Conclusions and next steps

Conclusion:

In this proposal, I construct a DSGE model with endogenous firm's capital structure in order to study the relationship between firm's capital structure and business cycles. The main **preliminary conclusion** is, in the absence of financial frictions, the debt plays a key role in strengthening the recovery of the economy in both shocks (productivity and asset shock).

Extensions:

1. A natural extension of this model is to embed financial frictions such as leverage restrictions on the firm's behavior
2. Another extension is to consider heterogenous firm and bankruptcy costs explicitly.

Both characteristics can help us in understanding better the relationship between capital structure and business cycle. I plan on considering these extensions in the development of this proposal.