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December 2015

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Debt, equity and the equity price puzzle*

Daria Finocchiaro† Caterina Mendicino‡

Sveriges Riksbank Working Paper Series
No. 314

December 2015

Abstract

We show that in a model with equity and debt financing, the specification of the borrowing constraint is crucial to generate empirically plausible responses of macro variables and asset prices to financial shocks. The interaction between financial frictions and labor demand, as in Jermann and Quadrini (2012), is key to the result. A collateral constraint a la Kiyotaki and Moore (1997) augmented with a working capital assumption generates similar results on impact.

Keywords: liquidity shocks, collateral constraints, stock prices, comovement
JEL codes: E32; E44

*We are grateful to Karl Walentin and seminar partecipants at Sveriges Riksbank for useful comments and suggestions. The opinions expressed in this article are the sole responsibility of the authors and should not be interpreted as reflecting the views of Sveriges Riksbank or of the European Central Bank.

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1 Introduction

Can financial shocks generate comovement between financial variables and economic activity? Comovement between asset prices and macro variables in response to financial disturbances is the basis of the *liquidity shock hypothesis*, i.e. a theory which suggests that financial factors are an important source of business cycles through their impact on asset prices. However, Shi (2015) documents puzzling positive effects of negative financial shocks on equity prices in a wide range of models with financial frictions. We argue that in the presence of equity and debt financing, the specification of the borrowing constraint is crucial to generating comovement between equity prices and key macro variables in response to financial shocks.

In a model that encompasses two popular borrowing constraints, i.e. a la Kiyotaki and Moore (1997) and a la Jermann and Quadrini (2012) (henceforth KM and JQ, respectively), asset prices and consumption fall substantially and persistently in response to a negative financial shock only in JQ. The interaction between the financial friction and the labor market is key to the result. Put simply, in JQ financial shocks are transmitted to the real sector through their effect on both investments and labor demand. When firm financing conditions tighten and it is costly to readjust the composition of external funds, the effective cost of labor increases thereby reducing labor demand. This effect on labor demand, absent in KM, strengthens macro-financial linkages. Consumption, employment and investment fall persistently in response to a negative financial shock. Importantly, tighter credit conditions also triggers a stock market crash. In contrast in KM, firms reacts to the shock by sharply cutting equity payouts, thereby insulating the rest of the economy, including the stock market, from disturbances to their financing conditions.

This paper contributes to the growing literature on macro-financial linkages (see Kiyotaki and Moore (1997), Bernanke et al. (1999) and Jermann and Quadrini (2012), among others) by showing that in order to generate an empirical plausible response in the economy to financial factors, the interplay between financial friction and labor market dynamics should not be neglected. Walentin (2014) highlights the importance of limited commitment for the comovement of macro variables and asset prices in response to news shocks, while Christiano et al. (2010), focus on nominal frictions. Our paper's emphasis is on disturbances which originate in financial markets, i.e. an unanticipated tightening of the collateral constraint. Our results highlight the important role of labor markets in the transmission mechanism of financial shocks.[1]

2 Model

Consider a discrete time infinite horizon economy populated by firms and households. Firms combine labor and capital to produce the final good. They can finance their activity with both debt and equity, but debt is preferred because it creates a tax shield. There are two sources of financial frictions. i) firms' ability to borrow is limited by a borrowing constraint ii) firms' financial structure is rigid, i.e. equity payout is subject to quadratic costs. Households are shareholders, consume the final good, supply labor and hold non-contingent bonds issued by the firms. In what follows, we describe in more details the economic environment.[2]

2.1 Setup

Preferences. Households hold both equity shares (s) and non-contingent bonds (b) issued by the firms. They choose consumption (c) and labor (l) in order to maximize their lifetime utility subject to a budget constraint

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln\left(c_t\right) + \eta \ln\left(1 - l_t\right)\right]$$

$$st : w_t l_t + b_{t-1}\left(1 + r_{t-1}\right) + s_{t-1}\left(d_t + q_t\right) - b_t - s_t q_t - c_t - T_t = 0$$

where T_t represents a lump-sum tax.[3]

Technology. The final output is produced by combining labor and capital according to a Cobb-Douglas production function, $Y_t = k_{t-1}^{\alpha} l_t^{1-\alpha}$. Each firm i maximizes its market value for the shareholders subject to the budget constraint and a borrowing constraint

$$\max E_0 \sum_{t=0}^{\infty} \Lambda_{t,t+1} d_{i,t}$$

$$st : Y_{i,t} - w_{i,t} l_{i,t} + b_{i,t} - \left(1 + r_{t-1}\left(1 - \tau\right)\right) b_{i,t-1} - I_{i,t} - \phi\left(d_{i,t}\right) = 0 \qquad (1)$$

[1] Wasmer and Weil (2014) reach a similar conclusion in a search theoretic model with financial and labor market frictions.

[2] The appendix reports all the first order conditions.

[3] Lump sum taxes are used to finance firms' interest rate deductions.

$$(1-\delta)\,k_{i,t}+\varrho\,(I_{i,t}(i),K_{t-1})-k_{i,t}=0 \tag{2}$$

$$b_{it}\leq BC \tag{3}$$

where $\Lambda_{t,t+1}=\beta\frac{c_t}{c_{t+1}}$ is the stochastic discount factor.

Investment (I_i) is subject to adjustment costs in aggregate capital (K), $\varrho\,(I_{i,t},K_{t-1})=\left(1-\frac{\Psi}{2}\left(\frac{I_{i,t}}{\delta K_{t-1}}-1\right)^2\frac{\delta K_{t-1}}{I_{it}}\right)I_{it}$ and equity payouts (d_t) are subject to a quadratic adjustment cost, $\phi\,(d_t)=d_t+\frac{\kappa}{2}\left(d_t-\bar{d}\right)^2$, where $\bar{d}$ is the steady-state payout target and κ can be interpreted as the degree of rigidity in a firm financial structure. Debt is limited by a borrowing constraint (BC) as specified below.

Financial Frictions. We consider three different specifications for the borrowing constraint (Eq.3)

$$JQ:\xi_t\,(k_t-b_t)-Y_t\,(k_{t-1},l_t)\geq 0,$$
$$KM:b_t+\Omega\frac{w_tl_t}{1+r_t}\leq\gamma_tE_t\frac{q_{t+1}k_t\pi_{t+1}}{(1+r_t)},\ \Omega\in\{0,1\}.$$

The first expression specifies an enforcement constraint, where ξ_t represents the probability that the lender will recover the full value of capital, k_t, in the event of liquidation. Exogenous changes in ξ_t, i.e. financial shocks, directly affect the effective cost of labor and its demand. Moreover, since both k_t and k_{t-1}, enter the constraint, present investment decisions have an impact on the future tightness of the constraint. This formulation follows Jermann and Quadrini (2012).[4]

The second formulation in which $\Omega=0$ represents a standard collateral constraint a la Kiyotaki and Moore (1997) (KM). Firms' borrowing capacity is limited to a fraction γ_t of the liquidation value of capital. When $\Omega=1$, producers are assumed to pay the wage bill before the realization of revenues (working capital). This modification creates a direct link between financial frictions and labor demand, as explained below. Exogenous movements in γ_t capture financial shocks in both specifications of the KM constraint.

[4]In Jermann and Quadrini (2012), it is assumed that the liquidation value of capital is k_t, rather than $q_{t+1}k_t$. Our main results are unchaged in a version of the model where q_{t+1} enters the constraint.

3 Financial Shocks and Equity Prices

3.1 Calibration

We calibrate the model to a quarterly frequency, closely following Jermann and Quadrini (2012).[5] Our benchmark calibration is reported in Table 1.

Table 1: Parameters' Values

Parameter		Value	Source or Target
α	Production technology	.360	Standard RBC
β	Discount factor	.985	JQ
υ	Utility parameter	1.630	$l_{ss} \approx 0.3$
δ	Depreciation rate	0.025	Standard RBC
τ	Tax advantage	.350	JQ
κ	Equity payout costs	.146	JQ
Ψ	Investment adjustment costs	1.728	Gertler and Karadi (2011)
$\bar{\gamma}$	Financial shock, mean	.380	$\frac{b}{Y} = 3.36$
$\bar{\xi}$	Financial shock, mean	.163	JQ
Ω	Working capital	0 (KM) or 1 (KM with working capital)	

3.2 Equilibrium responses to financial shocks

Figure 1 displays the impulse responses of key variables to a financial shock under the three alternative formulations for the borrowing constraint.[6] In what follows, we discuss the equilibrium dynamics in the three models separately.[7]

[5] We chose to calibrate the mean of the financial shock in KM, $\bar{\gamma}$, to target the same debt to quarterly GDP ratio as in JQ. Calibrating $\bar{\gamma}$ with flow of funds data on asset and liabilities for the non-financial corporate sector, would result in $\bar{\gamma} = .40$, a number roughly close to our benchmark calibration, $\bar{\gamma} = .38$.

[6] The shock is assumed to be 1% with a persistence of 0.95

[7] The models are log-linearized around the steady state under the assumption of an always binding collateral constraint.

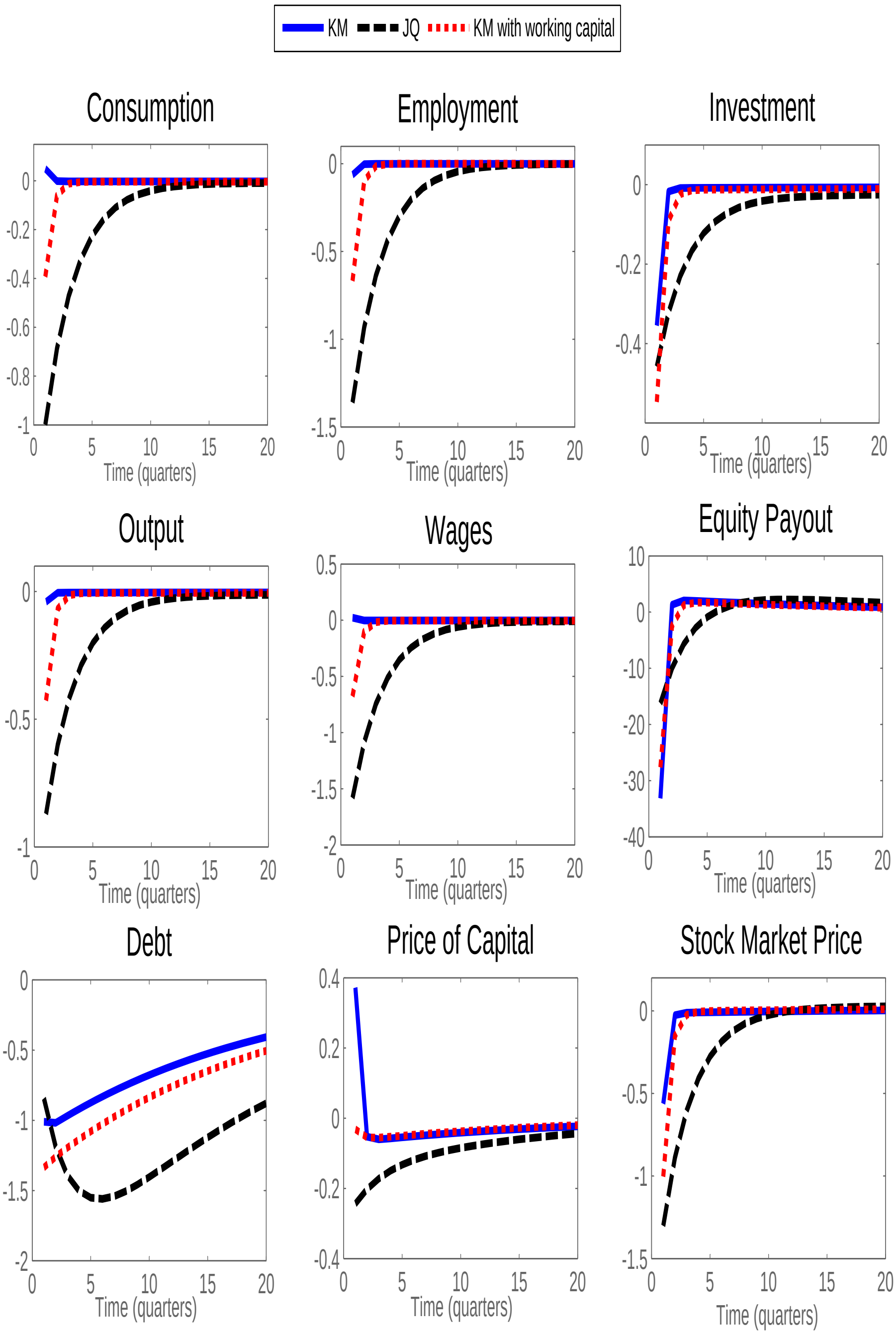

Figure 1. Responses to a negative financial shock under the three alternative specifications for the borrowing constraint.

Dynamics in JQ. A negative shock to ξ_t induces firms to restructure their financing position, by cutting debt and reducing equity payouts. In the presence of rigidities in firms' financial structure (κ) and investments (Ψ), firms are forced to reduce both employment and investments. This is better understood by inspecting of the labor demand schedule, $w_t = (1 - \phi_d(d_t)\mu_t) Y_{l_t}$ where $\phi_d(d_t) = 1 + \kappa(d - \bar{d})$ and μ_t is the Kuhn-Tucker multiplier on the enforcement constraint, i.e. a measure of financial tightness. The term $(1 - \phi_d(d_t)\mu_t)$ creates a labor wedge. The financial shock has a prolonged negative effect on both employment and consumption and thus, on the stochastic discount factor $(\Lambda_{t,t+1})$, thereby negatively impacting on asset prices. Both the stock market price, q_{stock}, and the price of capital, q_k fall.[8] To shed light on the response of q_k, it is useful to recall the two equations behind its dynamic

$$q_{k,t} = \mu_t \xi_t + E_t \Lambda_{t,t+1} \left[\frac{Y_{k_t}}{\phi_d(d_{t+1})} + (1-\delta) q_{k,t+1} - \mu_{t+1} Y_{k_t} \right] \tag{4}$$

$$q_{k,t} = \frac{1}{\left(1 - \Psi\left(\frac{I_t}{\delta k_{t-1}} - 1\right)\right) \phi_d(d_t)}, \tag{5}$$

the demand for capital and the Tobin's q relation, respectively. Eq. 4 expresses the price of capital as the discounted sum of the expected marginal return of investment. Notably, a future financing tightening (μ_{t+1}) depresses $q_{k,t}$ since capital investments in t influences the tightness of the constraint tomorrow through its impact on next period production. Eq. 5, documents how firms' ability to substitute debt for equity, i.e. a decrease in $\phi_d(d_t)$, has a positive effect on q_k. Nevertheless, this last channel does not prevail in JQ.

Dynamics in KM. The crucial difference between JQ and KM is the absence of a labor wedge linked to the firm's financing condition. The labor demand schedule now reads $Y_{l_t} = w_t$. This implies that rigidities in firms financial structure, (κ), do not impact employment or consumption but do impact investment and financial variables. Furthermore, the model shows a disconnect between the real and financial sectors. A financial tightening induces a sizable reduction in the equity payout, a short-lived and modest dampening in the stock market, and a counterfactual increase in the price of capital and consumption. The demand for capital is as follows

$$q_{k,t} = \frac{\mu_t \gamma_t}{(1 + r_t)} E_t q_{k,t+1} + E_t \Lambda_{t,t+1} \left[\frac{Y_{k_t}}{\phi_d(d_{t+1})} + (1-\delta) q_{k,t+1} \right].$$

[8] We refer to the stock market price as the value of the firms normalized by its networth, $q_{stock} = \frac{V}{k-b}$.

Intuitively, in KM the financial contraction is followed by a sharp reduction in dividend payouts. Despite the adjustment cost κ, switching source of finance does not impact on the labor market. The decrease in d, has a positive impact on q_k through the Tobin's q equation (Eq. 5). Moreover, the consumption response induces only a modest response in the stochastic discount factor. Importantly, a negative response of q_k to financial shocks is key to generating feedback effects from asset prices to the rest of the economy through their impact on the collateral constraint.

Dynamics in KM with working capital assumption. To further test our assumption about the importance of the interaction between financial frictions and the labor market we augment the standard KM constraint with working capital. The labor demand optimality condition now reads: $w_t = Y_{l_t}\left(1 + \mu_t \frac{\Omega}{(1+r_t)} \phi_d\left(d_t\right)\right)$. Working capital does indeed generate a labor wedge linked to credit market condition that contributes to the decline in the price of capital. With this variation, the model generates a more sizable response to financial shocks. However, with the exception of debt, all model variables display limited persistence.

4 Concluding remarks

We evaluate the asset price implications of financial disturbances. We document that a model with a borrowing constraint a la Jermann and Quadrini (2012), can successfully generate comovement across consumption, investment, hours worked and asset prices in response to financial shocks. The key is the interaction between credit conditions and labor demand. We also show that augmenting a standard KM constraint with a working capital assumption enhances the response of macro and financial variables after a financial shock, although the effects are not persistent.

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Appendix

Households' first order conditions

$$U_c = \frac{1}{c_t}$$

$$U_l = -v\frac{1}{1-l}$$

$$-\frac{U_{l_t}}{U_{c_t}} = w_t,$$

$$U_{c_t} = \beta E_t U_{c_{t+1}} \frac{(1+r_t)}{\pi_{t+1}},$$

$$\beta E U_{c_{t+1}} (d_{t+1} + q_{t+1}) = U_{c_t} q_t$$

Firms' first order conditions

$$
\begin{aligned}
q_{k,t}\varrho' &= \frac{1}{\phi_d\left(d_t\right)} \\
\varrho'\left(I_t, K_{t-1}\right) &= 1-\Psi\left(\frac{I_t}{\delta k_{t-1}}-1\right) \\
\varrho\left(I_t, K_{t-1}\right) &= \left(1-\frac{\Psi}{2}\left(\frac{I_t}{\delta k_{t-1}}-1\right)^2\frac{\delta k_{t-1}}{I_t}\right)I_t
\end{aligned}
$$

$$
\begin{aligned}
Y_t - w_t l_t + b_t - \left(1+r_{t-1}\left(1-\tau\right)\right)\frac{b_{t-1}}{\pi_t} - I_t - \phi\left(d_t\right) &= 0, \\
\left(1-\delta\right)k_{t-1} + \varrho\left(I_t, K_{t-1}\right) - k_t &= 0
\end{aligned}
$$

$$
\begin{aligned}
Y_t &= k_{t-1}^{\alpha} l_t^{1-\alpha} \\
Y_{l_t} &= \left(1-\alpha\right) l_t^{-\alpha} k_{t-1}^{\alpha} \\
Y_{k_{t-1}} &= \alpha l_t^{1-\alpha} k_{t-1}^{\alpha-1}
\end{aligned}
$$

with KM constraint

$$b_t + \Omega\frac{w_t l_t}{1+r_t} \leq \gamma\zeta_t E_t\frac{q_{t+1}k_t}{1+r_t}$$

$$Y_{l_t} = w_t\left(1+\mu_t\frac{\Omega}{\left(1+r_t\right)}\phi_d\left(d_t\right)\right),$$

$$\mu_t = \frac{1}{\phi_d\left(d_t\right)} - E_t\Lambda_{t,t+1}\frac{1}{\pi_{t+1}}\frac{1}{\phi_d\left(d_{t+1}\right)}\left(1+r_t\left(1-\tau\right)\right),$$

$$q_{k,t} = \frac{\mu_t\gamma_t E_t q_{k,t+1}}{\left(1+r_t\right)} + E_t\Lambda_{t,t+1}\left[\frac{Y_{k_t}}{\phi_d\left(d_{t+1}\right)} + \left(1-\delta\right)q_{k,t+1}\right]$$

with JQ constraint

$$\xi_t\left(k_t - b_t\right) - Y_t \geq 0$$

$$Y_{l_t} = \frac{w_t}{\left(1-\phi_d\left(d_t\right)\mu_t\right)}$$

$$\xi_t\phi_d\left(d_t\right)\mu_t + \Lambda_{t,t+1}\left(1+r_t\left(1-\tau\right)\right)\frac{\phi_d\left(d_t\right)}{\phi_d\left(d_{t+1}\right)}\frac{1}{\pi_{t+1}} = 1$$

$$q_{k,t} = \mu_t \xi_t + E_t \Lambda_{t,t+1} \left[\frac{Y_{k_t}}{\phi_d \left(d_{t+1} \right)} + (1 - \delta) \, q_{k,t+1} - \mu_{t+1} Y_{k_t} \right]$$

Resource constraint

$$Y_t - c_t - \frac{\kappa}{2} \left(d_t - \bar{d} \right)^2 - I_{t+1} = 0$$

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