Leverage and Capital Utilization

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ABSTRACT

I document the cyclical relationship between capital structure and capital utilization of US firms. Capital utilization affects firms' investment decisions by means of endogenous depreciation of capital stock. Furthermore, since investment is financed by mixing of cash, debt and equity, movements on capital utilization can affect capital structure by means of investment. Using a DSGE model, I explore the role of capital utilization in determining capital structure and evaluate how this mechanism responds to financial shock and marginal efficient investment shock. I find that capital utilization amplifies the effects of financial shocks, and that the investment shock is more important to explain the dynamic of real and financial variables than the financial shock.

I. Introduction

In this paper, I argue that one fundamental economic mechanism, capital utilization, has important implication for the firms' capital structure. Since the adjustment of the rate of capital utilization is an optimal response of the firm over the business cycle this should have strong implications in the firm's production and cost, therefore the composition of debt should also be affected by this mechanism.

Conceptually, capital utilization is the proportion of the physical capital which is used in every period by the firm. In other words, capital utilization captures how much of the existing capital stock is being used (Betancourt and Clague, 1981). The role of capital utilization in investment decisions can be seen in the capital accumulation equation in which an increase in capital utilization generates a higher depreciation of current capital stock. As a result the capital investment should increase to keep the original planned new capital stock. Additionally, since sources of investment are cash, debt issuance and equity issuance, movements on capital utilization can affect firms' capital structure. This relation could be seen as follow: an increase in capital utilization generates higher depreciation, which increases the investment level modifying the current level of financing sources.

I start to document the relationship between the cyclical component of the firm capital structure and capital utilization at the aggregate level. I find that the correlation between these variables is positive and significant. For instance, for the sample of 1980.I-2017.IV, the correlation between capital utilization and total liabilities is 0.54 while for debt in current liabilities is 0.49. Furthermore, when I control this relationship by firm's size, I find a complementary effect in debt in current liabilities and long-term debt for large firms. In other words, the correlation of both variables with capital utilization is positive and significant, 0.49 and 0.23 respectively. Additionally, there is a substitution effect in medium firms. That is, the correlation of debt in current liabilities is negative in contrast with the positive correlation of long-term debt. Regarding small firms, their debt composition does not react to movements in capital utilization.

Although the correlation analysis suggests some evidence on the relationship between the firm capital structure and capital utilization, it is necessary to carry out a deeper evaluation on the causality. To do this, I evaluate capital utilization in an empirical leverage model based on Frank and Goyal (2009). I find that capital utilization is statistically significant for explaining firms' leverage.

Since this empirical evidence suggests the relevance of capital utilization in determining capital structure decisions, I develop a DSGE model based on Jermann and Quadrini (2012) to evaluate how the capital utilization affects the firm capital structure. Moreover, in this setting, I evaluate how financial shocks affect financial and real variables when the firm endogenously chooses its level of capital utilization. Given that the investment shocks are important to explain the business cycle, I consider this shock in the model, as well. Under the calibration of the model, the investment shock explains more accurate the behavior of financial and real variables than the financial shock, which suggests that relevance of this shock not only in real variables but also in financial variables.

Capital utilization is one of the most important transmission mechanism of shocks, at the same time the investment shock has a key role in business cycles (Greenwood et al., 1988; Jaimovich and Rebelo, 2009). However, in spite of the relevance of both variables, they have been barely studied in financial settings. One of the few studies was done by Garlappi and Song (2017). They study how the capital utilization, market power, and the investment shock affect asset prices. One of their main conclusion is that the price of risk for investment shocks depends on the flexibility of capital utilization.

In contrast to asset pricing, the literature is silent regarding studies about firm's capital structure and capital utilization in spite of the fact that the empirical evidence suggests that this relationship is important. In this paper I attempt to make some progress to understand this relationship.

II. Facts

This section has two goals. The first is to describe the variables used in the analysis of the relationship between capital structure and capital utilization. The second is to document the cyclical relationship among them.

A. Data

The full dataset consists of quarterly COMPUSTAT data from 1970Q3 to 2017Q4 for publicly listed firms, excluding financial firms and utilities. Following Covas and Den Haan (2011), I report results for the period from 1980Q1 to 2017Q4, since it is well known that the change in the behavior of financial variables starting in the beginning of the 1980s make the window before the 80's not directly comparable.

I review four capital structure measures: liabilities, debt in current liabilities, long-term debt, and total equity which is the sum of common/ordinary equity and preferred/preference stock. These variables are studied in level given I am interested in how the behavior of the cyclical component is related to the cyclical behavior of capital utilization. Additionally, I study the behavior of five corporate finance variables: assets, liabilities and stockholders equity, stockholders equity, common/Ordinary equity, and preferred/preference Stock.

Capital utilization (or capacity utilization) is obtained from Federal Reserve Economic Data (FRED). This data is available monthly from 1967M1 to 2018M5. In order to make thi comparable with the capital structure variables, I take a sample from 1980M1 to 2017M12, and compute the quarter value as the average monthly values of every quarter. For instance, for the first quarter of 2017, there are three monthly values (from 1917M1 to 1917M3), the average of these three values is what I consider as the quarter value. Finally, all variables are seasonal adjusted and detrended using the HP filter.

B. Aggregate data

Figure 1 plots the cyclical component of four capital structure measures and the cyclical component of capital utilization. It shows that the relationship between capital structure and capital utilization has been strengthened over time. Clearly, this relationship has became stronger since 2000s, and especially during recession events such as the financial crises of 2007-2008.

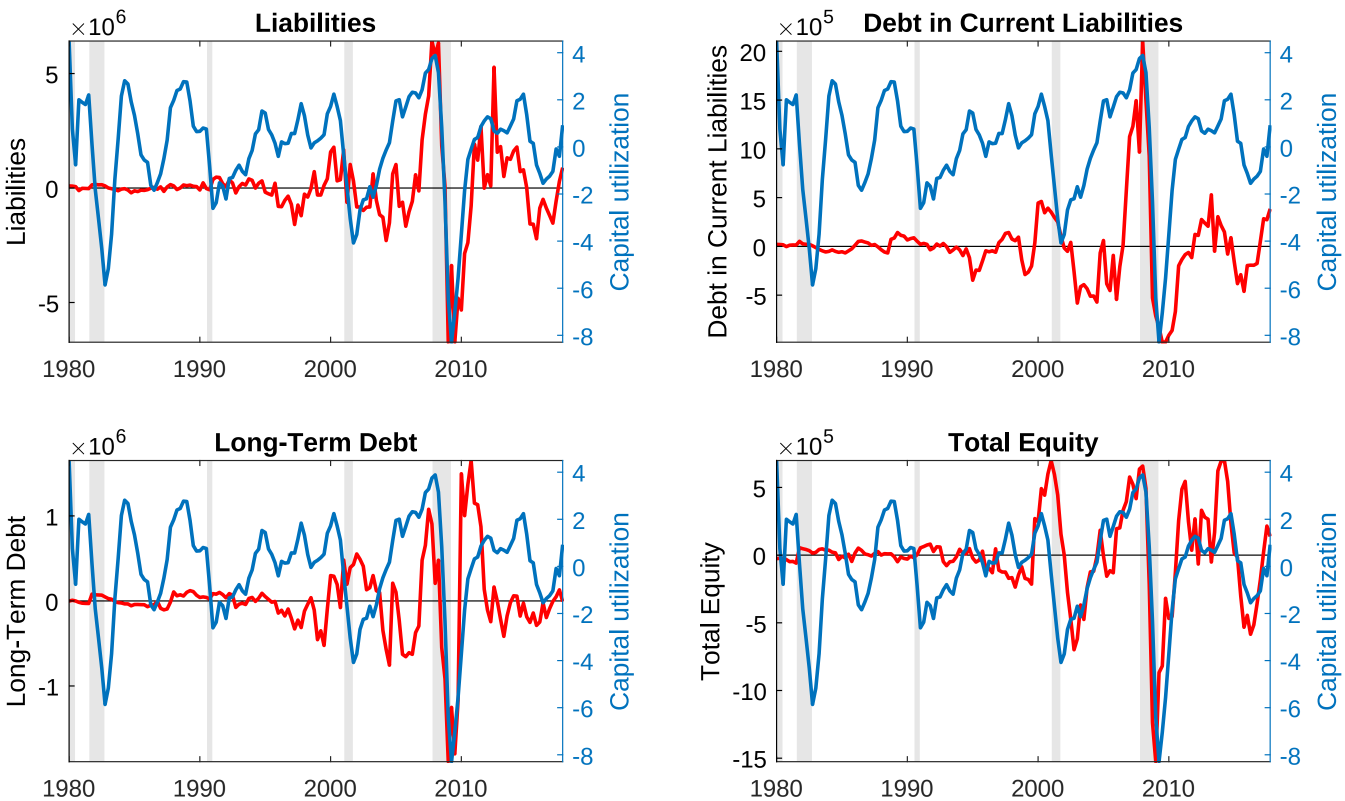

Figure 1. Cyclical behavior of capital structure and capital utilization: HP filter (quarterly data). The right axis corresponds to the cyclical component of capital utilization, and the left axis corresponds to the capital structure variables. The shaded areas are NBER recessions.

This first analysis suggests that all the capital structure measures mantain a positive correlation with capital utilization but the long-term debt. The cyclical behavior of this variable goes in the

Table I
Statistics of Cyclical Component, 1980:I - 2017:IV

Variable	Standard deviation	Corr(Variable,CapUt)	Autocorrelation
Capital Utilization (CapUt)	2.15	1.00	0.88
Capital Structure			
- Liabilities	1.69	0.54	0.74
- Debt in Current Liabilities	0.41	0.49	0.83
- Long-Term Debt	0.47	0.21	0.69
- Total equity	0.33	0.52	0.84
Asset, Liabilities, and Equity measures			
- Assets	1.98	0.57	0.75
- Liabilities and Stockholders Equity	1.98	0.57	0.75
- Common/Ordinary Equity	0.35	0.55	0.84
- Preferred/Preference Stock (Capital)	0.04	-0.66	0.83
- Stockholders Equity	0.33	0.53	0.84

All series have been seasonally adjusted by X-13ARIMA-SEATS and detrended by HP filter. Standard deviation of all variables expect Capital Utilization has a factor of 1.0e+06 because these variables are in millions US$.

opposite direction than the capital utilization, with the excepttion of the last financial crises. This could be interpreted as in normal times, the firms reduce the long-term debt when they use more intensively their capital, while in recession, long-term debt is reduced as other liabilities. Moreover, the minimum point of these variables included the capital utilization is observed during the financial crises which gives us a signal that the relationship among these variables has become stronger.

Table I provides a set of statistics of the cyclical components. It documents that the relationship between the capital structure variables and capital utilization is considerable and positive which is observed in the value and sign of the correlations. This means that when the capital utilization goes up, liabilities, debt in current liabilities, and total equity goes up as well. Moreover, The correlation with the long-term debt suggests that this relationship is positive but lower. For the assets, liabilities and the equity measures, the relationship with capital utilization is considerable and positive, as well except for preferred/preference stock where it shows a negative correlation.

As we observe in table I, capital utilization, debt in current liabilities, and total equity are all highly persistent. This issue is relevant because of the following reasons. First, this means that these variables could keep the effect of exogenous shocks over time. Second, this implies that an increase in *current* capital utilization might go on the followings quarters. Given this positive correlation with debt in current liabilities and equity, and since these variables are persistent, both variables go up not only the *current* quarter but also the following quarters. This strengths the idea of the strong relationship between the capital structure variables and capital utilization.

The previous analysis highlights the *current* relationship between the capital structure variables

Table II
Dynamic Correlation of the Cyclical Component, 1980:I - 2017:IV

	$Corr(CapUt_t, Variable_{t+j})$								
Variable\ j	-4	-3	-2	-1	0	1	2	3	4
Capital Structure									
- Liabilities	-0.13	0.07	0.28	0.46	0.54	0.55	0.49	0.38	0.25
- Debt in Current Liabilities	-0.22	-0.02	0.21	0.39	0.49	0.51	0.49	0.43	0.36
- Long-Term Debt	0.00	0.11	0.22	0.26	0.21	0.10	-0.06	-0.24	-0.37
- Total equity	0.09	0.27	0.44	0.54	0.52	0.44	0.33	0.21	0.11
Asset, Liabilities, and Equity measures									
- Assets	-0.09	0.11	0.33	0.49	0.57	0.56	0.49	0.37	0.23
- Liabilities and Stockholders Equity	-0.09	0.11	0.33	0.49	0.57	0.56	0.49	0.37	0.23
- Common/Ordinary Equity	0.11	0.30	0.47	0.57	0.55	0.46	0.35	0.22	0.11
- Preferred/Preference Stock (Capital)	-0.27	-0.44	-0.59	-0.69	-0.66	-0.56	-0.40	-0.25	-0.12
- Stockholders Equity	0.10	0.29	0.46	0.55	0.53	0.44	0.32	0.19	0.08

All series have been seasonally adjusted by X-13ARIMA-SEATS and detrended by HP filter. This table shows the dynamic correlation between the cyclical component of financial variables and the cyclical component of capital utilization. For instance, when j equals 0, this means contemporaneous correlation $Corr(CapUt_t, Variable_t)$. In the same way, when j equals 1, this means the correlation between a financial variable lead one period (quarter) $(t + 1)$ and the current period capital utilization (t): $Corr(CapUt_t, Variable_{t+1})$.

and capital utilization. However, given the dynamic behavior of the economic variables, it is worth noting the *dynamic* relationship between them. Table II reports the dynamic correlation of the cyclical component of capital structure and capital utilization. This documents that liabilities, debt (current and long-term), and equity have important dynamic relationships with capital utilization. Liabilities shows significant and positive correlation until three quarters after the increase of capital utilization. Debt in current liabilities shows almost the same but until the fourth quarter. Both liabilities and debt in current liabilities have the strongest correlation in the first quarter after a movement in capital utilization. This suggests that the firm requires more liquidity to finance the operating cost generated by increasing the capital utilization ratio. Furthermore, both variables, liabilities and debt in current liabilities, increase in the previous quarter before the capital utilization goes up. This change in liabilities is due to the necessity to finance the expected intensive used of capital in the following quarter.

Another result to highlight in table II is that long-term debt shows a monotonic decreasing correlation over the followings four quarters. This correlation turns out to be negative since the second quarter, which could suggest the firm will reduce its long-term obligations when it experiments an increase in the current capital utilization.

C. Controlling by size of firm

It is well known the size of the assets has a key role in the behavior of firms' capital structure (Gonzalez and Gonzalez, 2012; Kurshev and Strebulaev, 2015). To study how the size of the assest might affect the relationship between the capital structure variables and capital utilization I categorize firms under three approaches. The first is based on Covas and Den Haan (2011), who considers two ways to clasified firms: the first one consists to split the set of firm in seven categories, and the second one consists to split it up in two categories without taking into account large firms. They show that cyclical results are the same when considering acyclical definition of firm groups or the true percentiles to define firm groups. I follow the latter, that is, I compute percentiles of assets for every quarter to construct firm groups. The second approach is based on Frank and Goyal (2003), who considers small firms are those with assets below the percentile 33 in each period, and large firms are those with assets above the percentile 33. The last approach splits up the sample in three groups: small, medium, and large firms. The first group is the same of Frank and Goyal (2003), the second one considers firms with assets between the percentil 33 and 75, and the last group considers firms with assets above percentile 75.

Table III reports the correlation of the cyclical component of the capital structure variables with capital utilization controling by size categories. As documented in this table, small firms has a different cyclical pattern of capital structure than large firms for the three approaches. The magnitude of the correlation for debt in current liabilities is greater for firms that belong to the range $[99, 100]$ in the first approach), $[33, 100]$ in the second approach), and $[75, 100]$ in the third approach. In contrast, for small firms the correlation is lower, even negative for two groups, under the first approach. This suggests that when capital utilization increases, small firms reduce their debt in current liabilities, but larger firms increase it.

What happens with the relationship between the capital structure variables and capital utilization when we consider dynamic correlation? Some interesting features appear when the dynamic setting is considered. Figure 2 plots the dynamic correlation between the cyclical component of capital structure and the cyclical component of capital utilization, controling by the size of firms. Three remarkable patterns can be seen in the figure 2. First, the capital structure variables of small firms has lower correlation with capital utilization. Although, the correlation of debt in current liabilities increases continuously for three quarters, this keep in lower levels. Second, it seems that medium firms reduces its debt in current liabilities when they expect an increase in capital utilization in the following quarters. In contrast, long-term debt increases after a positive change of capital utilization.

Third, large firms keep high correlation between debt in current liabilities and capital utilization for three quarters after the increase in capital utilization. The magnitude of this correlation is the greatest from the three group of firms. Furthermore, there is a substitution effect between debt in

Table III
Cyclical Behavior of Capital Structure, 1980:I - 2017:IV

	Correlation of Capital Utilization with:			
Size classes	Liabilities	Debt in Current Liabilities	Long-Term Debt	Total Equity
$[0, 25]$	0.23	0.08	-0.08	0.26
$[25, 50]$	0.10	-0.29	0.16	0.51
$[50, 75]$	0.30	-0.16	0.22	0.57
$[75, 90]$	0.20	0.08	0.07	0.60
$[90, 95]$	0.34	0.29	0.01	0.47
$[95, 99]$	0.23	0.32	-0.20	0.51
$[99, 100]$	0.57	0.49	0.23	0.24
$[0, 95]$	0.33	0.20	0.08	0.61
$[0, 99]$	0.30	0.31	-0.08	0.58
All firms	0.54	0.49	0.22	0.49
Small and Large firms				
$[0, 33]$	0.23	0.02	-0.03	0.29
$[33, 100]$	0.54	0.49	0.22	0.49
Small, Medium, and Large firms				
$[0, 33]$	0.23	0.02	-0.03	0.29
$[33, 75]$	0.27	-0.21	0.22	0.58
$[75, 100]$	0.54	0.49	0.21	0.47

All series have been seasonally adjusted by X-13ARIMA-SEATS and detrended by HP filter.

current liabilities and long-term debt: while the former increases, the latter decreases monotonically.

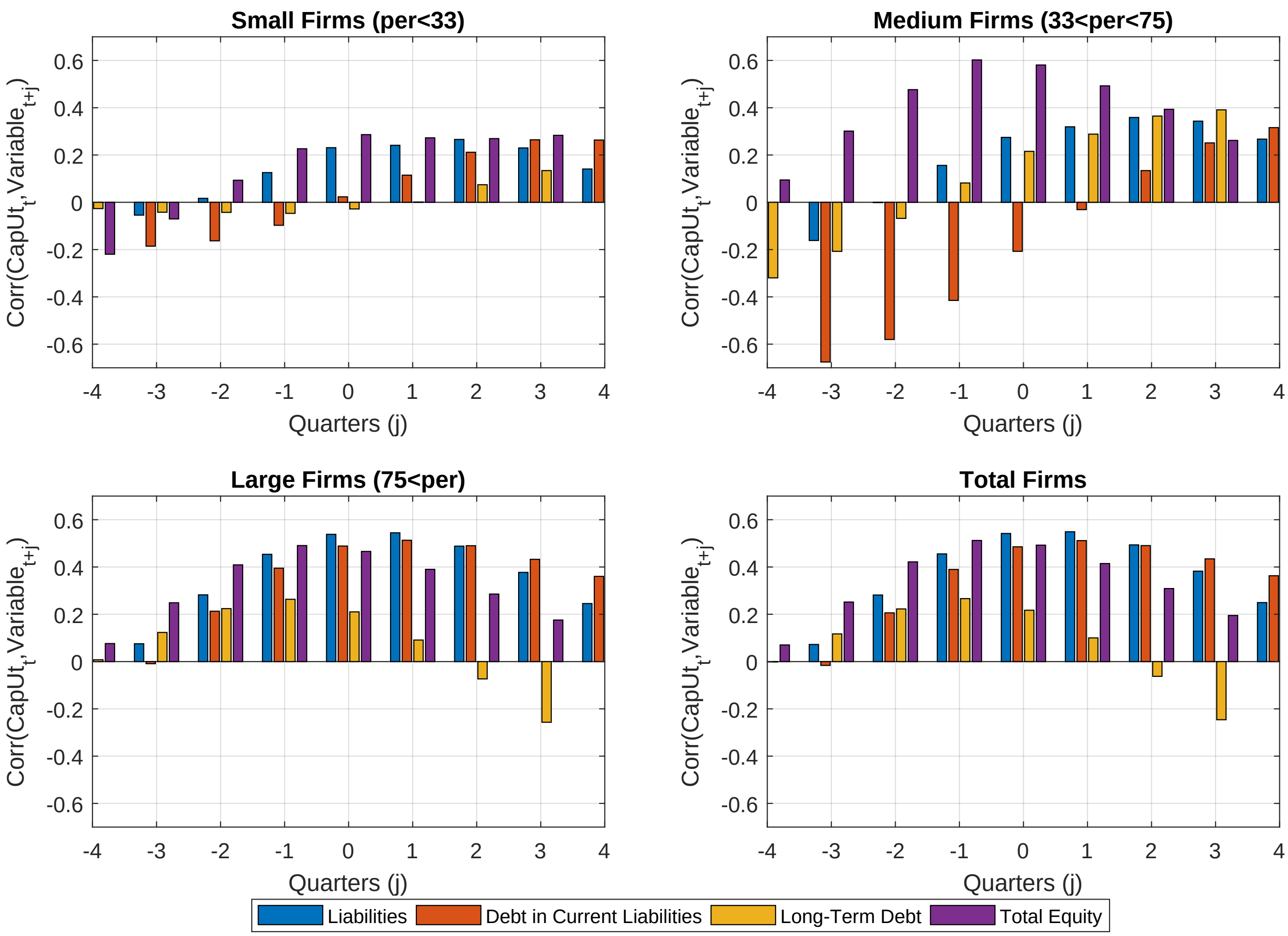

Figure 2. Dynamic correlation between the cyclical component of capital structure and the cyclical component of capital utilization by size of firm (1980:I-2017:IV). All series have been seasonally adjusted by X-13ARIMA-SEATS and detrended by HP filter. This table shows the dynamic correlation between the cyclical component of capital structure and the cyclical component of capital utilization. For instance, when j equals 0, this means contemporaneous correlation $Corr(CapUt_t, Variable_t)$. In the same way, when j equals 1, this means the correlation between a financial variable lead one period (quarter) $(t + 1)$ and the current period capital utilization (t): $Corr(CapUt_t, Variable_{t+1})$.

D. Empirical Evidence of the relevance of capital utilization

The correlation analysis in the previous section suggests the dynamic relationship between firm's capital structure and capital utilization even when the size of the firm is considered. The natural question that emerged from that analysis is about the existence of statistical evidence about the relevance of capital utilization in determining capital structure. Based on Frank and Goyal (2009), I introduce capital utilization in a set of reliable variables which explain capital structure. I then regress three definitions of leverage to these variables by OLS technique. In doing so, I find the capital utilization is statistical significant as the proposed variables by Frank and Goyal (2009).

Table IV
Model of leverage, 1980:I - 2017:IV

	Total Debt/Asset (t)	Long-term debt/Asset (t)	Current liabilities/Asset (t)
Constant	0.2985*	0.2630*	0.0292
	(0.0404)	(0.0165)	(0.0352)
Capital utilization (t-1)	0.0021*	-0.0010*	0.0030*
	(0.0004)	(0.0002)	(0.0004)
Size (t-1)	-0.0497*	0.0073*	-0.0540*
	(0.0058)	(0.0010)	(0.0051)
Income ratio (t-1)	-10.3175*		-9.7892*
	(1.1033)		(0.9602)
Growth (t-1)	0.0009*		0.0010*
	(0.0003)		(0.0002)
Adjusted R^2	0.511	0.4651	0.6931
Observations	151	151	151

*Significant at the 0.01 level

All series have been seasonally adjusted by X-13ARIMA-SEATS. *Size* is the log of ratio of total asset to GDP, *growth* is the annual growth of assets by quarter, and *income ratio* is the operating income before depreciation.

The result are shown in table IV.

Two results stand out from the regression in table IV. First, capital utilization has positive sign when the numerator of leverage is defined as current liabilities which contains short-term debt. In contrast, when the numerator is long-term debt, the sign of capital utilization is negative. This result is consistent to the previous correlation analysis and suggests the firm prefers to increase its short-term debt and to reduce long-term debt when it experiments a higher capital utilization. Second, in absolute value, the magnitude of the coefficient associated to capital utilization is the highest when the numerator of leverage is current liabilities. This suggests that capital utilization has a key role in short-term debt.

III. A Model with Capital Utilization and Capital Structure

I introduce capital utilization and a shock to marginal efficiency of investment (MEI) in a Real Business Cycle model with financial frictions. The economy is populated by representative firm and household.

A. Firms

I assume the firm's technology follows a Cobb-Douglas representation $F(z_t, k_t, h_t, n_t) = z_t(h_t k_t)^\theta n_t^{1-\theta}$ where the production inputs are stock of capital k_t, which is determined in the previous period, capital utilization h_t, and labor n_t. This function, $F(z_t, k_t, h_t, n_t)$, represents firm's revenue as well. Furthermore, the firm's productivity z_t follows an AR(1) process, that is, $ln(z_t/z_{ss}) =$

$\rho_z ln(z_{t-1}/z_{ss}) + \mu_{z,t}$, in which the productivity shock $\mu_{z,t}$ follows a stochastic behavior.

Capital Structure. 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. As a result, the variable which represents the capital structure is debt b_t. The maturity of debt is one period (quarter), then it could be considered as short-term debt.

Accounting equations. Earning before interest and taxes (EBIT) is expressed as revenue minus labor cost $EBIT_t = F(z_t, k_t, h_t, n_t) - w_t n_t$. Furthermore, the profits are the available resources after taxes from the difference between EBIT and debt payment included the principal $\pi_t = (1-\tau)[EBIT_t - R_{t-1}b_{t-1}]$ where R_t is the gross interest rate $R_t = 1 + r_t$. It is worth noting taxes produce tax-shield by means of interest debt as it claims to the trade-off theory. Two accounting equations are special in the model. First, retained earnings is the result of the difference between profits and the payment of dividends which includes the adjustment cost of dividends. This relation is expressed as $RE_t = \pi_t - \varphi(d_t)$. The functional form of adjustment cost of dividends is based on Jermann and Quadrini (2012) and its representation is as follows $\varphi(d_t) = d_t + \kappa(d_t - d_{ss})^2$, where d_t represents dividends and d_{ss} is the steady state value of dividends. Second, the financing investment conditions requires that investment will be financed by means of retained earnings and new debt: $i_t = RE_t + b_t$.

Capital utilization and MEI shock. The firm invests to accumulate new capital or assets for the next period. The accumulation of the capital is represented by $k_{t+1} = (1-\delta(h_t))k_t + v_t i_t(1 - S(i_t, i_{t-1}))$. Three elements are important to specify. First, the depreciation is endogenous and depends on capital utilization positively. The functional form of depreciation is based on Jaimovich and Rebelo (2009): $\delta(h) = \delta_0 + \delta_1 \left[\frac{h^{1+\chi}-1}{1+\chi}\right]$, where I consider that capital utilization in steady state h_{ss} is one. Furthermore, in steady state, the depreciation equals δ_0. Because of this, in the calibration stage, I will consider that $\delta_{ss} = \delta_0$. The sensibility of depreciation to capital utilization is represented by χ: higher χ, the effect of capital utilization on depreciation is lower. Then, χ reflects the flexibility of capital utilization, as well.

Second, investment is subject to the MEI shock, which increases the firm's capacity to transform one unit of investment in new capital when the shock is positive. As is usual in the literature, this shock follows an AR(1) representation: $ln(v_t/v_{ss}) = \rho_v ln(v_{t-1}/v_{ss}) + \mu_{v,t}$.

Third, the change on investment generates a cost $S(i_t, i_{t-1})$, which depends positively on the actual level of investment and negatively on the previous one. This means that the current investment increases the adjustment cost, in contrast to the previous investment that reduces it. Since the investment has benefits (increase of new capital stock) and costs (adjustment cost), the current investment becomes a control variable and the previous investment becomes a state variable.

Following Justiniano et al. (2010), the functional form of adjustment cost is $S(i_t, i_{t-1}) = \frac{\phi}{2}(\frac{i_t}{i_{t-1}} - 1)^2$.

Enforcement constraint and financial shock. Following Jermann and Quadrini (2012), the firm requires intraperiod loans to finance the working capital. This working capital is necessary at the beginning of every period because of the realization of the revenues is at the end of every period. Working capital includes investment expenses, wage payroll, equity payout and its adjustment cost, debt, and payment of taxes. I assume that this loan l_t is paid at the end of the period and it does not generate interest payments[1].

$$l_t = i_t + \varphi(d) + w_t n_t + R_{t-1} b_{t-1} + \tau(F(z_t, k_t, h_t, n_t) - w_t n_t R_{t-1} b_{t-1}) - b_t \tag{1}$$

The enforcement constraint requires the remaining asset, available after paying debtholders, to be greater than loan.

$$\xi_t(k_{t+1} - b_t) \geq l_t \tag{2}$$

In the condition 2, ξ_t is the probability that the lender recovers the full value of k_{t+1} in the event of a default. Since an decrease of ξ reflects a deterioration of the financial health of firm, the lender reduces the supply of loans. Furthermore, an decrease of ξ can be understood like the firm must have more assets to access a loan. Then, a reduction in ξ could be considered as a financial shock. As previous shocks, this financial shock follows an AR(1) representation: $ln(\xi_t/\xi_{ss}) = \rho_\xi ln(\xi_{t-1}/\xi_{ss}) + \mu_{\xi,t}$.

Firm's budget restriction. From the accounting equations for EBIT, profits, retained earnings, and financing investment, we can get the firm's budget restriction, which is described below.

$$(1-\tau)[F(z_t, k_t, h_t, n_t) - w_t n_t - R_{t-1} b_{t-1}] = (i_t - b_t) + \varphi(d_t) \tag{3}$$

It is important to highlight that when we consider the firm's budget restriction and enforcement condition, the loan becomes equal to revenues, that is, $l_t = F(z_t, k_t, h_t, n_t)$. As a result, the condition 2 becomes:

$$\xi_t(k_{t+1} - b_t) \geq F(z_t, k_t, h_t, n_t) \tag{4}$$

A.1. Recursive Formulation of the Firm's Problem

The firm maximizes dividends subject to the available technology, the capital accumulation equation, the adjustment cost of capital, and enforcement constraint.

$$V(k_t, b_{t-1}, i_{t-1}; z_t, v_t, \xi_t) = \max_{d_t, n_t, h_t, b_t, i_t, k_{t-1}} \{d_t + \mathbb{E}_t m_{t+1} V(k_{t+1}, b_t, i_t; z_{t+1}, v_{t+1}, \xi_{t+1})\}$$

subject to

$$\begin{aligned}(1-\tau)(F(z_t,h_t,k_t,n_t)-w_tn_t-R_{t-1}b_{t-1}) &= i_t-b_t+\varphi(d_t)\\ k_{t+1} &= (1-\delta(h_t))k_t+v_ti_t(1-S(i_t,i_{t-1}))\\ \xi_t(k_{t+1}-b_t) &\geq F(z_t,h_t,k_t,n_t)\end{aligned}$$

In the process of obtaining the first-order conditions I get two lagrange multiplier. The first is q_t, which is associated to the capital accumulation equation. It is known in the literature as **Tobin's q**. The second lagrange multiplier is μ_t, which is associated to the enforcement constraint. The first-order conditions are as follows:

$$F_n(z_t,h_t,k_t,n_t)=\frac{w_t(1-\tau)}{(1-\tau)-\mu_t\varphi_d(d_t)} \tag{5}$$

$$F_h(z_t,h_t,k_t,n_t)=\frac{q_t[\delta_h(h_t)k_t]\varphi_d(d_t)}{(1-\tau)-\mu_t\varphi_d(d_t)} \tag{6}$$

$$1=\left[\mu_t\xi_t+\mathbb{E}_tm_{t+1}\left(\frac{(1-\tau)R_t}{\varphi_d(d_{t+1})}\right)\right]\varphi_d(d_t) \tag{7}$$

$$\mathbb{E}_tm_{t+1}\left[F_k(z_{t+1},h_{t+1},k_{t+1},n_{t+1})\left(\frac{1}{\varphi_d(d_{t+1})}(1-\tau)-\mu_{t+1}\right)+q_{t+1}(1-\delta(h_{t+1}))\right]+\mu_t\xi_t=q_t \tag{8}$$

$$\mathbb{E}_tm_{t+1}[-q_{t+1}[v_{t+1}i_{t+1}S_i(i_{t+1},i_t)]]+q_tv_t[(1-S(i_t,i_{t-1}))-i_tS_i(i_t,i_{t-1})]=\frac{1}{\varphi_d(d_t)} \tag{9}$$

The detailed derivation of these equation is in the Appendix C. The equation 5 represents the demand for labor which equals the marginal productivity of labor to the marginal cost. In this case, the marginal cost is affected by the degree of tightness oon the enforcement constraint, that is, $\mu_t\varphi_d(d_t)$. A tighter constraint means $\xi_t(k_{t+1}-b_t)-F(z_t,h_t,k_t,n_t)$ tends to zero, as a result the lagrange multiplier μ_t increases ($\mu_t>0$) generating that the marginal cost increases, as well and the demand of labor goes down.

The equation 6 shows the optimal capital utilization h_t decision of firm. The marginal cost is the increase of the depreciation which is affected by the tightness of the enforcement constraint as labor demand. A tighter constraint reduces capital utilization.

The equation 7 shows the optimal debt. To get more insights, let us assume that the debt does not pay interest ($R_t=0$) and there is not an enforcement constraint ($\mu_t=0$). The equation 7 becomes $1=\varphi_d(d_t)$, which means that issuing one unit of debt costs a variation in dividends. This optimum decision is based on the equation of retained earnings ($RE_t=\pi_t-\varphi(d_t)$) and financing investment ($i_t=RE_t+b_t$)[2]. However, in the case with financial frictions, the cost of debt has one additional element $\mu_t \xi_t$. This means that issuing debt produces a tighter constraint. Furthermore, since the debt has a cost reflected in the interest rate, this must be considered in the total cost of debt. Nevertheless, given the presence of taxes, there is a tax-shield of debt. Therefore, the net cost considering interest rate and tax-shield is $(1-\tau)R_t$.

The optimality condition for capital, equation 8, equals the marginal benefit (left side) to the marginal cost (right side). The present value of the marginal benefit is compounded by three elements. The first is the marginal productivity of new capital after taxes and net of the cost of a tighter constraint μ_{t+1}. The later turns out from the enforcement constraint. Clearly, this shows that a financial shock has effects on the optimal capital. The second element is the value of the new capital after depreciation $q_{t+1}(1-\delta(h_{t+1}))$. The third element is the benefit of new capital in terms of assets in the enforcement constraint $\mu_t \xi_t$. Finally, the marginal cost is expressed by the current value of capital q_t.

The equation 9 is the firm's optimal investment decision. The left side describes the marginal benefit of one unit of investment. In the next period, we have the value of the lower cost of one unit of investment in current period. It is worth noticing that $S_i(i_{t+1}, i_t) < 0$, then this is a benefit in terms of lower adjustment cost given by the variation of current investment. The second term represents the value of one unit of investment after taking into account the level and the marginal increase of adjustment cost. Finally, the right side of the equation 9 shows the benefit of one unit of investment.

B. Households

All households of the economy has the same preferences, utility function, and budget constraint. Therefore, the household sector is represented by a representative agent with the following preferences: $u(c_t, n_t) = \frac{1}{1-\gamma}\left[\left(c_t - \frac{n_t^{1+\theta}}{1+\theta}\right)^{1+\gamma} - 1\right]$. This representative household supplies labor to the firm n_t at competitive wages w_t. It is assumed the labor and goods market are both competitive. The household, owner of the firm, obtains income from three sources: corporate bonds b_t which pay a gross interest rate R_t, dividends d_t and prices of shares p_t, and labor income $w_t n_t$. Additionally, the taxes paid for firms become a transfer to households: $T_t = \tau(EBIT_t - R_{t-1}b_{t-1})$

B.1. Recursive Formulation of the Households' Problem

Representative households maximize expected lifetime utility of consumption and leisure subject to a sequential budget constraint:

$$V(b_{t-1}, s_t) = \max_{c_t, n_t, b_t, s_{t+1}} \{u(c_t, n_t) + \beta \mathbb{E}_t V(b_t, s_{t+1})\}$$

Subject to the budget constraint:

$$w_t n_t + R_{t-1} b_{t-1} + s_t(d_t + p_t) + T_t = b_t + s_{t+1} p_t + c_t$$

From the first order condition (FOC), we can obtain the labor supply, and the optimal condition for debt and for shares:

$$u_{n_t} = -u_{c_t} w_t \tag{10}$$

$$u_{c_t} = \beta \mathbb{E}_t(u_{c_{t+1}} R_t) \tag{11}$$

$$p_t = \mathbb{E}_t\left[\left(\beta \frac{u_{c_{t+1}}}{u_{c_t}}\right)(d_{t+1} + p_{t+1})\right] \tag{12}$$

The first condition determines the supply of labor which does not depend of consumption's level. This means that income effect is not present in the supply of labor. The advantage of this formulation is that this allows to analyze the "clean" effect of capital utilization on labor equilibrium. The second condition determines the interest rate, and the last condition determines the price of shares.

Furthermore, from the last condition we can obtain the stochastic discount factor using forward substitution.

$$p_t = \mathbb{E}_t \sum_{j=1}^{\infty} \left(\frac{\beta^j u_c(c_{t+j}, n_{t+j})}{u_c(c_t, n_t)}\right) d_{t+j} \tag{13}$$

Therefore, the stochastic discount factor is $m_{t+j} = \beta^j \frac{\beta^j u_c(c_{t+j}, n_{t+j})}{u_c(c_t, n_t)}$.

IV. Quantitative Analysis

A. Calibration

The parameters of the model can be categorized in three groups: preferences, production, and shocks.

Preferences. Given that the gross interest rate in steady state is the inverse of the discount factor, that is, $1 + r_{ss} = R_{ss} = 1/\beta$, I choose β in order to obtain an annual interest rate of debt in steady state equals to 7.32 percent. Greenwood et al. (1988) suggests the intertemporal elasticity of substitution (IES) in labor supply $1/\theta_n$ varies between 0.3 and 2.2. Hence, it is reasonable to choose 1.1 within this range, implying $\theta_n = 0.9$. Regarding of the coefficient of relative risk aversion[3], γ, I follow to Greenwood et al. (1988), who suggests that $\gamma = 2$.

Production. The average of the share of capital in the total production is around 0.36 in accordance with Jones (2016). The value of the tax corporate rate is 0.35, which is based on Graham (2000).

Regarding δ_0, it is equal to the depreciation in steady state which is 0.025. This assumption is common in the literature of business cycles because of this allows to obtain a depreciation of 10 percent, annually. In order to get that $\delta_0 = \delta_{ss}$, I assume that capital utilization in steady state is one, which means that in the long-run equilibrium the firm uses its full capacity. The parameter of adjustment cost of dividends is taken from Jermann and Quadrini (2012) and its value is 0.146. Furthermore, the elasticity of marginal depreciation, χ, is provided for Greenwood et al. (1988) and its value is 0.42. The value of adjustment cost of investment, $\phi = 3$, is based on Justiniano et al. (2010). Finally, the parameter for the slope in the depreciation function is chosen to be 0.008 in order to keep positive values of debt in steady state.

Shocks. In order to identify the productivity and the financial shock, I take the estimated values of Jermann and Quadrini (2012). In particular, the persistence and volatility of the productivity shock are 0.9457 and 0.0045, respectively. For the financial shock, its persistence is 0.9703 and its volatility is 0.0098. In order to identify the MEI shock, I use the steady state relationship of this shock and the Tobin's q. In steady state, the investment shock is the inverse of tobin's q. To compute the persistence and volatility of the MEI shock I follow three steps. First, based on COMPUSTAT database I construct the aggregate Tobin's q quarterly in accordance with the following equation.

$$\text{Tobin's q} = q_t = \frac{\text{Total Assets} + \text{Market Value} - \text{Total Common and Ordinary Equity}}{\text{Total Assets}} \tag{14}$$

To keep the consistency with the data used in the empirical analysis section, I calculate Tobin's q for the sample from 1980.Q1 to 2017.Q4. The second step is compute the inverse of this variable. Finally, I compute the persistence ρ_v and the volatility σ_v of this latter variable. As result, $\rho_v = 0.8287$ and $\sigma_v = 0.0521$. Table V shows the calibration of the model.

B. *Capital Utilization as Transmission Mechanism*

One of the main points of this paper is that capital utilization behaves as a transmission mechanism of shocks. Since different shocks affect different elements of the firm, the reaction of capital utilization depends on what shock is presented in the economy. To show that, I analyze separately how capital utilization reacts when the economy suffers two types of shochs. A financial shock and an investment shock.

MEI shock. Since the MEI shock is one affecting the transformation of investment into future capital input, a *negative* MEI shock means that the firm reduces its transformation capacity of investment respect to its steady state value, it does not mean that the level of the financial shock is negative. This shock could reflect the loss of efficiency of the firm in the investment process. In order to understand how the MEI shock affects the real and the financial variables, and how capital

Table V
Parameter values used in quarterly calibration

Group	Description	Symbol	Value
Preference	Discount factor	β	0.9825
	Inverse of IES of labor	θ_n	0.9
	Coefficient of relative risk aversion	γ	2
Production	Capital share on output	θ	0.36
	Corporate tax rate	τ	0.35
	Dividend adjustment cost	κ	0.146
	Elasticity of marginal depreciation	χ	0.42
	Investment adjustment cost	ϕ	3
	Depreciation in SS	δ_0	0.025
	Parameter rate slope	δ_1	0.008
Shocks	Persistent of productivity shock	ρ_z	0.9457
	Volatility of productivity shock	σ_z	0.0045
	Persistent of financial shock	ρ_ξ	0.9703
	Volatility of financial shock	σ_ξ	0.0098
	Persistent of MEI shock	ρ_v	0.8287
	Volatility of MEI shock	σ_v	0.0521

utilization amplifies the effects of the shock, we have to take a look at the optimal equations of the firm optimzation problem and its accounting equations.

First of all, the MEI shock affects the optimal investment -equation 9-. Since the transformation of investment is lower because of the negative shock, and any change in investment generates costs, the optimal response of the firm is to reduce the level of investment, which produces lower capital in the next period. Second, in order to keep binding the enforcement constraint, the firm reduce its labor demand. To see this, I substitute the loan equation 1 into the enforcement constraint, equation 2.

$$\frac{\xi_t}{1-\xi_t}(k_{t+1}-i_t-\varphi(d)-w_t n_t-R_{t-1}b_{t-1}-\tau(F(z_t,k_t,h_t,n_t)-w_t n_t-R_{t-1}b_{t-1}))\geq F(z_t,k_t,h_t,n_t) \tag{15}$$

Third, since the reduction in absolute value of capital in the next period is greater than the reduction of current investment because of the MEI shock, the enforcement constraint is binding. In order to keep binding the enforcement constraint, the firm can adjust two control variables: dividends and labor demand. Given that the change in dividends is costly, the firm reduces its demand of labor. As a result, the production or revenue goes down. The implication is that EBIT and profits of the firm decreases and the retained earnings goes below its steady state value. As the firm reduces its investment, it does not need more debt, generating lower leverage.

These effects of the MEI shock on real variables are strengthened by capital utilization. The optimal level of capital utilization is affected by the MEI shock by means of Tobin's q -equation 6-.

The deterioration of asset (or capital) increases Tobin's q. The optimal response of the firm is to reduce its capital utilization. This latter variable pushes down the demand of labor. Additionally, the depreciation increases generating a reduction of current stock of capital. As a result, the production, investment, and capital suffer an additional reduction.

Furthermore, retained earnings suffers an additional reduction because of a decreasing of revenues. However, debt and dividends increase more. This is because of in this model the firm finances dividends with debt. This is optimal given the supply of debt is elastic and it is represented by the coefficient of risk aversion. Then, given that movements in the demand of debt does not push up strongly the interest rate, it is optimal to the firm to get more debt when the capital utilization reduces more the retained earnings, particularly below its steady state value. Note that when we do not consider capital utilization, the firm reduces its debt because it has enough profits to finance dividends, in this case, profits are above its steady state. The impulse-response functions are described in the figure 3.

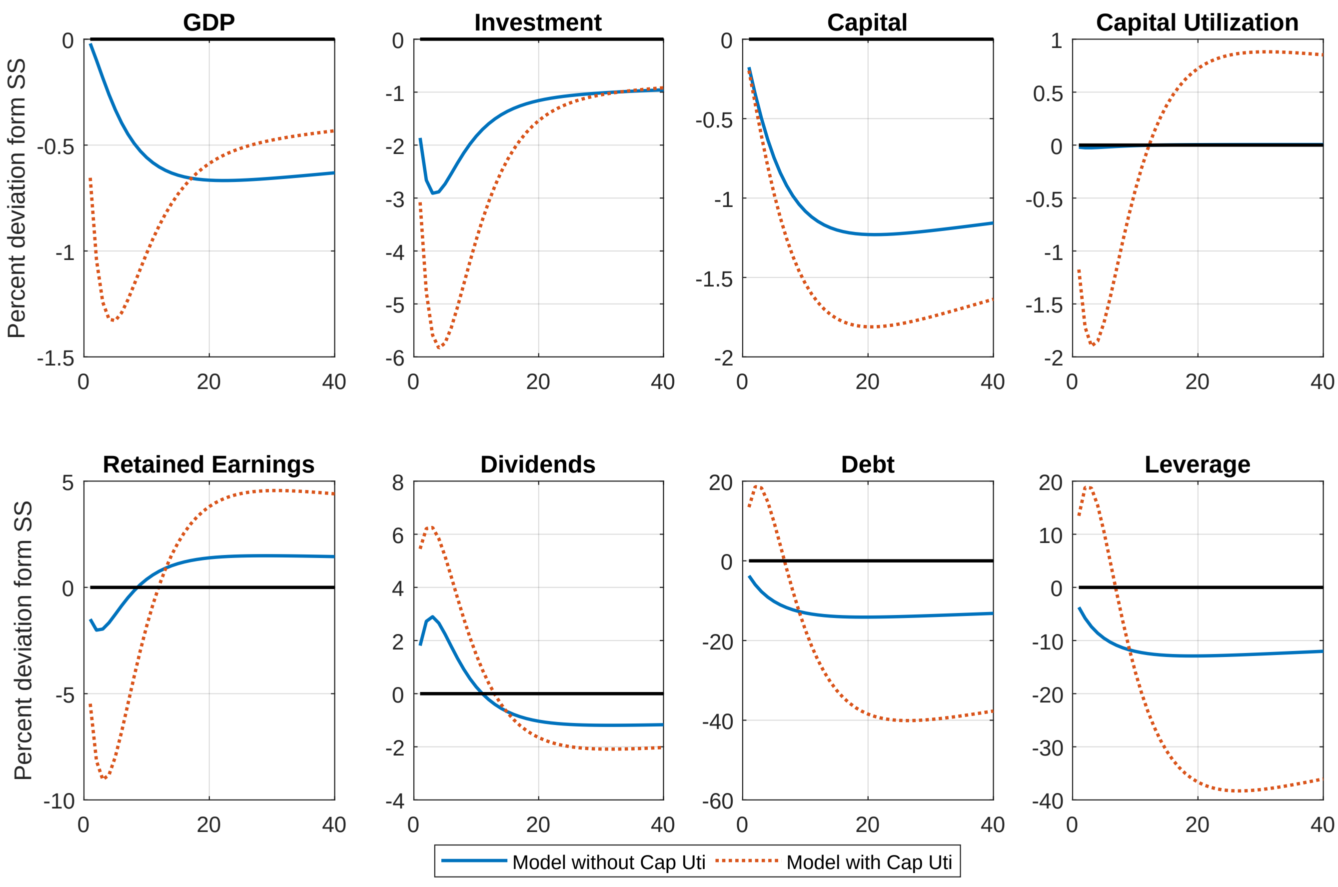

Figure 3. Capital Utilization as Transmission Mechanism of MEI Shock. $\rho_v = 0.8287$ and $\sigma_v = 0.0521$

Financial shock. Negative financial shock is understood as a reduction of the probability that lender recovers all the value of the loan. This shock affects directly the enforcement constraint -equation 4- and the optimal capital -equation 8-.

The optimal response of the firm to a financial shock is to reduce the level of investment, or dividends, or employment, or some combination of these variables. It can be seen in the enforcement constraint -equation 15-. Additionally, the firm can reduce its capital utilization as an optimal response to the financial shock. In doing so, the demand of labor is affected by means of two ways: by the reduction of capital utilization and by the straightforward reduction as an effect of the financial shock. Furthermore, the production decreases as a consequence of the reduction in employment and capital utilization generating that the retained earnings goes down more than in the case when the capital utilization is not present.

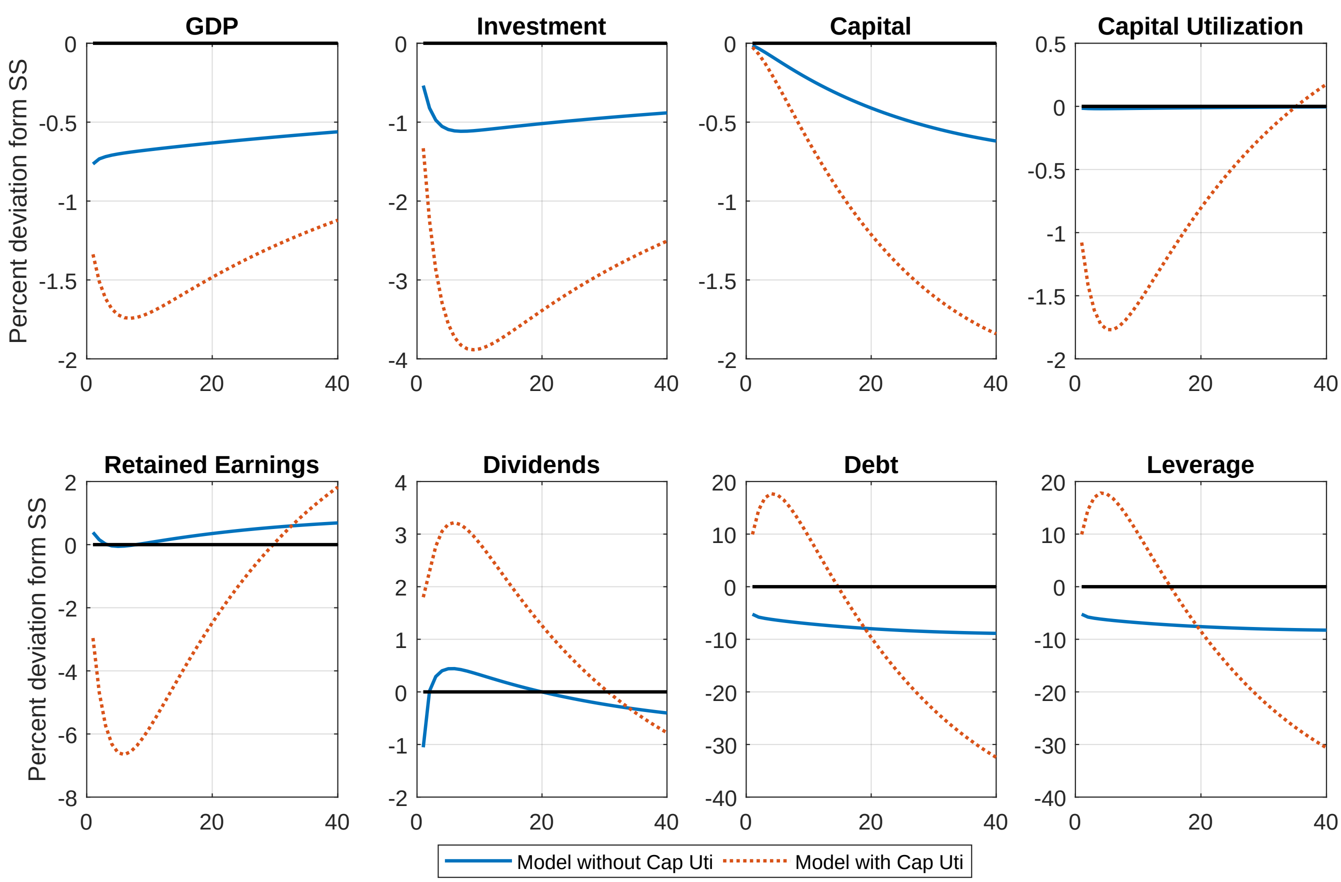

Figure 4. Capital Utilization as Transmission Mechanism of Financial Shock. $\rho_\xi = 0.9703$ and $\sigma_\xi = 0.0098$

In the same way in the MEI shock, it is optimal for the firm to finance the dividends with debt because of the interest rate is elastic. As we can see in the followings sections, one way to explain the willingness of the lender to reduce its supply of debt is when it is more risk averse. In this case, the leverage increases but in lower level. The impulse-response functions are described in the figure 3

C. *What Shock is more Important?*

The business cycles literature suggests that one of the main shocks used to explain the cyclical components of real variables is the investment shock. This analysis is usually done without the presence of credit restrictions such as the enforcement constraint.

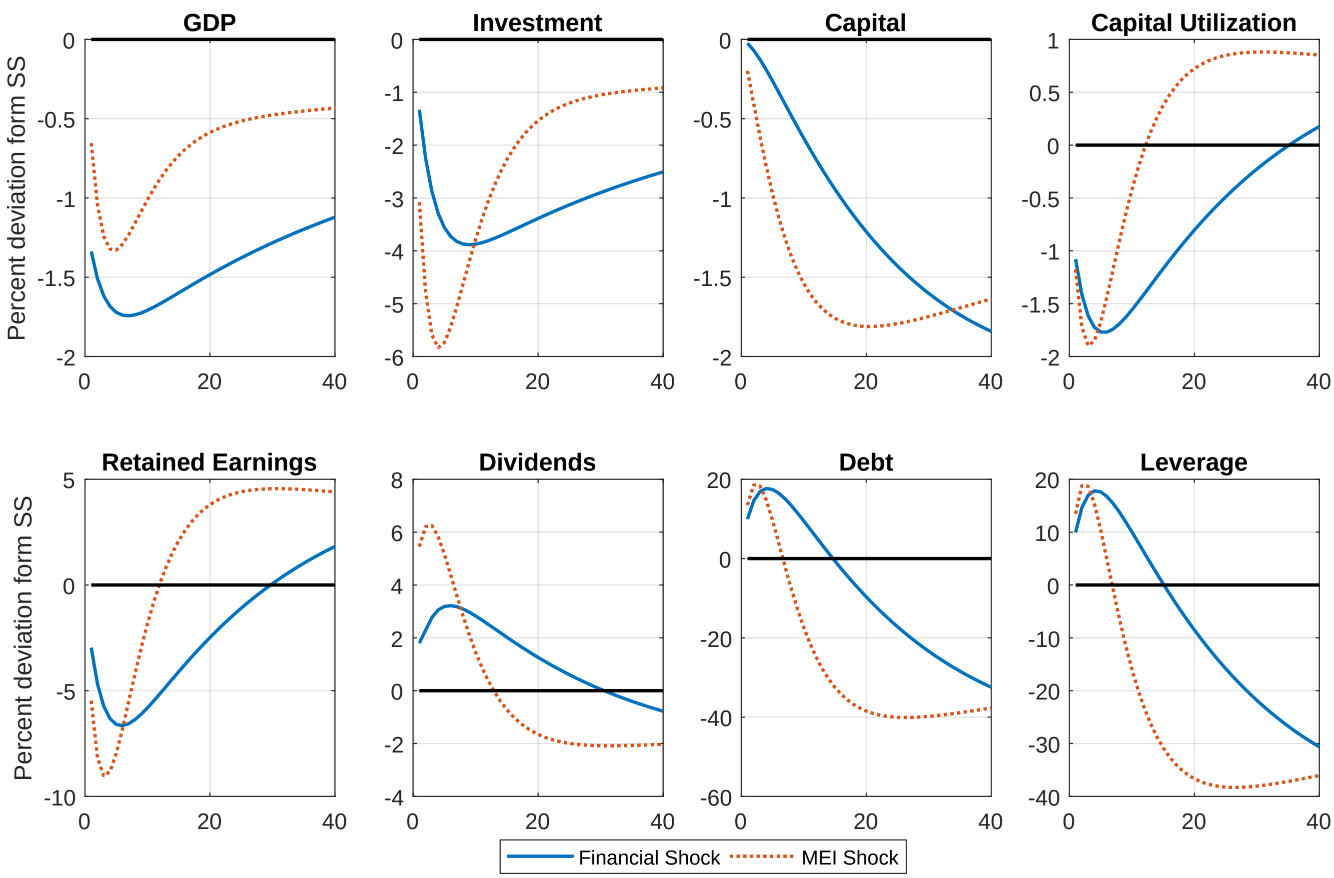

Figure 5. Financial Shock and MEI Shock. Every shock has its own persistence and standard deviation. For financial shock: $\rho_\xi = 0.9703$ and $\sigma_\xi = 0.0098$. For MEI shock: $\rho_v = 0.8287$ and $\sigma_v = 0.0521$.

When it is taken into account the capital utilization along with the enforcement constraint, the MEI shock has more important effects on real and financial variables than the financial shock. This can be seen in the figure 5. After both shocks, the capital utilization plays a key role in transmitting their effects on the real and financial variables. However, the strength of the MEI shock depends on the magnitude of its standard deviation. In the figure 5 the standard deviation σ_v of the MEI shock is 0.0521, which is five times the standard deviation of the financial shock. However, if I consider the same standard deviation and persistence for both shocks, the financial shock has more important effects than the MEI shock, which can be seen in the figure 6. This suggests that to be able to conclude somthing about the relevance of every shock is important to identify adequately those.

In this paper, the identification of the MEI shock is based on the inverse of the Tobin's q. This relationship has been obtained from long-run equilibrium. Furthermore, the identification of the financial shock is based on the estimation of Jermann and Quadrini (2012).

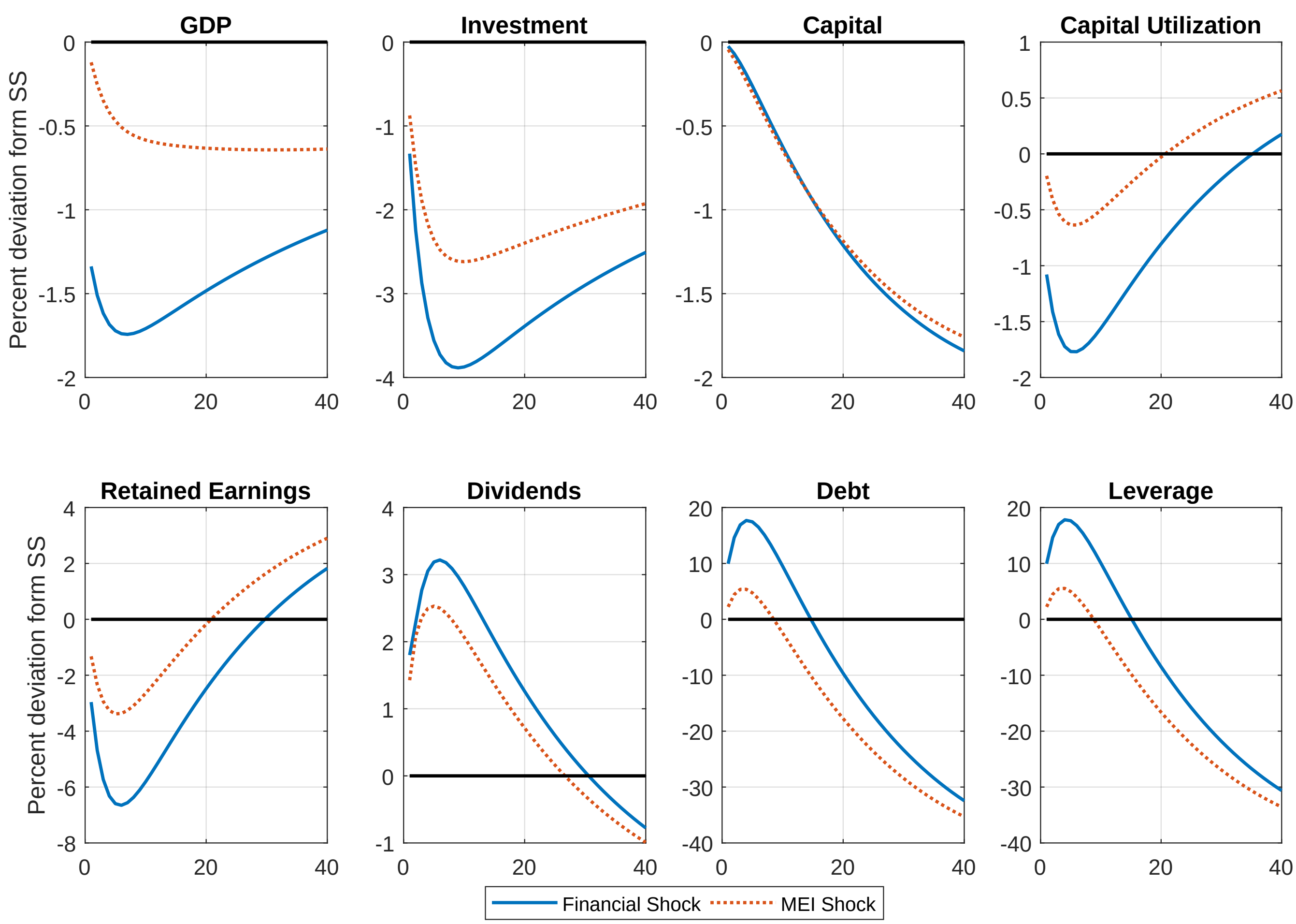

Figure 6. Financial Shock and MEI Shock. In order to compare both shocks, I consider the same persistence ($\rho_\xi = 0.9703$) and standard deviation ($\sigma_\xi = 0.0098$), which belong to the financial shock.

V. Conclusion

In this paper I document the cyclical relationship between the firm's capital structure and capital utilization. Based on quarterly aggregate data for US firms, I conclude that this relationship is relevant even controlling for firm's size.

The DSGE model, which includes a financial and MEI shock, captures that, under the value of a set of parameters, the MEI shock is more important than the financial shock at explaining the behavior of the economy after the shock. This is particularly important to understand the agrgegate effects. This conclusion depends on the identification of the shocks given by the real data.

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Appendix A. Data Sources

Appendix A. Variable Definition

Appendix B. Seasonal Adjustment of Variables

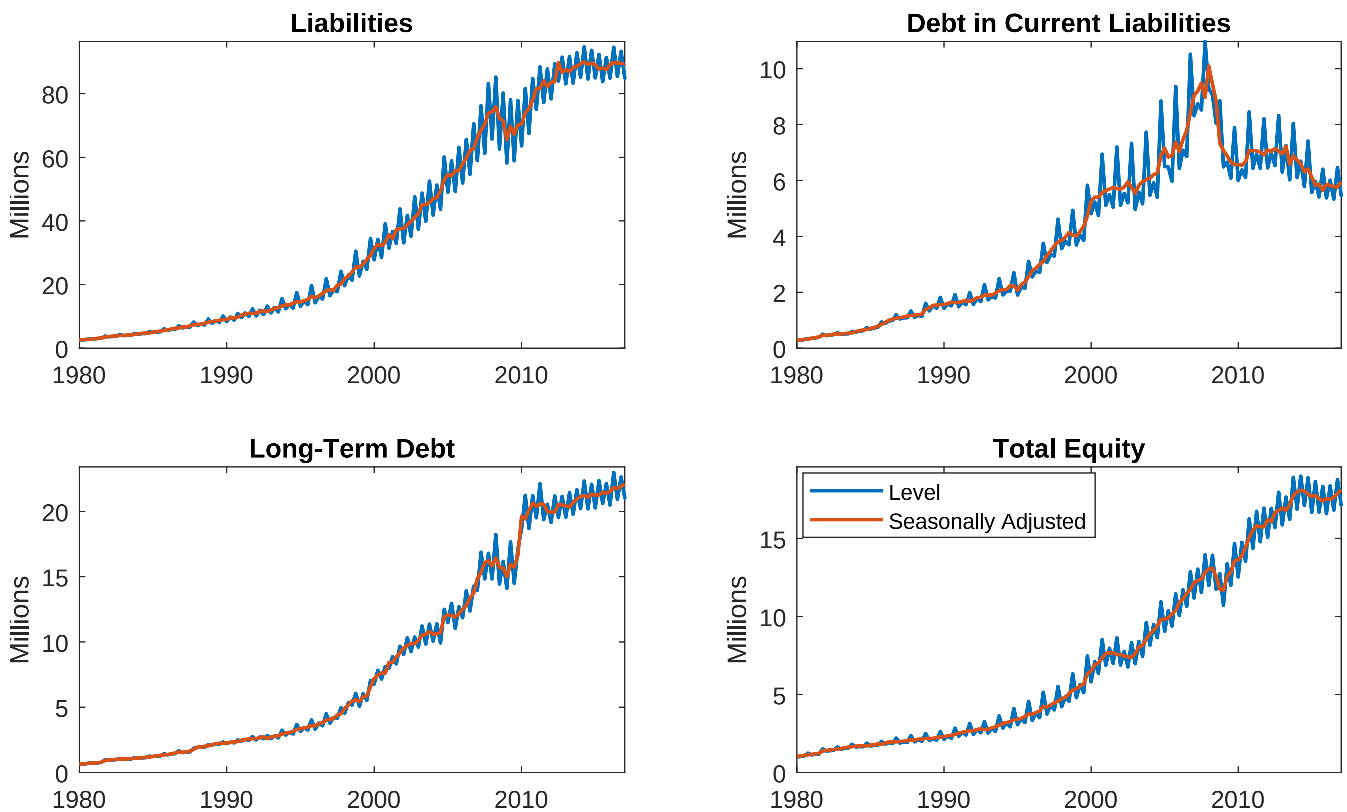

Figure 7. Seasonal adjustment of capital structure and capital utilization (quarterly data). All series have been seasonally adjusted by X-13ARIMA-SEATS. This methodology belongs to the Center for Statistical Research and Methodology U.S. Census Bureau

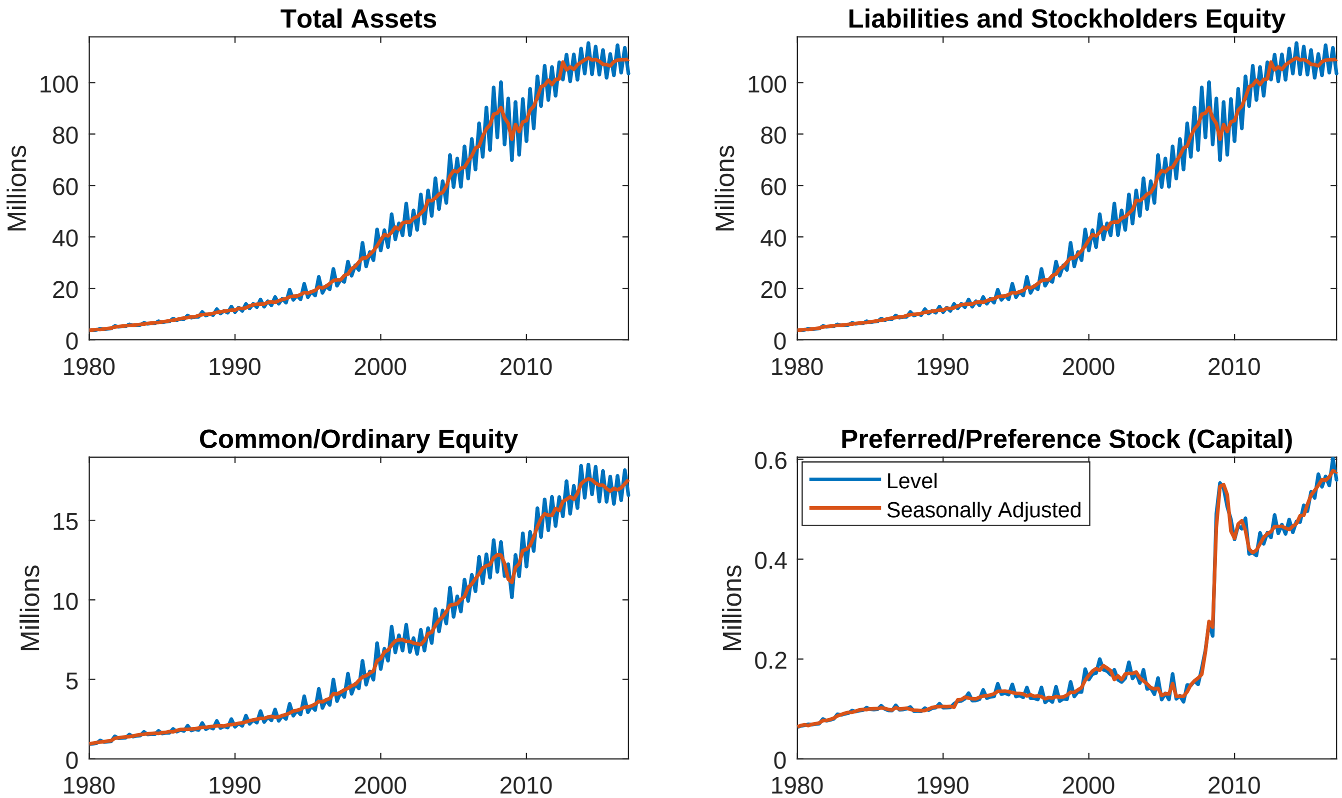

Figure 8. Seasonal adjustment of assets, liabilities, and equity measures (quarterly data). All series have been seasonally adjusted by X-13ARIMA-SEATS. This methodology belongs to the Center for Statistical Research and Methodology U.S. Census Bureau

Appendix C. Model: optimization details

Appendix D. Sensitivity Analysis

Appendix A. Financial Shock

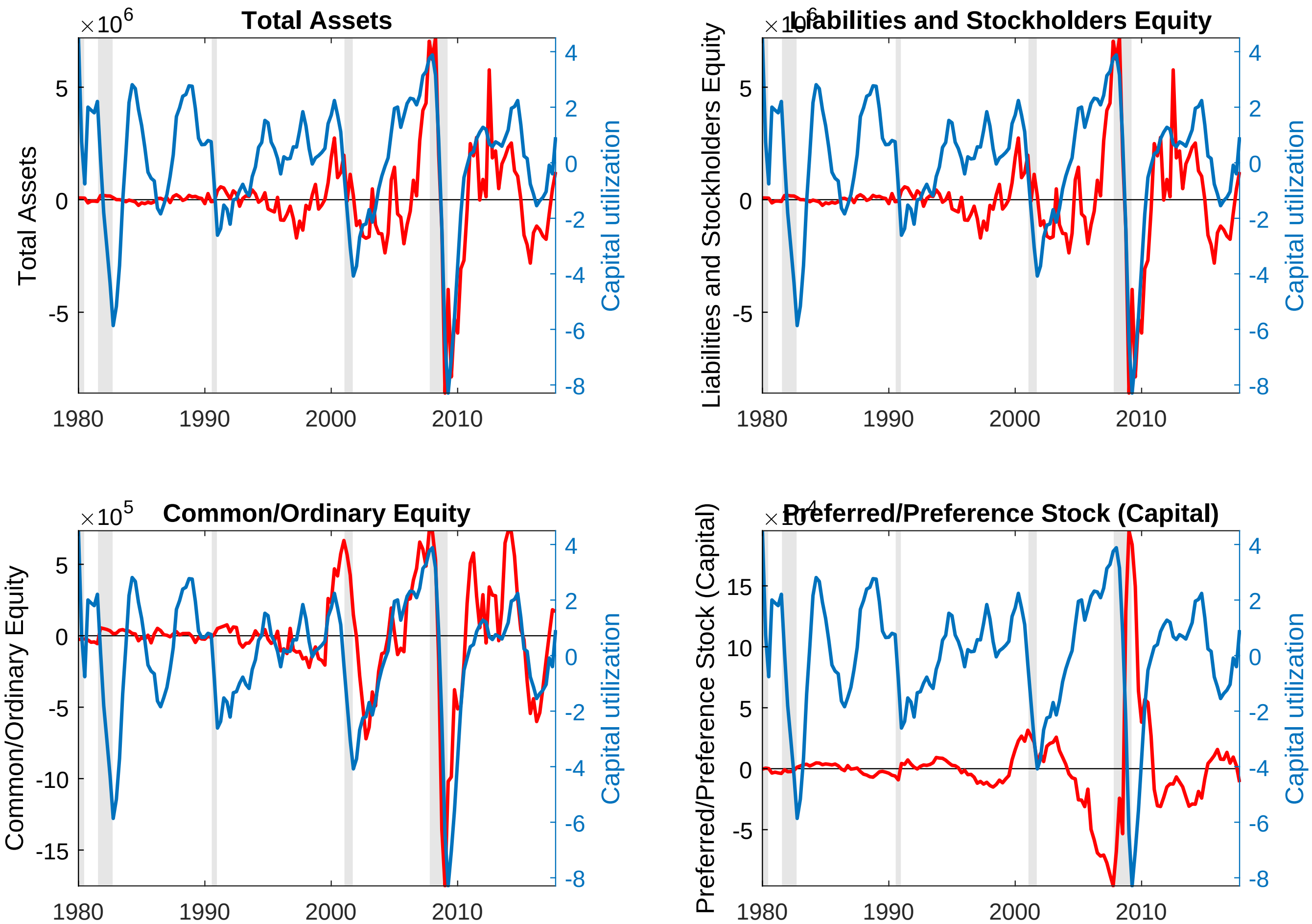

Figure 9. Cyclical behavior of assets, liabilities, and equity measures: HP filter (quarterly data). The right axis corresponds to cyclical component of capital utilization, and the left axis corresponds to capital structure variables. The shaded areas indicates NBER recessions.

Appendix B. Marginal Efficiency of Investment Shock

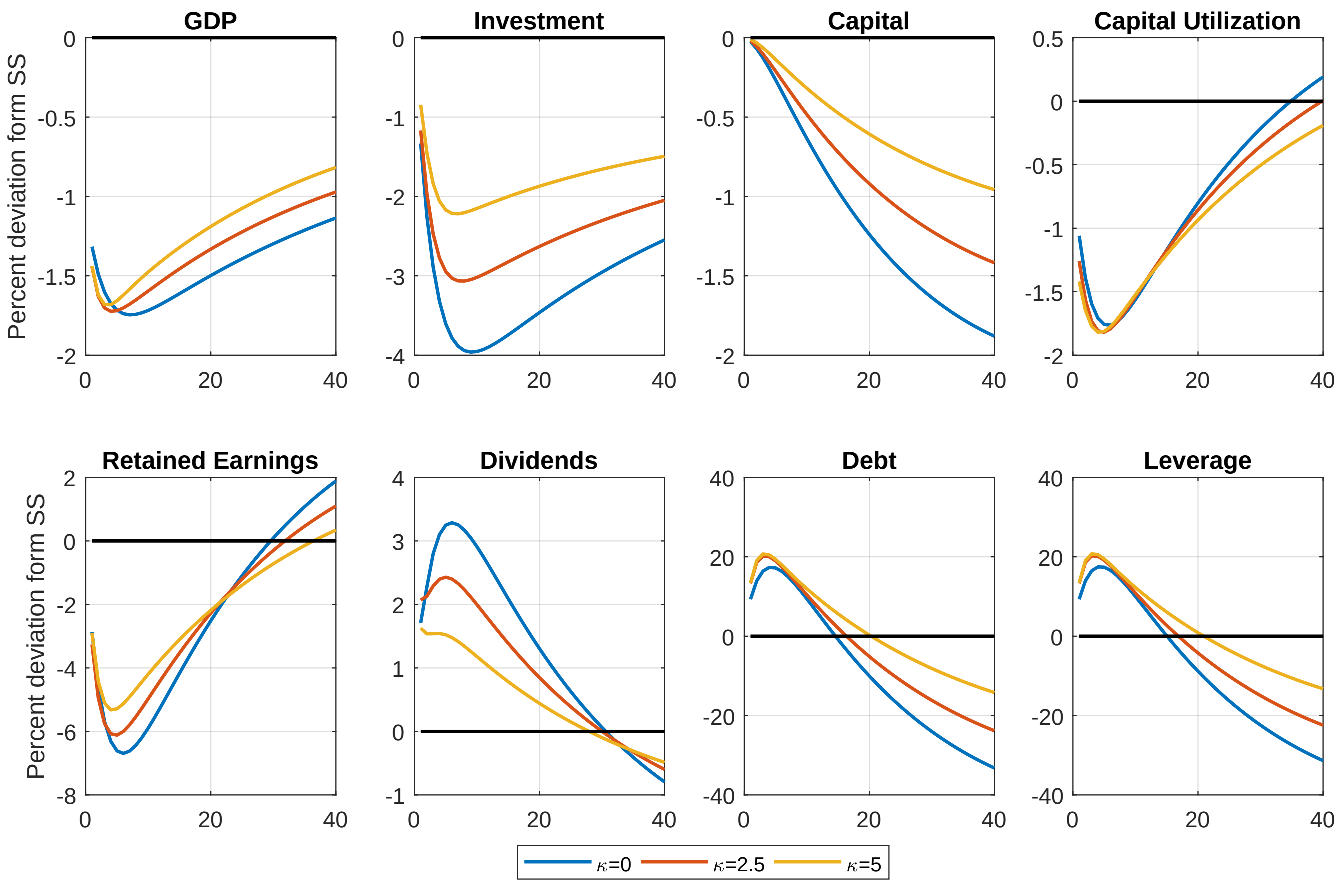

Figure 10. Sensitivity Analysis (Financial Shock): This graph reports the sensitivity of the model to the equity (dividend) cost κ. If the κ increases, the cost of changing dividends is higher.

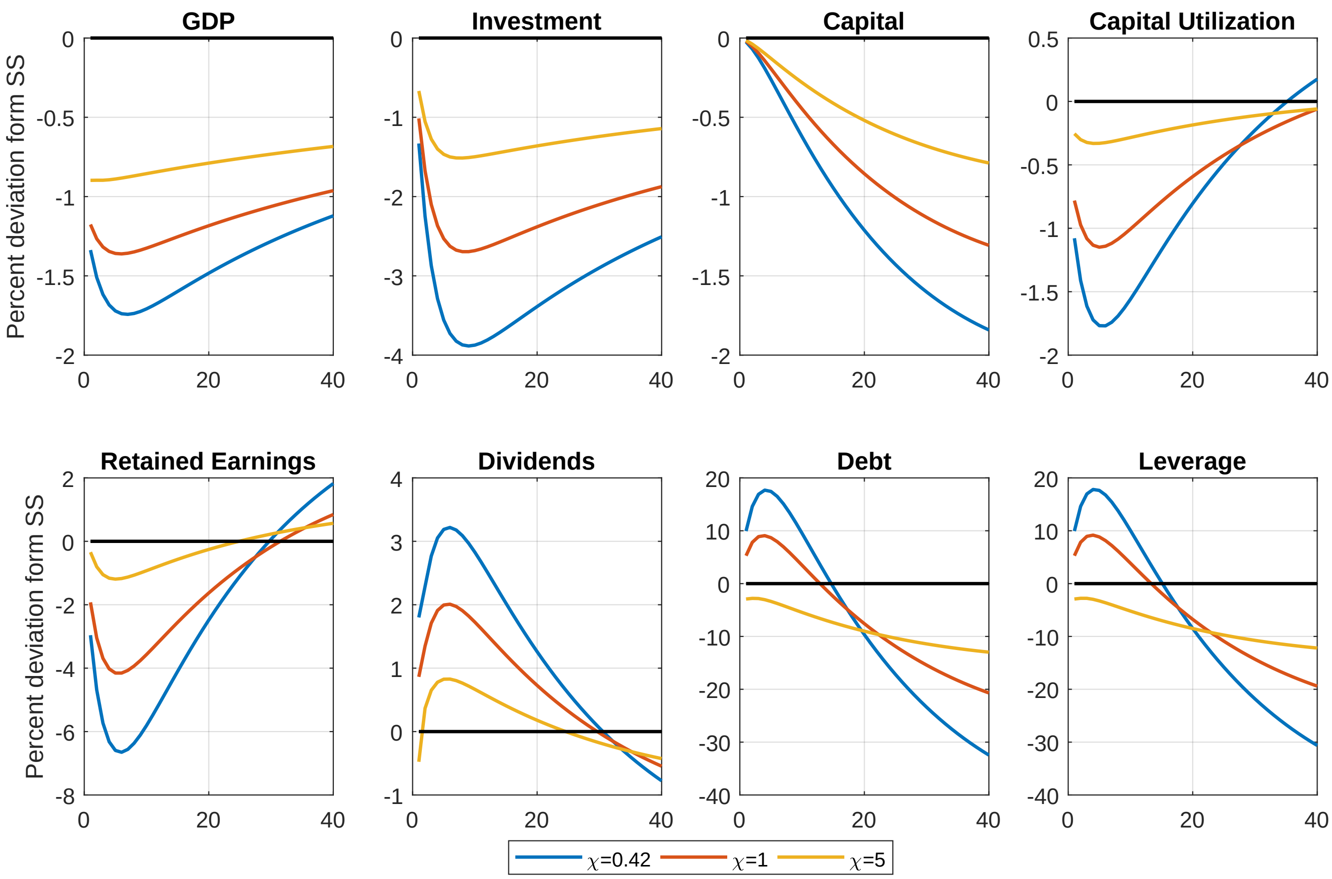

Figure 11. Sensitivity Analysis (Financial Shock): This graph reports the sensitivity of the model to the degree of flexibility in capital utilization χ. If the χ increases, the capital utilization is more fixed.

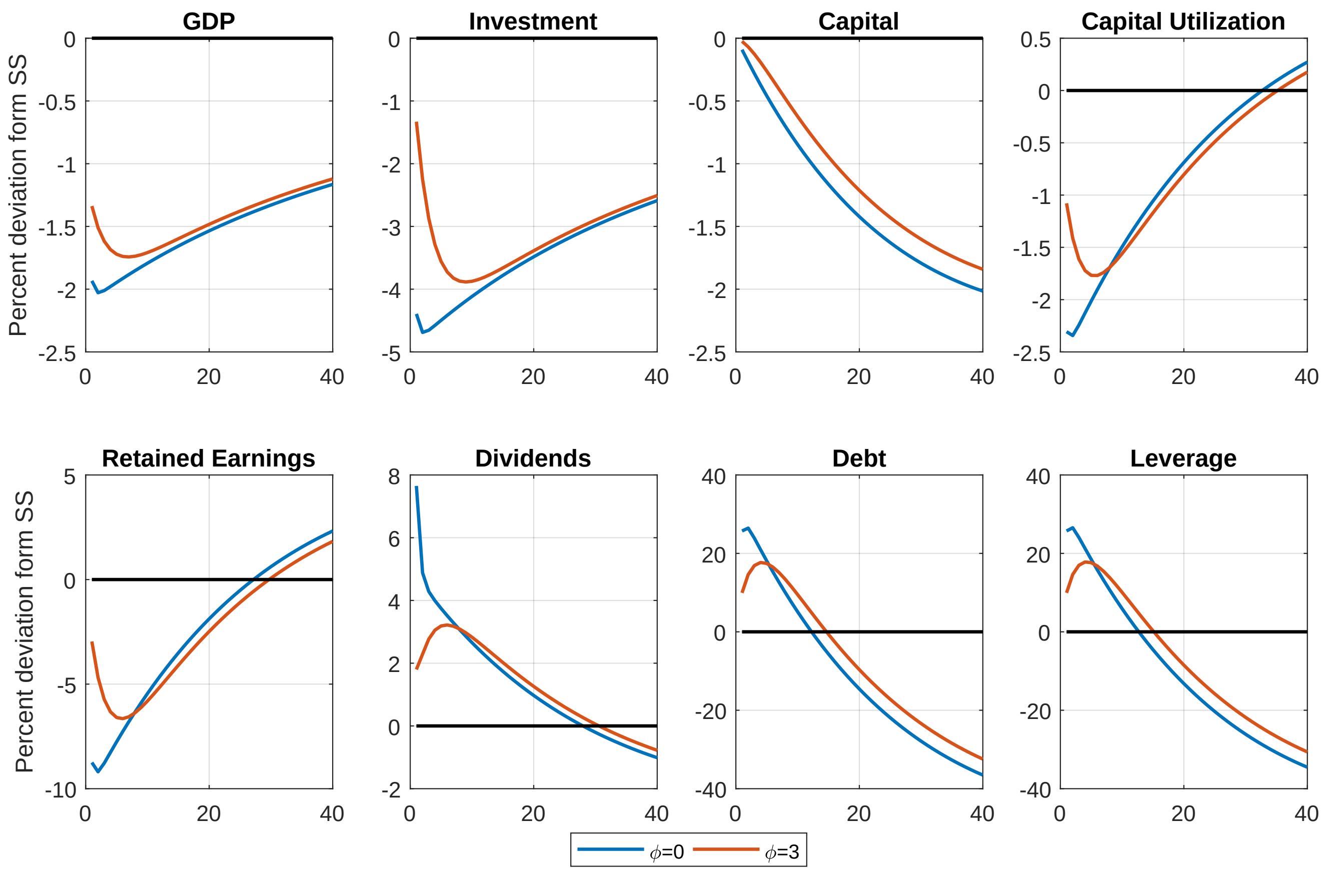

Figure 12. Sensitivity Analysis (Financial Shock): This graph reports the sensitivity of the model to adjustment cost of investment ϕ. If the ϕ increases, the adjustment cost of investment increases.

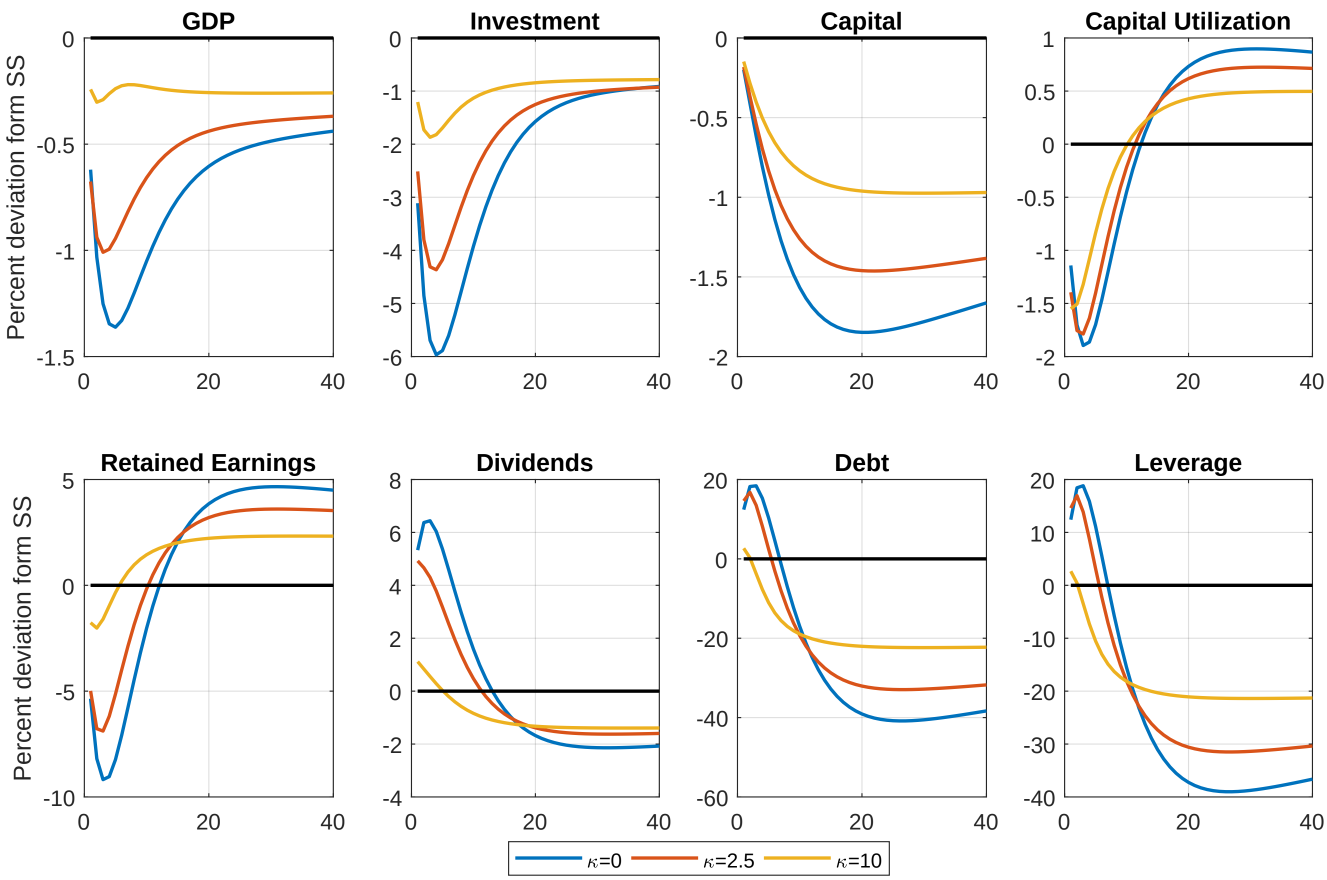

Figure 13. Sensitivity Analysis (Marginal Efficiency of Investment Shock): This graph reports the sensitivity of the model to the equity (dividend) cost κ. If the κ increases, the cost of changing dividends is higher.

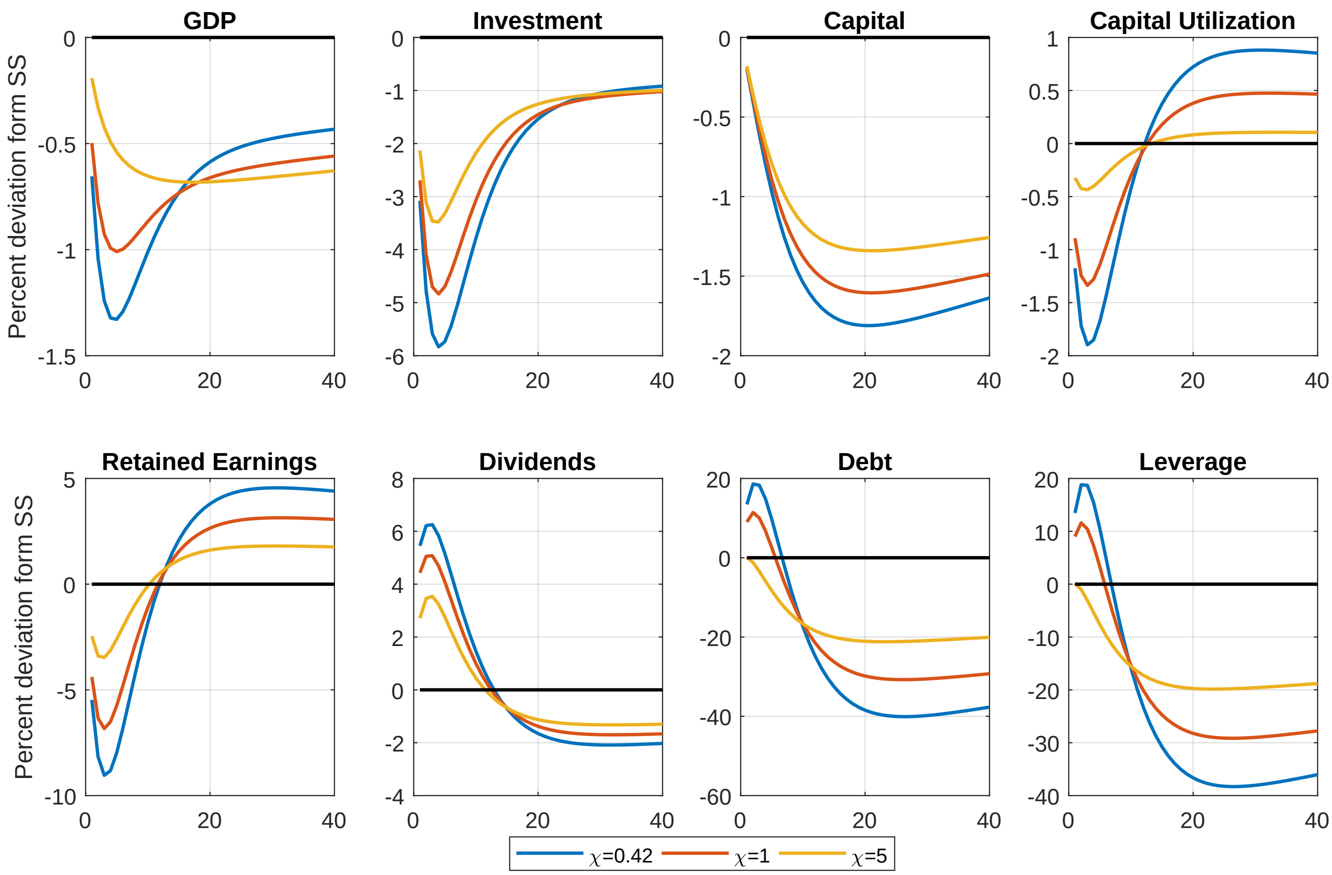

Figure 14. Sensitivity Analysis (Marginal Efficiency of Investment Shock): This graph reports the sensitivity of the model to the degrees of flexibility in capital utilization χ. If the χ increases, the capital utilization is more fixed.

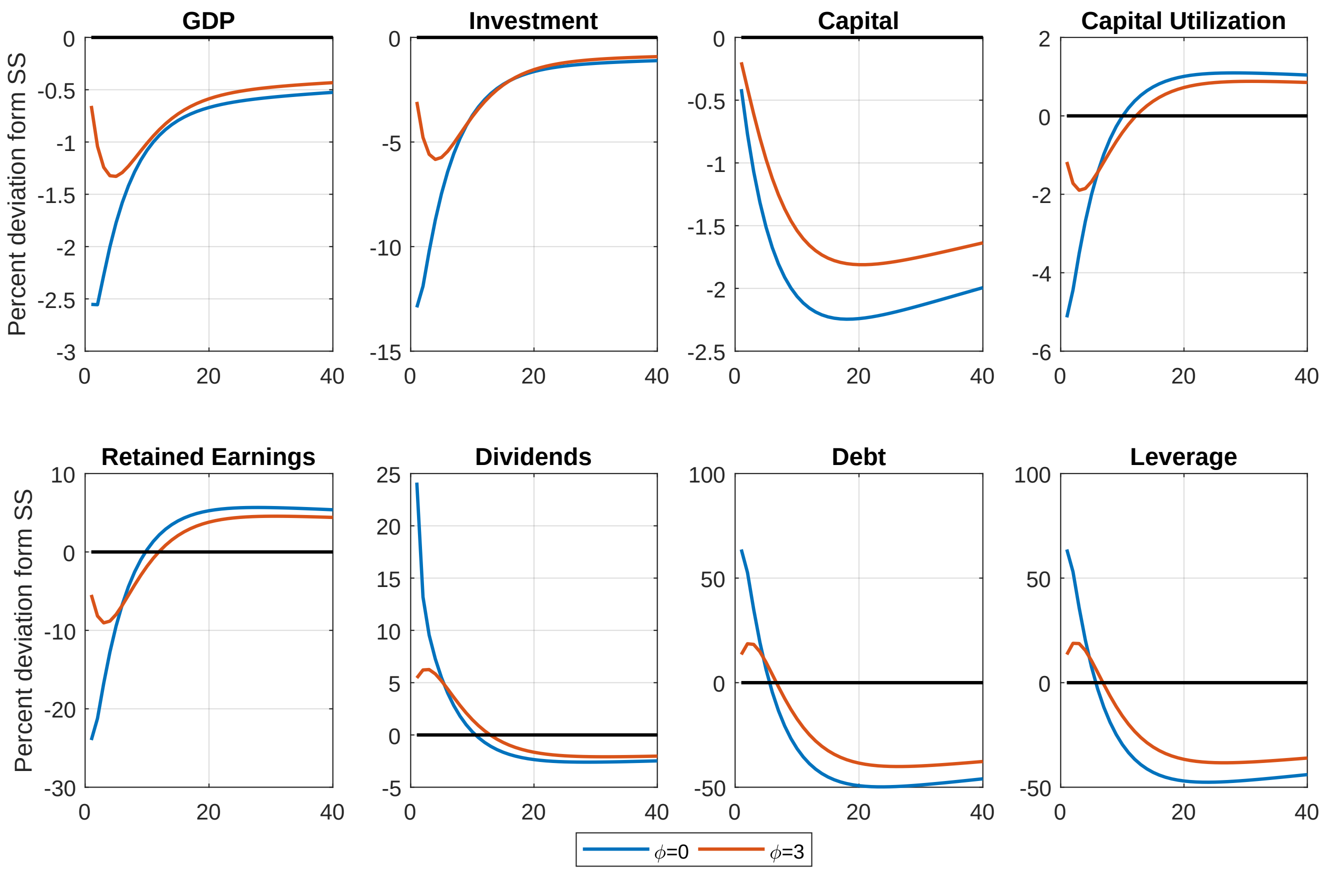

Figure 15. Sensitivity Analysis (Marginal Efficiency of Investment Shock): This graph reports the sensitivity of the model to the adjustment cost of investment ϕ. If the ϕ increases, the adjustment cost of investment increases.

Notes

[1]This assumption simplifies the analysis by allowing me to focus on the interest rate of debt. Also, this assumption is the same hold by Jermann and Quadrini (2012).

[2]$\Delta RE_t = -\Delta\varphi(d_t)$ keeping profit constant. In the same way, $\Delta i_t = \Delta RE_t + \Delta b_t$. Assuming that investment does not vary we have that $\Delta\varphi(d_t) = \Delta b_t$

[3]In contrast to Jermann and Quadrini (2012), who use $\gamma = 1$, I assume $\gamma = 2$ because of the presence of capital utilization. Other values such as those proposed by Barro and Ursa (2012) are shown in the appendix.