Firm Entry and Financial Shocks

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Abstract
Firm entry dynamics over the business cycle are an important part of the propagation of financial shocks to the real macroeconomy. A VAR documents that adverse financial shocks in the U.S. postwar period are associated with a significant fall in new firm creation and a decline in firm equity values. We study the interaction of firm entry, equity price, and output determination in a novel DSGE business cycle model that combines endogenous firm entry and financial frictions. Firms have a choice of financing entry through debt as well as equity. We find that a fall in the number of firms can be a margin of macroeconomic adjustment to an adverse financial shock, as it buffers the equity value and financial stance of surviving firms.

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1. Introduction

Recent events have spurred interest in the financial sector as a source of business cycle fluctuations. As is well known, if firms rely upon financing for current production costs, shocks to the ability to secure such financing can lead to fluctuations in production.[1] Less well known is the fact that in addition to a fall in production, the recent financial crisis also has been characterised by a dramatic fall in the rate of new firm creation: the quarterly rate of establishment births in the U.S. fell 22.5% from June 2007 to its low point in June 2009.[2] This paper shows that the fall in firm entry is an important part of the transmission of financial shocks to the real economy. While it has become common in recent business cycle models of financial frictions to study how financial frictions affect the real economy through the need for external financing to cover current production costs, we believe it is also important to study the implications for what may be the greatest need for external financing of a firm, its initial startup costs.

The paper represents a contribution to the growing literature on firm entry dynamics. While this literature has shown that firm entry is important for understanding business cycle dynamics, it has focused mainly on the propagation of productivity shocks or monetary policy shocks.[3] Further, this literature tends to abstract from the question of how this entry is financed, either assuming equity financing or not specifying the means of financing.[4] Inspired by empirical evidence that new entrants must rely on a combination of external borrowing and equity issuance to finance entry costs, we model firms with a choice between alternative means of financing. The endogenous shift in this financing choice in response to a financial shock helps explain the comovement of financial market conditions, firm valuations, and entry decisions.[5]

The paper begins by documenting new facts regarding the dynamic relationship

[1] See for example Jermann and Quadrini (2012), and Monacelli, Quadrini and Trigari (2011).

[2] Source: author calculations based on quarterly establishment birth statistics of the Business Employment Dynamics report of the U.S. Bureau of Labor Statistics (BLS).

[3] For leading examples on firm entry dynamics, see Bilbiie, Ghironi and Melitz (2007, 2012), Bergin and Corsetti (2008), Corsetti, Martin and Pesenti (2007), and Ghironi and Melitz (2005).

[4] Our model is also distinct from the few papers that do model entry cost financing in the form of debt or bank lending, such as Stebunovs (2008), Cacciatore, Ghironi, and Stebunovs (2015), Notz (2012), Casares and Poutineau (2013), Karasoy (2012), Macnamara (2012), and Uusküla (2015a, b), in that we model the endogenous choice that firms have between debt and equity financing rather than a fixed type of financing. It is the endogenous shift in this financing choice in response to a financial shock that generates our key results.

[5] Our model is also distinct from work in the macro-finance literature studying the effect of financial shocks on the allocation of resources between different groups of agents (for example Bassetto, Cagetti, and De Nardi (2015) and Buera, Jaef, and Shin (2015)), as these papers do not focus on firm entry dynamics, and hence do not uncover our finding that a fall in firm entry helps offset the effects of a financial shock on surviving firms. They also do not model the endogenous firm financing decision between debt and equity that drives our results.

of firm entry and equity prices in response to a financial shock. The fall in firm creation observed in the recent crisis is not atypical; using a vector-autoregression on U.S. postwar data, we find that an adverse financial shock leads to a fall in new firm creation. We also find that the financial shock is associated with a fall in equity prices. The fall in entry is hump-shaped, building over several quarters before becoming significant, while the impact on equity price applies to the short run and dies away around the time that the fall in firm entry becomes substantial.

In constructing a DSGE model that can replicate these facts, a key is our novel specification that firm entry is financed by an endogenous mix of debt and equity. The choice between debt and equity financing has consequences for real economic activity in our model, as heterogeneity in time preferences among agents breaks the Modigliani-Miller (MM) theorem. This is consistent with developments in the corporate finance literature, where there is ample empirical evidence of failure in Modigliani-Miller,[6] as well as significant research focused on the microeconomic implications of capital restructuring between debt and equity.[7] Further, empirical support for cyclical reallocations of firm financing between debt and equity has been provided by Jermann and Quadrini (2012).

An adverse financial shock takes the usual form of a tightening of the collateral constraint for borrowing working capital during a period, which reduces the scale of firm production. Since equity is used as collateral, the shock creates an incentive for firms to reallocate firm financing away from intertemporal debt toward equity financing. Because equity is a more costly form of firm financing (due to a lower degree of patience among investors compared to workers), this capital structure reallocation raises the cost of financing new firm entry, and hence deters potential entrants from entering the market. So the endogenous choice of firm financing transmits a standard adverse financial shock, affecting the overall level of production and profits, to affect also the level of new firm entry.

This model of firm entry provides new insights into the economic adjustment to an adverse financial shock. In particular, the adjustment in the extensive margin of firm numbers buffers the effect at the intensive margin of firm size and profits, and even mitigates the impact of the shock on macroeconomic aggregates. This results from a fundamental implication of the free entry condition, that the impact of a negative financial shock is split between a fall in firm value (and hence firm equity price) and a fall in the number of firms. To the degree that an adverse financial shock lowers the number of active firms, each existing firm gets a larger share of aggregate

[6] For example, see Rajan and Zingales (1995); Berger and Udell (1998); Hovakimiana, Hovakimian and Tehranianc (2004).

[7] See Strebulaev and Whited (2011) for a survey

profits, buffering the fall in incumbents' equity price. Firstly, this can help explain our empirical finding that equity prices tend to recover rather quickly after an adverse financial shock, once firm entry begins to respond to the shock. Secondly, given that the tightness of the financial constraint depends on the collateral value of the firm equity, a fall in the number of firms moderates the impact of a shock to tighten the financial constraint. In fact, in simulations where the fall in entry is dampened by an adjustment cost, an adverse financial shock has greater bite on borrowing for production, and aggregate output falls more.[8]

The model's specification of the financial friction is related to Kiyotaki and Moore (1997) and more recent work such as Jermann and Quadrini (2012) in that a firm's borrowing capability is restricted by its asset value. In particular, Jermann and Quadrini (2012) introduces the idea of capital structure into a macro-finance model without firm entry.[9] We show that firm entry fundamentally alters the way that capital restructuring works, as the free entry condition implies a linkage between a firm's equity price and the entry of the marginal firm. This both imposes a restriction on the ability of a firm to use capital restructuring to manipulate its own equity price in equilibrium, and also amplifies the response of new firm entry to a financial shock. Our paper is most similar to Macnamara (2012), which studies the importance of financial frictions for entry over the business cycle. We differ in that financial shocks influence entry decisions by affecting the cost of financing startup costs rather than just through affecting production and expected future profits. This allows financial shocks of the standard type to have large effects on firm entry levels in our model.

The remainder of this paper is structured as follows. Section 2 documents new stylised facts. Section 3 introduces the DSGE model and provides some intuition for model implications. Section 4 presents simulation results. Section 5 concludes.

2. Empirical Motivation

We use a vector autoregression to estimate the dynamic response of firm entry and stock prices to financial shocks in the U.S. economy. The number of new incorporations is one measure of firm entry, compiled by the Dun and Bradstreet

[8] This finding does not contradict claims that a fall in firm entry can also have other harmful effects not included in the standard firm dynamics literature, such as if new firms are disproportionately responsible for new job creation, as found in Foster, Haltiwanger and Syverson (2012). Although our model abstracts from heterogeneity between firms, due to the complexity associated with monopolistic competition in the goods market, our findings provide a complement to this argument that has not been presented previously in the literature.

[9] Some papers in the macro-finance literature include firm entry, but their focus differs from ours. For example, Khan, Senga and Thomas (2014) studies how credit crunch affects capital misallocation, aggregate TFP, and the cyclicality of entry and exit. Gomes and Schmid (2014) explores the importance of credit risk in explaining risk premium and aggregate fluctuations.

Corporation and obtained from Economagic.[10] For robustness, we will also consider the index of net business formation published in the Survey of Current Business. The S&P500 index, which covers 75% of US equities, is used as a proxy of stock prices.[11]

A 6-variable VAR model is estimated at a quarterly frequency, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of new incorporations, and logarithm of S&P500 index. The interbank lending rate is used as a measure of tightness of financial conditions over time as in Chor and Manova (2012), as it is a broad measure of overall financial liquidity. We represent an exogenous financial shock as an innovation to the lending rate orthogonal to contemporaneous movements in other macroeconomic variables, including the nonborrowed reserves ratio. The latter variables are included to help disentangle the effects on the lending rate due to monetary policy from the effects of an exogenous financial shock. We follow Eichenbaum and Evans (1995) and Bernanke and Mihov (1998) to assume that output and consumer prices are not contemporaneously affected by monetary policy shocks, and thus specify a VAR ordering the non-borrowed reserves ratio after industrial production and CPI. We order entry after the variables representing shocks discussed above, which allows the data to speak as to whether this variable responds on the impact of shocks or with a lag (see Bergin and Corsetti (2008)). We order stock prices last, which allows for the possibility that stock prices tend to respond quickly to new information (see Thorbecke (1997)).[12]

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[10] This data series is commonly used in empirical finance literature (see Black and Strahan, 2002), running from 1959:1 to 1996:9. We do not use the establishment births data series of the BLS noted in the introduction because that data series only begins in 1994 and covers only two recessions, so it is less suitable for time series analysis. There are other data sources that provide new firm incorporation data, such as the datasets of the Annual Survey of Manufacturers (ASM) and the Census of Manufacturers (CM) of the Longitudinal Research Database (LRD) compiled by the U.S. Bureau of the Census. However, the ASM dataset last for the period of 1972 to 1997 at an annual frequency (see Lee and Mukoyama, 2015), and the CM dataset was only collected every five years for the period of 1963 to 1982.

[11] Data on the net business formation index comes from the Survey of Current Business, running from 1951:1 to 1994:12. In addition to using the S&P 500 as a measure of the general level of stock prices, we also use the Nasdaq Composite and the Wilshire 5000 as measures of equity prices for robustness checks. Results are consistent with our baseline results, regardless of how equity price is measured, implying that the composition of the index in terms of large or small firms does not affect our empirical result.

[12] A well-known disadvantage of using a Cholesky decomposition on the reduced-form residuals is that results can be sensitive to the ordering of variables, calling into question the validity of the restrictions used for identification. In addition, ordering restrictions typically are not derived from a theoretical model. We conduct robustness checks of alternative orderings, reported in the supplementary appendix A1, to investigate which ordering assumptions are important for our results and which are not. We find that the results do not depend on the assumptions about whether entry is contemporaneously correlated with other disturbances in the system. We also find that our conclusions regarding the negative response of stock prices to an exogenous financial shock are robust to alternative orderings, provided the stock prices index is placed after the lending rate. This is intuitive, as stock prices are generally thought to respond to new information quickly. We also found results are robust to alternative orderings and also alternative data sources for identifying financial shocks. (Again

Fig. 1a reports impulse responses for the system including new incorporations, covering the sample period 1963:1 to 1996:3, for which the data are available.[13] Error bands indicate plus and minus two standard deviations. It shows that firm numbers respond negatively and persistently to a credit tightening shock. However, the responses of firm numbers to the financial shock requires 6 quarters before becoming significant, and the negative effect lasts 12 quarters. The maximal drop occurs 8 quarters after the shock. In contrast, stock prices respond instantly to a credit tightening shock, and the negative responses of stock prices last for around 4 quarters. An adverse financial shock also leads to an immediate and persistent fall in output. The responses of CPI and the nonborrowed reserves ratio are not significant to an adverse financial shock.

Fig. 1b reports impulse responses for the VAR system including net business formation, covering the sample period 1963:1 to 1994:4, for which the data are available. The figure shows that impulse responses are very similar to those in the previous figure. In addition, we provide some robustness checks: using alternative measures of the equity price; replacing lending rate by other measures of financial conditions, such as TED spread (interbank lending rate - 3 month T-bill rate) and Chicago Fed National Financial Conditions Index; and reordering the variables in our recursive VAR model. Our benchmark results are robust to other alternative choices of financial shock identifications. The results are available in the supplementary Appendix A1.

We conclude that financial shocks leading to recession do have negative effects on firm entry and equity prices, but that the effect on entry is hump-shaped and the effect on equity prices is short-lived while that on entry emerges around the time that the effect on equity prices disappears. We next look to our theoretical model to provide an explanation for this pattern of empirical findings.

3. Model

The model considers a closed economy with four different types of agents: (1) a perfectly competitive final goods sector that combines all available intermediate goods with a CES aggregator, (2) a monopolistically competitive intermediate goods sector with endogenous firm entry, (3) a representative investor who finances new and existing intermediate firms through equity purchase, and (4) a representative worker who supplies labor to the intermediate firms and purchases bonds from these firms.

The final goods are consumed by the investor and the worker. As is common in

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see appendix A1.)

[13] Our sample starts from 1963:1 because data on 3-month interbank lending rate coming from Datastream starts from 1963:1.

the literature (see Perri and Quadrini (2011), for example), we assume that the investor is less patient than the worker; that is, the investor has a smaller discount factor than the worker. Because firms are owned by the investor, the assumption generates a borrowing incentive for firms: the lower discount factor of the investor implies that in equilibrium firms prefer borrowing from the worker.[14] The investor's only income is from the equity investment in the intermediate firms, while the worker finances his consumption through wage payments and bond investment in the intermediate firms.

The intermediate goods producers are monopolistically competitive, and each of these firms produces a distinct variety. They hire labor from the worker and issue equities and corporate bonds, which are purchased by the investor and the worker, respectively. To finance production (working capital), they must also borrow an intra-period loan. Because the borrowers may default on their loan repayment, their borrowing is subject to an enforcement constraint.

New firms are free to enter the intermediate goods market subject to a one-time sunk investment, and entrants can finance this startup investment with a mix of debt and equity. Our model of firm entry differs from the most common specification, as found in Bilbiie, Ghironi and Melitz (2012), in that firms are permitted to begin production immediately in the period of entry. This specification allows us to assume identical financial constraints defined over working capital facing all firms, both incumbents and new entrants, implying identical capital structure decisions among all firms. This homogeneity among firms significantly simplifies the model analysis, as will be discussed further below.

3.1 Final goods sector

The final goods sector is perfectly competitive. The production of final goods (Y_t) is a CES aggregate of all $\tilde{n}_t$ existing varieties ($y_{i,t}$) at the beginning of period *t*, $Y_t = \mathrm{N}_t \left[\int_0^{\tilde{n}_t} y_{i,t}^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}$, where the efficiency index N_t is defined as $\mathrm{N}_t \equiv \tilde{n}_t^{\gamma - \frac{\sigma}{\sigma-1}}$, capturing the effect of variety on the production of final goods. For a given

[14] Some motivation for this discount factor heterogeneity might be taken from the fact noted in Iacoviello (2005, 2015) that the average annual return on bonds (2%) is lower than that on equities (6%). Our assumption that investors, who are the only holders of equities in our model, are more impatient than workers, who are holders of bonds, is one way of making the model consistent with this fact. Indeed, this difference in returns will be used below to calibrate these two discount factors.

requirement Y_t, the larger the efficiency index N_t, the smaller the demand of produced goods $\int_0^{\tilde{n}_t} y_{i,t} di$. As in Benassy (1996) σ is the intratemporal substitution elasticity across varieties, and γ captures the degree of love for variety. When γ is restricted so that $\gamma = \sigma / (\sigma - 1)$, our specification of final goods production is the standard one in Dixit and Stiglitz (1974). But robustness checks to follow will investigate sensitivity to this restriction.

The demand for individual variety and the corresponding price indices are thus given by:

$$y_{i,t} = \mathrm{N}_t^{\sigma-1} \left(\frac{p_{i,t}}{P_t} \right)^{-\sigma} Y_t = \tilde{n}_t^{-\gamma} Y_t, \tag{1}$$

$$P_t = \frac{1}{\mathrm{N}_t} \left(\int_0^{\tilde{n}_t} p_{i,t}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}} = \tilde{n}_t^{1-\gamma} p_{it} \tag{2}$$

where the second equalities are from the symmetric equilibrium as shocks in the economy are at the aggregate level and common to all firms. The CES aggregator suggests that when there are more varieties, a household could spend less to derive the same amount of welfare, ceteris paribus. Therefore, the price index decreases and the relative price of each variety rises.

3.2 Production, enforcement constraint, and endogenous entry

We build on the specification of financial frictions in Jermann and Quadrini (2012) by assuming that firms use equity and debt to finance production. Debt is preferred to equity because borrowers (firm owners) discount the future more heavily than lenders (workers), implying that debt is cheaper for firm financing. That is, $\beta_I < \beta$. Here, β_I and β represent the discount factor of investors (firm owners) and the household workers, respectively. When borrowers discount the future more heavily than lenders, the cost of external financing (through bond issuance, denoted by b_t) is lower than the cost of internal funds (through equity share issuance, denoted by s_t). This assumption of heterogeneous agents ensures that the borrowing constraint is not irrelevant.

The timeline of the economy is shown in Table 1. Each period starts with two aggregate state variables: the technology shock (A_t), and the financial shock (ξ_t). We will describe the financial shock (ξ_t) in more detail in the next section. At the beginning of each period, the economy consists of n_{t-1} incumbent firms, each of which has a matured debt repayment b_{t-1}. There are also ne_t new entrants who enter the market, hire labor and produce as the existing incumbents do, except that these new entrants do not have a matured debt repayment from last period. The final goods are constructed over the $\left(n_{t-1}+ne_t\right)$ varieties. That is, $\tilde{n}_t \equiv n_{t-1}+ne_t$.

Then, the incumbents and the new entrants hire labor, issue corporate bonds and stocks and produce goods, workers supply labor and make consumption and bond investment decision over the $\tilde{n}_t$ firms, investors purchase goods for consumption as well as corporate equities of the $\tilde{n}_t$ firms, and goods and labor markets clear.

At the end of each period after all markets have cleared, there is an exogenous death shock which applies to all incumbents and new entrants, and which occurs with a probability of λ. Because death shock occurs at the end of each period, only n_t firms remain in the market after the death shock:

$$n_t = \left(1-\lambda\right)\left(n_{t-1}+ne_t\right). \tag{3}$$

3.2.1 Enforcement constraint

The labor market requires that firms must make factor payments to the worker at the beginning of each period before the realization of revenue. In addition to the inter-temporal debt, b_t as described above, firms borrow an intra-period loan to pay the wage payment $w_t l_{it}$, where w_t is the wage rate and l_{it} is the labor input of firm i. The intra-period loan is repaid at the end of each period and there is no interest. In addition, the dividend from the current period can be easily diverted, and thus only the end-of-period firm value, $E_t(m_{t+1}V_{i,t+1})$, can be used as collateral, where

$m_{t+1} = \beta_I (1-\lambda) U_{CI,t+1} / U_{CI,t}$ is the discount factor as the firms are essentially owned by the investor through equity purchases. In this case $E_t(m_{t+1}V_{i,t+1})$ is the ex-dividend market value of the firm, that is, the end-of-period equity value which excludes the dividend of period t.

As firms may default on their debt repayments, their borrowing ability is restricted by an enforcement constraint:

$$\xi_t E_t(m_{t+1}V_{i,t+1}) \geq w_t l_{i,t} . \quad (4)$$

It can be shown that the end-of-period firm value is the same as the firm's equity value (q) as the latter is defined as the expected discounted value of dividend payouts starting from period $t+1$. The end-of-period firm value is typically decreasing in debt issuance, because debt issuance reduces the future payments that can be delivered to the shareholders, holding everything else equal.

In our setting, this enforcement constraint stipulates that lenders are willing to lend only if the liquidation value in case of default is at least sufficient to cover the loaned amount. Here, the lenders can only liquidate the firms' end-of-period value $E_t(m_{t+1}V_{i,t+1})$, but suffer a liquidation loss ($\xi_t < 1$). The stochastic innovation ξ_t is defined as "a financial shock," which captures the countrywide "liquidity" of firm assets. When market credit conditions worsen, lenders might have a low probability of finding a buyer, or might possess low bargaining power in liquidating the firm's remaining assets. Consequently, lenders impose tighter constraints on firm borrowing when liquidity dries up or when firm assets have low liquidity.

3.2.2 Firm production and pricing

Each incumbent firm produces a unique variety, requiring only one factor, labor:

$$y_{i,t} = A_t l_{i,t}, \quad (5)$$

where A_t is the aggregate productivity common to all firms, and $l_{i,t}$ is the input of labor by firm i.

Firm dividends are given by:

$$d_{i,t} = \pi_{i,t} - \left(b_{it-1} - \frac{b_{it}}{R_t} \right), \quad (6)$$

where $\pi_{i,t} = p_{i,t} y_{i,t} / P_t - w_t l_{i,t}$ defines the operating profit from firm production.

The optimization problem is choosing the price of the individual variety, $p_{i,t}$, the dividend payout, $d_{i,t}$, and the new debt, $b_{i,t}$, to maximise the cum-dividend market value of the firm, $V_{i,t}(b_{it-1})$, that is, the beginning-of-period firm value which includes dividend:

$$V_{i,t}(b_{it-1}) = \max_{p_{i,t}, b_{it}} \{d_{i,t} + E_t(m_{t+1} V_{i,t+1}(b_{it}))\}, \tag{7}$$

subject to the dividend equation, (Eq. 6), the enforcement constraint, (Eq. 4), the demand for individual variety (Eq. 1) and the production technology (Eq. 5).

The optimization implies the following pricing rule and the multiplier associated with the enforcement constraint:

$$\frac{p_{i,t}}{P_t} = \frac{\sigma}{\sigma - 1} \frac{w_t}{A_t} (1 + \mu_t), \tag{8}$$

$$\mu_t = \frac{1/R_t - E_t m_{t+1}}{\xi_t E_t m_{t+1}}, \tag{9}$$

where μ_t is the Lagrange multiplier associated with the enforcement constraint. It is the shadow price of the intra-period loan on firm value, and measures the relative cost of bond financing (R_t) to equity financing ($1/E_t m_{t+1}$) for a financially constrained firm adjusted by the financial market condition (ξ_t). Holding everything else constant, a worsening financial market condition (falling ξ_t) increases the tightness of the financial constraint (rising μ_t).

To avoid the tightness induced by an adverse financial shock, a firm may reduce its debt issuance to smooth its real production. This is because when a firm decreases its bond issuance, it reduces the current period dividend payouts but simultaneously enjoys the benefit of increased end-of-period equity value and loosened financial constraint since equity is used as collateral. Equation (9) equates this benefit and cost of bond issuance.

More specifically, when a firm increases its bond issuance by one additional unit, its current period dividend payouts will increase by $1/R_t$ as shown in Equation (6), which contributes positively to the beginning-of-period firm value, holding the firm's end-of-period equity value unaffected as shown in Equation (7). However, more debt issuance generates two negative effects on the end-of-period firm value: directly reducing the value by $E_t m_{t+1}$, and indirectly reducing the value by $\mu_t \xi_t E_t m_{t+1}$ due to a tighter financial constraint. The direct effect is that one more unit of debt issuance will increase next period's debt repayment and reduce next period's firm value by one additional unit, which equals a drop of $E_t m_{t+1}$ in terms of present value. The indirect effect works through the increased tightness of the financial constraint. The drop of present equity value reduces the value of firm collateral assets, decreasing the intra-period loan by the amount of $\mu_t \xi_t E_t m_{t+1}$, relying on the financial market condition (ξ_t) and the shadow value of the collateral asset (μ_t).

Eq. (9) also shows that, first, in steady state it is always the case that $\mu > 0$, as bond financing is cheaper given that workers are more patient than investors, and firms prefer cheaper bond financing to more expensive equity financing. This suggests that the enforcement constraint is binding and a firm borrows up to the limit. Second, an adverse financial shock (falling ξ_t) will increase the tightness of the financial constraint (rising μ_t), holding everything else constant. This increased tightness will cause a switch from cheaper bond financing to more expensive equity financing as the equity asset is more valuable when adverse financial shocks hit the financial constraint (Eq. 4).

The increased tightness (rising μ_t) will lead to rising goods prices according to Eq. (8), holding all else constant. The wedge term, $\left(1+\mu_t\right)$, represents the credit channel introduced by the financing constraint arising from the intra-period loan, and suggests that financial shocks work first through affecting labor demand. This is because under a binding financial constraint, a firm's marginal cost of production is the labor cost (w_t/A_t) augmented by the wedge term that depends on the 'effective' tightness of the enforcement constraint (μ_t). When an adverse financial shock increases the tightness of the financial constraint, it increases the effective cost of labor and reduces labor demand, and hence affects real production. The impact of financial shocks on real production is further magnified by the entry dimension adjustment as the capital restructuring from debt toward equity financing induces falling firm value at the beginning of period which deters firm entry, and the entry adjustment makes it more costly for an individual firm to do capital restructuring (see more discussion of this point below).

3.2.3 Firm entry

A new entrant makes several decisions: whether to enter, how much debt to issue, and the decision of what price to set, which directly implies the level of production and labor demand. As noted in Table 1, we assume that these decisions take place in the same period, rather than specifying that the entry decision is made in the period before production begins. [15]

Our derivation of the entry condition parallels that in Arellano, Bai and Zhang (2012a), as we share with their model the feature that payment of the entry cost occurs in the same period as the decision of how much debt to issue, which allows us to claim that payment of the entry cost, K_t^E, is in part debt financed.[16] Begin by specifying the value of entering the market:

$$V_{it}^{entry} = \max_{p_{it}^{new}, b_{it}^{new}} \left\{ d_{it}^{new} + E_t \left(m_{t+1} V_{it+1} \left(b_{it}^{new} \right) \right) \right\}. \tag{10}$$

This differs from the value of an incumbent firm of in Eq. (7) in that the new entrant begins the period with zero debt inherited from the previous period ($b_{it-1}^{new} = 0$). A new entrant produces and generates profits in the initial period, as well as issuing debt and paying the entry cost which is measured in units of final goods.[17] The term d_{it}^{new}

[15] We do not assume a lag between entry and production because the assumption of simultaneous entry and production simplifies our model significantly, by allowing us to preserve the property that all firms, both incumbents and new entrants, are homogeneous and face the same enforcement constraint. If we were to specify that new entrants make their equity/debt decision when paying a sunk cost in a period prior to production, the fact that there is no production for the new firm in that period means they do not face a constraint for working capital that period, and hence they will make a different equity/debt decision than incumbents, and firms will not be homogeneous in terms of their capital structure.

[16] While directly analogous to Arellano, Bai and Zhang (2012a), there are two differences. First, K_t^E for us is an entry cost while for them it is investment in initial capital stock. Second, because we have production in the initial period, we must also include operating profits in the initial period. However in their paper as production requires capital accumulated from last period, they do not have production in the same period as entry, so current operating profits do not appear in their entry condition.

[17] In supplementary Appendix A3 we find that our benchmark results still hold when entry cost is

represents retained earnings by the new entrant in the initial period, and will take the value: $d_{it}^{new} = \pi_{it}^{new} + b_{it}^{new} / R_t - K_t^E$ where the operating profits are $\pi_{it}^{new} = p_{it}^{new} y_{it}^{new} / P_t - w_t l_{it}^{new}$. Substituting this into Eq. (10), we may write the value of new entry as $V_{it}^{entry} = \pi_{it}^{new} + b_{it}^{new} / R_t + E_t\left(m_{t+1} V_{it+1}\left(b_{it}^{new}\right)\right) - K_t^E$. Given that firms produce in the initial period of entry as in the specification of Melitz (2003), our term V_{it}^{entry} corresponds to what Melitz defines as his "net value of entry," which nets out the entry cost.

As in Melitz (2003), new firms enter as long as the net value of entry (V_{it}^{entry}) is positive. This directly implies the entry condition:

$$\frac{b_{it}^{new}}{R_t} + E_t\left(m_{t+1} V_{it+1}\left(b_{it}^{new}\right)\right) + \pi_{it}^{new} = K_t^E . \tag{11}$$

Since issuance of equity and bonds happens at the same time as payment of the entry cost, this entry condition can be used to show how the liquidity used to pay the entry cost comes from three sources: part is financed by issuing debt, which is a claim to future interest payments; part is financed by selling equity, which are claims to future dividends, computed as profits minus interest payments plus newly issued debt; finally, part is financed by retained profits in the current period.

To facilitate our analysis of the firm entry decision, we will report several different measures of firm value. We explicitly define a firm "asset value" as $V_{i,t}^a = \frac{b_{it}^{new}}{R_t} + E_t\left(m_{t+1} V_{it+1}\left(b_{it}^{new}\right)\right)$, which is the sum of bond value and equity price. In the entry condition (Eq. (11)), $V_{i,t}^a$ captures the liquidity available to a new entrant from issuing financial assets, the equity ($E_t\left(m_{t+1} V_{it+1}\left(b_{it}^{new}\right)\right)$) and the bond ($b_{it}^{new}$), which can be used toward paying the entry cost. In addition, given that production occurs in the period of entry, a new entrant also has operating cash flows (π_{it}^{new}). So we also define an explicit symbol for the "beginning of period total value of the new entrant" $V_{i,t}^{new} = V_{i,t}^a + \pi_{it}^{new}$, which includes both asset value and operating cash flow. This is the measure most relevant economically for understanding firm entry, because

specified in units of effective labor and wage is sticky.

the entry condition (Eq. (11)) indicates that entry continues until this measure of firm value equals the sunk entry cost, K_t^E. A firm will enter as long as it is able to raise the amount of liquidity required to pay the entry cost.[18]

Our entry condition is consistent with the empirical literature on external financing of firm entry, which states that firms use various external financing sources, such as operational incomes, equity as well as debt, to finance their entry cost, and debt financing plays a significant role in the entry stage.[19] In the theoretical corporate and macro-finance literature, entry conditions involving debt are not new: see for example Cooley and Quadrini (2001), Chen, Miao and Wang (2010), and Monacelli, Quadrini and Trigari (2011)).

We now turn to the financing and pricing/production decision of the new firm. Just as for the incumbents, the new firm maximises the beginning-of-period firm value (Eq. 10, in this case) subject to the retained earning equation, (Eq. 6), the enforcement constraint, (Eq. 4), and the demand for individual variety (Eq. 1). In addition to facing an entry cost, another difference in the problem of a new firm from that of an incumbent is that a new firm enters the period with no matured debt payment ($b_{it-1}^{new} = 0$). Because the enforcement constraint here is not affected by the initial bond position, the first order conditions are the same as for an incumbent (Eqs. 8 and 9). We thus conclude that the choice variables of the new firms are the same as for the incumbents: $b_{it}^{new} = b_{it}$, $p_{it}^{new} = p_{it}$. From Eqs. (1), (5) and (6), we then have that $y_{it}^{new} = y_{it}$, $l_{it}^{new} = l_{it}$, and $\pi_{it}^{new} = \pi_{it}$, which further indicates that new entrants and incumbents hold the same level of firm asset value, that is, $V_{i,t}^a = \frac{b_{it}}{R_t} + E_t\left(m_{t+1}V_{it+1}\left(b_{it}\right)\right)$ applies to incumbent firms as well as new entrants.

So new firms will respond to an adverse financial shock in the same way as incumbent firms, by choosing a smaller level of debt issue than they otherwise would choose, as this raises end-of-period equity value and relaxes the financial constraint arising from borrowing working capital. In the context of the entry condition (11) this indicates that new firms switch the financing of entry cost payments away from

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[18] Note that new entrants do not pay dividends in the initial period, as the retained profits are used to help finance the entry cost rather than pay out dividends. This simply reflects the specification that entrants begin producing in the same period as they pay entry costs, rather than assuming a lag before production begins.

[19] See for example Berger and Udell (1998) and Arellano, Bai and Zhang (2012a) for evidence on private firms, and Rajan and Zingales (1995), and Hovakimian, Hovakimian, and Tehranian (2004) for evidence on public firms.

cheaper debt financing toward more expensive equity financing, with a lower level of $\frac{b_{it}^{new}}{R_t}$ and a rise in $E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$. However, the fact that purchasers of equity are less patient than purchasers of debt means that this shift toward equity makes entry more difficult. For every unit that $\frac{b_{it}^{new}}{R_t}$ falls there is a fall in interest payments in the future which become future dividend payments. But because investors discount these future payments by more than the interest rate R_t, this rise in dividends raises current end of period firm value $E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$ by a smaller amount than the fall in debt issue. So the total asset value of a firm $V_{i,t}^a$, the sum of $\frac{b_{it}^{new}}{R_t}$ plus $E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$ is lower as a result of the shift in financing, which is shown in Fig 2[20]. This implies that the marginal firm will not choose to enter the market because the effective cost of entry is greater than the expected value from entering the market. Once entry drops, and there are fewer firms to share the market, the expected level of dividends per firm will be higher, which raises $E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$ so that raises asset value $V_{i,t}^a$ sufficiently to restore the entry condition.

3.2.4 Sunk cost specification

We specify that the cost of new firm entry is a positive function of the total number of firms entering the market:

$$K_t^E = \bar{K}^E\left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}, \tag{12}$$

where $\bar{K}^E$ is the steady state level of sunk entry costs, and ne_t describes the

[20] The entry condition, Eq. (11), shows that $\frac{b_{it}^{new}}{R_t}+E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)+\pi_{it}^{new}=K_t^E$, where the sum of the first two terms is the firm asset value $V_{i,t}^a$. An adverse financial shock will lower the bond value as shown in Fig. 2, which shifts firm's financing from debt to equity financing. If the equity price, $q_{it}=E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$, cannot rise enough to prevent the firm asset value $V_{i,t}^a$ from falling, entry will decrease because the firm does not have sufficient liquidity to cover the entry cost.

number of new entrants who compete with each other. This is a common feature in the DSGE firm dynamics literature, and is analogous to familiar quadratic adjustment costs for investment in physical capital. Under congestion externality, entry is harder for new entrants as the greater the number of new entrants in any given period, the larger the entry costs faced by each potential entrant. It serves the function of capturing the behavior that entry dynamics do not respond instantaneously to new shocks, but respond gradually over time, and hence help the model generate hump-shaped impulse responses of firm entry to financial shocks as that observed in data.

This functional specification of entry costs has been motivated in terms of an imperfectly elastic supply of a factor specific to entry.[21] This is also a feature of matching models of the labor market: as new firms open vacancies, it takes more time to match with a worker for any given vacancy, so the probability of a successful match declines, which increases the expected cost of creating a new firm/vacancy (see the classical work of Pissarides (1990) and Mortensen and Pissarides (1994)).

3.3 Worker preferences and optimization

The representative worker derives utility from consuming the basket of goods ($C_{w,t}$), and the disutility from labor supply (L_t) in each period, and maximises expected lifetime utility,

$$\max\ E_0 \sum_{t=0}^{\infty} \beta^t U(C_{wt}, L_t), \qquad with \qquad U(C_{wt}, L_t) = \frac{C_{wt}^{1-\rho}}{1-\rho} - \kappa \frac{L_t^{1+\psi}}{1+\psi},$$

where $\rho > 0$ is the worker's degree of risk aversion, $\beta \in (0,1)$ is the subjective discount factor, and $k, \psi > 0$ are the relative utility weight of labor and the inverse Frisch elasticity of labor supply, respectively.

The worker derives income by providing labor services (L_t) at the real wage rate (w_t), and receiving financial income from holding corporate bonds of the η_{t-1}

[21] See also Bergin and Lin (2012) and Lewis (2009) for discussions of this model feature. Our functional specification of entry costs more closely resembles that in Lewis (2009) in specifying the rise in entry cost as a function of the number of new entrants, motivated in terms of an imperfectly elastic supply of a factor specific to product entry such as advertising. Bergin and Lin (2012) also allows for the possibility of a congestion externality in entry but specifying the rise in entry cost as a function of total number of active firms. Their specification is in line with Berentsen and Waller (2010), which was motivated using a matching externality found in Rocheteau and Wright (2005) and common in monetary search models.

existing firms (b_{t-1}). The worker then purchases consumption ($C_{w,t}$), and updates its corporate bond investment to the $\left(n_{t-1}+ne_t\right)$ firms at a price of $1/R_t$.

The period budget constraint may thus be written as:

$$C_{w,t}+\frac{\left(n_{t-1}+ne_t\right)b_t}{R_t}\leq w_t \mathrm{L}_t+n_{t-1}b_{t-1}.$$

From the constraint, we see that the worker receives financial income from the n_{t-1} surviving incumbents, but purchases corporate bonds of both the surviving incumbents (n_{t-1}) and the new entrants (ne_t).

The worker maximises expected lifetime utility subject to the budget constraint, implying the following first-order conditions:

$$U_{C_{w,t}}w_t+U_{L,t}=0, \tag{13}$$

$$\beta(1-\lambda)E_t\left[U_{C_{w,t+1}}R_t\right]=U_{C_{w,t}}, \tag{14}$$

where Eq. (13) is the labor-leisure tradeoff condition, and Eq. (14) is the Euler equation for holding corporate bond.

3.4 Investor preferences and optimization

The representative investor derives utility from consuming the basket of goods ($C_{I,t}$) in each period, and maximises his expected lifetime utility:

$$\max\ E_0\sum_{t=0}^{\infty}\beta_I^t U(C_{I,t}), \quad with \quad U(C_{I,t})=\frac{C_{I,t}^{1-\rho_I}}{1-\rho_I},$$

where $\rho_I>0$ is the investor's degree of risk aversion, and $\beta_I\in(0,1)$ is the subjective discount factor.

The representative investor doesn't supply labor, but receives financial income from dividends and sale of the equity shares of surviving firms. In additional to expenditure on consumption, it makes equity purchases of firms. Their budget constraint is thus:

$$C_{I,t}+\left(n_{t-1}+ne_t\right)q_t s_t\leq n_{t-1}s_{t-1}\left(q_t+d_t\right), \tag{15}$$

where q is the stock price, in units of final goods, and s_t is the equity share of the firms producing intermediate goods, held by the investor at time t. Note in this constraint that newly created firms share the same equity sale price (end of period equity value) as incumbent firms, as demonstrated in section 3.2.3 above.

The optimization implies the following first-order condition:

$$\beta_I (1-\lambda) E_t \left[U_{C_{I,t+1}} (q_{t+1} + d_{t+1}) \right] = U_{C_{I,t}} q_t \, , \tag{16}$$

where Eq. (16) is the Euler equation for holding corporate shares.

3.5 Equilibrium

Shocks are common to all firms; thus, this study solves the symmetric equilibrium in which firms behave identically. In other words, $z_t(i) = z_t$ for an endogenous variable z, independent of firm i. In addition, as the intermediate firms are fully owned by the investor, the equity share is thus normalised at $s_t = 1$ for all t.

As both incumbents and new entrants hire the same amount of labor in production, the market clearing condition for labor is thus given by:

$$L_t = (n_{t-1} + ne_t) l_t \, . \tag{17}$$

Because final goods are consumed by the investor ($C_{I,t}$), the worker ($C_{w,t}$), and the new entrants paying entry costs (K_t^E), the market clearing for final goods are:

$$Y_t = C_{w,t} + C_{I,t} + ne_t K_t^E \, . \tag{18}$$

The technology and financial shocks are AR(1) processes in logs, with normally distributed innovations :

$$\log A_t - \log \bar{A} = \rho_A (\log A_{t-1} - \log \bar{A}) + \varepsilon_{A,t} \, , \tag{19}$$

$$\log \xi_t - \log \bar{\xi} = \rho_\xi (\log \xi_{t-1} - \log \bar{\xi}) + \varepsilon_{\xi,t} \, , \tag{20}$$

where $\varepsilon_{A,t}$ and $\varepsilon_{\xi,t}$ are technology and financing innovations, respectively, which are i.i.d. random variables with homoscedastic variances.

Equilibrium is a sequence of the following 18 endogenous variables: $C_{w,t}$, w_t, L_t,

$R_t, y_t, p_t/P_t, ne_t, d_t, q_t, V_t, b_t, l_t, \mu_t, V_t^{new}, \eta_t$, $C_{I,t}$, Y_t, K_t^E. The 18 equilibrium conditions are as follows: First, price indices and demands for individual varieties (1-2). Second, equations from intermediate goods sector: dynamics of firm varieties (3); conditions for incumbents including firm enforcement constraint (4), production function, firm profit and value function, and firm first order conditions (5-9); conditions for new entrants: new entrant's total firm value (10); entry conditions (11); entry cost specification (12). Third, worker optimization conditions: labor-consumption tradeoff (13) and Euler equations for bond holding (14); investor optimization conditions: the budget constraint (15), and the Euler equation for stock holding (16). Last, market clearing conditions for labor (17), and for final goods (18). The full equilibrium conditions are listed in Benchmark Economy in supplementary Appendix Table 1.

3.6 Some intuition from the entry condition

This section provides some intuition for the model's novel implications regarding the interaction of firm entry, equity prices and capital structure. Since in equilibrium new firm choices will be the same as those for incumbents, the entry condition (Eq.11) can be simplified and written as:

$$q_t + \frac{b_t}{R_t} + \pi_t = \bar{K}^E \left(\frac{ne_t}{ne_{t-1}} \right)^{\tau}, \tag{21}$$

where the right-hand side is the entry cost a potential entrant must pay, while the left-hand side is the funding resources the entrant can obtain to pay the sunk cost.

For purposes of comparison, consider a restricted version of our model, which more closely resembles a standard model of firm entry. Suppose no debt can be issued to pay entry cost ($b_t = 0$ and there is no first order condition for bond issue); suppose firms are required to wait one period before beginning production, so no profits are generated in the period of entry ($\pi_t = 0$); and suppose there is no congestion externality in the entry cost ($\tau = 0$). Under these standard assumptions, the entry condition would simplify to $q_t = \bar{K}^E$. This version of the entry condition is the same as the standard used in models in the firm dynamics literature if entry costs are in goods units. This implies an equity price in equilibrium that is constant, which would be unable to explain the cyclical properties of equity price noted above.[22] While the

[22] Though the literature has widely specified entry costs in units of goods, it is also common to see

conventional understanding of equity prices as equal to the present discounted value of dividends is still true, these dividends are endogenous, and in equilibrium would adjust so that the equity price equals the exogenous constant value of the entry cost.

In contrast, Eq. (21) shows that our model includes several features that allow for a richer relationship among equity prices, entry, and firm financing. First, the presence of the congestion externality in entry allows equity prices to commove with the level of new entry: as ne_t rises, this implies a rise in the entry cost and hence the equilibrium equity value. Second, if firms lower debt, this allows equity prices to rise. Note that equity prices depend on the path of dividends paid, not profits per se, and this distinction matters in a model with endogenous capital structure, as dividends in a period can differ from profits. Finally, because production occurs in the same period as entry, current period profits also appear in the entry condition. Experiments to follow will show that the first two of these additional features of the entry condition are important for the ability of our model to explain the cyclical dynamics of entry and equity prices, while the third is not.

4 Quantitative Analysis

To analyze the full response path of firm entry, equity prices and other key macroeconomic variables in response to financial shocks, the system of 18 equilibrium conditions is log-linearised around the unique deterministic steady state. We calibrate parameters and numerically solve the log-linearised model for the dynamic responses to exogenous shocks using the method of generalised Schur decomposition.

4.1 Parameter values

Parameter values of financial and technology shocks are adopted from Jermann and Quadrini (2012). A period is identified as a quarter, and the persistence and standard deviation of financial shocks are set at $\rho_\xi = 0.97$ and $\sigma_\xi = 0.0098$, respectively; the technology counterparts are set at $\rho_A = 0.95$ and $\sigma_A = 0.0045$. The means of technology and financial shocks are set at $\bar{A}=1$ without loss of generality, and $\bar{\xi} = 0.16$ as in Jermann and Quadrini (2012).[23] In addition, we set $\beta = 0.995$

models specifying entry costs in units of effective labor. For instance, in Bilbiie, Ghironi, and Melitz (2012), entry costs are in units of effective labor. Consequently, entry costs vary with wage levels, and so do equity prices. In Appendix A3 and Appendix Fig. A3, we examine whether our main findings rely on entry cost specification.

[23] The mean value of financial variable, $\bar{\xi} = 0.16$ in our model, produces a steady state ratio of debt

and $\beta_I = 0.985$ to capture an annual bond return of 2% and an annual stock return of 6%, which are consistent with those used in Iacoviello (2005, 2015). The exogenous death shock probability is set at $\lambda = 0.015$ to match the 6% annual firm exit rate of the U.S. manufacturing plants documented in Lee and Mukoyama (2015).

The elasticity of substitution across varieties is set at $\sigma = 6$ to deliver a 20% markup of price over marginal cost (Rotemberg and Woodford, 1992). Following Bergin and Corsetti (2008), the love of variety parameter is set at $\gamma = \dfrac{\sigma}{\sigma - 1}$ in the baseline calibration. The risk aversion of the worker and the investor are set respectively at $\rho = 2$ (Arellano, Bai and Kehoe, 2012b) and $\rho_I = 1$ (Iacoviello, 2005) to reflect that firms are more willing to take risks than workers. Both values are commonly used in macroeconomics literature. However, the difference in risk aversion between investors and workers does not have important implication for our main findings.

The steady state level of sunk entry cost does not affect the impulse responses, so we set at $\bar{K}^E = 1$. We also set the weight of the disutility of labor in the period utility function at $\kappa = 1$. Though the choice of κ affects the steady state value of each variable, it does not affect the relative magnitude of these variables, and has no effect on the quantitative results. Labor supply elasticity is set at $1/\psi = 1.9$, following Hall (2009).

Table 2 lists the parameter values in the benchmark setting. The entry adjustment cost parameter τ is calibrated at 2.42 to match the standard deviation of new incorporations in the model to that in the data, as reported in Table 3.

4.2 Benchmark results

The selected impulse responses (percent deviations from steady state) to an adverse financial shock for the benchmark model specification and baseline parameter calibration are reported in the (red) solid line in Fig. 2.[24] The horizontal axis

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over GDP which matches the data. In the data, the average ratio of bonds outstanding for the non-financial business sector based on the SIFMA data over the period of 1984-2010 (http://www.sifma.org/research/statistics.aspx) to business GDP (from National Income and Product Accounts, http://research.stlouisfed.org/fred2/data/GDPCA.txt) is 1.5, which is not from the sample used for VAR estimation in Section 2. In our benchmark model, the steady state ratio of debt over GDP is around 1.6.

[24] In the supplementary Appendix A2 and Appendix Fig.A2 we show that all our results continue to hold under an alternative specification of the model where firms pay the sunk cost one period prior to beginning production. This version of the model assumes that new entrants inherit the same financial portfolio mix of debt and equity as incumbent firms, rather than deriving this portfolio as an optimal choice as in the benchmark model. This assumption is made to maintain the homogeneity among firms, which significantly simplifies model solution. See supplementary Appendix Table 1 for the model

represents the number of quarters, and the shock is a one standard deviation fall in ε_{ξ}. The adverse financial shock leads to a fall in new entrants that builds over 5 quarters to a substantial amount (1.67%). The hump-shaped response of firm entry matches what we identified in the empirical section as a key feature of the empirical impulse response, although the impact effect in the initial period is nonzero. The change in new entrants implies a gradual but persistent fall in the total number of firms. Experiments below will show that this fall in firm entry depends crucially upon the change in firm financing, as discussed in section 3.2.3. Fig. 2 shows the signs of this change in firm financing in response to the adverse financial shock: debt is reduced through a postponement of dividends, which fall in the initial periods and gradually rise in subsequent periods.

Figures report several related measures of firm value. Equity price ($q_{it} = E_t\left(m_{t+1}V_{it+1}\left(b_{it}\right)\right)$) corresponds to our data for the S&P500 price index, so it is most relevant for comparing our model's implications to data. Firm asset value ($V_{i,t}^{a}$) includes not only the end of period equity price, but also the bond value, representing the liquidity available to a new entrant from issuing financial assets. And new entrant firm value (V_{it}^{new}) in addition includes current period operating cash flows of new entrants, and is the measure most relevant economically for understanding firm entry, because the entry condition (Eq. (11)) indicates that entry continues until this measure of firm value equals the sunk entry cost, K_t^E.

The figure indicates that equity price falls on impact, but then improves over time. Again, this matches what we identified in the empirical section as a key feature of the empirical impulse response. As equity price equals the discounted sum of future dividend payments, the fall in equity price reflects both the protracted fall in dividends and the fall in firm discount factor. The mechanism driving the change in discount factor is as follows. The means by which firms shift from debt to equity financing in response to the financial shock is by deferring current dividends, and using the proceeds to pay down debt. Since these dividends are income to the investors, the drop in current dividends lowers their current consumption, which makes them less willing to save, and so lowers their stochastic discount factor. The impulse responses in Fig. 2 show clearly these declines in dividend, investor consumption, and discount factor (where the impact effect of the shock on m_{t+1}

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specification.

corresponds to period 2 of the graph, given the dating of this variable). In Appendix Fig. A7, we examine the equity price when the change in discount factor is shut off, that is, when the pricing kernel, $m_{t+1} = \beta_I \left(1-\lambda\right)$, is no longer responsive to exogenous shocks. In the absence of a fall in discount factor, the fall in equity price from Fig. 2 does not materialise, which shows the critical role that the discount factor plays in our equity price dynamics.

Fig. 2 shows that the value of firm financial assets $(V_{i,t}^{a})$ and new firm value $(V_{i,t}^{new})$ both respond to the financial shock in a pattern similar to equity price, falling on impact of the shock and then gradually rising over time. The magnitude of the response in $V_{i,t}^{a}$ is slightly dampened compared to the equity price component, and that in $V_{i,t}^{new}$ is yet a bit more dampened. While these measures of firm value include components other than just equity price, the fact that the impact of the shock is so similar in shape and magnitude to that on equity price underscores the importance of equity price movements in shaping these variables, and hence in shaping firm entry.

While it is true that equity price must equal the discounted stream of dividends, we wish to emphasise that the path of dividends is, itself, endogenous. We can see several channels at work to determine dividends if we substitute into the definition of firm dividends (6) the production function (5), CES demand (1), price index (2), and the optimal price setting rule (8):

$$d_{i,t} = \left(\frac{1+\sigma\mu_t}{\sigma-1}\frac{w_t}{A_t}\right)\tilde{n}_t^{-\gamma}Y_t - \left(b_{it-1} - b_{it}/R_t\right).$$

The first term in brackets represents the marginal profit per unit of good sold. This is multiplied by the level of production per firm, which consists of the aggregate level of demand, Y_t, and the share of aggregate demand allocated to an individual firm, $\tilde{n}_t^{-\gamma}$. The last term in brackets represents the effect of capital restructuring to postpone current dividends to the future.

There are three variables in this expression that move in our impulse responses in a direction to lower dividends. One is the fall in aggregate demand, Y_t: when the adverse financial shock tightens the financial constraint it forces a reduction in labor demand and production, which tends to lower the demand facing each firm, and hence lower dividends over the horizon of the shock. Augmenting this channel is the fall in wage, due to the fall in labor demand, which works in the equation above to lower dividends by lowering firm prices. Further, the reduction in debt issuance in the last set of brackets reflects the capital restructuring response to shocks, which is critical to the time path in dividends. By reducing debt issues and hence lowering debt burden in the future, firms postpone dividend payouts to the future: dividends fall more in the initial period but less in subsequent periods.

In contrast, there are two channels which work to moderate this fall in dividends. One is the rise in μ_t, representing the greater tightness in the financial constraint, which works to increase price markups. The other is the fall in firm numbers, which implies that the share of demand going to each firm is higher, raising dividends. This effect is captured by dividing the aggregate demand by $\tilde{\eta}$, in other words, when the parameter γ equals 1.The fact that γ, representing the love of variety, can be greater than one for a typical calibration ($\gamma = \sigma/(\sigma - 1)$) indicates that love of variety has an additional effect, working in the same direction and augmenting the effect above. The variety effect can be directly shown if we decompose the demand of each individual variety as follows: $y_t \equiv \tilde{n}_t^{1-\gamma} \frac{Y_t}{\tilde{n}_t}$, where $\tilde{n}_t^{1-\gamma}$ captures the variety effect which disappears when $\gamma = 1$. In terms of intuition, the variety effect creates a wedge between the aggregate demand index and the simple sum of demands facing individual firms. As the number of varieties of goods falls, the index will fall even if the average size of individual demands does not. This helps explain why an overall fall in demand after a financial shock may not hurt the demands facing individual firms as severely. Experiments below will explore the contributions of these channels. (The role of the variety effect is examined in supplementary Appendix Fig. A6.)

Output and employment also fall after the adverse financial shock, as should be expected. In addition, we see drops in wage and in consumption, both for the investor and worker, following similar patterns to output and employment. As the financial shock directly restricts the intratemporal loan needed to pay labor costs, it directly lowers worker income. Further, investor income falls due to the drop in dividend payout associated with the capital restructuring response to the shock. The drop in firm entry augments the fall in output, by lowering the demand for final goods to use in paying the entry cost.

To further evaluate the properties of our benchmark model economy, we compute the second moments of some key macroeconomic variables and compare them to those of the data. Following Bilbiie, Ghironi, and Melitz (2012), we constructed data-consistent variables of the model economy that remove the effect of changing number of varieties: for any variable X_t measured in units of the consumption basket, the data-consistent counterpart would be $X_{d,t} = \frac{X_t}{p_t/P_t}$, where p_t/P_t is the relative price of an individual variety.

Table 4 reports the data-consistent second-moments of the key variables.[25] The model produces reasonable second moments consistent with data when both financial and technology shocks are used. For instance, the standard deviation of GDP in the model is 1.50%, which is close to that in data (1.63%). The ratio between model and data standard deviations of GDP is 0.92. In addition, the model produces reasonably volatile movements of consumption, employment, firm creation and investment. Following Bilbiie, Ghironi, and Melitz (2012), investment is defined as the product of the number of new firms and the data-consistent measure of firm equity price.

The relative standard deviations of aggregate consumption, investment, firm creation and employment to GDP in model (and in data) are 0.89 (0.82), 2.84 (3.10), 1.47 (1.35) and 0.89 (0.63) respectively. As in the broader literature (see Gomes and Schmid (2014)), the model cannot produce sufficient volatility in equity prices. The relative standard deviation of equity prices to GDP in model is 2.2, while 5.32 in data.

Fig. 3 reports the data-consistent correlations of key macroeconomic variables with GDP at leads and lags in the baseline case of the benchmark model. We first note that the model shares with standard RBC models a tendency to generate high levels of procyclicality in macro aggregates. In particular the model can reproduce the pro-cyclicality of firm creation, equity prices, investment and consumption.

In summary, the baseline calibration of the benchmark model generally succeeds in reproducing the key facts of the empirical VAR, a fall in firm entry, equity price, and output. To better identify the exact mechanism underlying these results, below we explore several variations of the model that isolate particular aspects of this mechanism. The role of the congestion externality is studied in Section 4.3, and debt financing in Section 4.4.[26]

[25] Here we focus on data-consistent variables only in order to compare the implications of the model to data. Though we report the impulse responses of welfare-consistent variables alone to understand the mechanism of the model economy, the impulse responses of data-consistent variables closely resemble their counterparts of welfare-consistent variables. We also report the simulation statistics separately for the productivity shock and financial shock in Appendix Table 2 and Appendix Table 3. The variance decomposition is presented in Appendix Table 4.

[26] We also examined the role of labor supply elasticity, death rate and variety effects in supplementary appendices A4 to A6, respectively.

4.3 Role of congestion externality

The ability of the model to explain the hump-shaped response in new firm entry above derives from convexity in the costs of firm entry. The (blue) dashed line in Fig. 2 represents the case of constant entry cost by choosing the parameter value $\tau = 0$. Firm entry falls by much more on impact than under the convex cost in the baseline case in Fig. 2, and the maximal effect is in the initial period. In the baseline case in Fig. 2 in contrast, a fall in entry costs reflects a fall in congestion, creating the hump-shaped fall in entry as observed in data. The specification and logic of this adjustment cost is directly analogous to the familiar specification of convex investment adjustment costs. While there might be other ways to generate a hump-shaped response in entry, our main point is that replicating the dynamics of entry are crucial to understanding the dynamics of other key variables in this economy.

One of these variables is the equity price. The constant entry cost case in Fig. 2 shows that without convex entry cost the equity price rises rather than falls. The path of firm dividends falls by less in the initial periods than in the baseline case in Fig. 2, and it rises by more in later periods. This higher level in the path of dividends per firm is partly due to the smaller number of firms observed in the constant entry cost case in Fig. 2, so the piece of the sales and profit pie going to each firm is larger. We conclude that properly capturing the hump-shaped response in firm entry is important to the impact of the financial shock on equity price.

Further, the dynamics of entry have significant consequences for the transmission of the financial shock to the real economy. Fig. 2 shows that the impact on output is half as large in the hypothetical experiment reported in the constant entry cost case compared to the baseline case, and the overall standard deviation of output is 57% of that in the baseline case, as shown in Table 3. As noted above, this moderation in the fall in output is associated with a large increase in the fall in new entry, which completely eliminates the initial fall in equity price. Further, the rise in the Lagrange multiplier on the financial constraint, indicating the tightening of the constraint due to the shock, is one sixth of that in the benchmark case. When less of the adverse financial shock is passed on to a fall in equity prices and more passed on to a fall in firm entry, the higher level of equity prices counteracts the tightening of the financial constraint due to the shock. In other words, when there is a reduction in the number of firms, a given level of aggregate profits is split among a smaller number of firms, raising the equity value of a given firm. As a result, the remaining firms have a stronger financial position, and their financial constraints are less adversely affected by the shock.

This means that firms are less hindered in their ability to borrow working capital to support the demand for labor. Production falls less, and there is a smaller fall in the level of employment. This also implies a smaller drop in real wage, as it is wage payments, the product of employment and wage, which is subject to the financial constraint. Consumption levels also fall less in this experiment, along with the smaller fall in production. Overall, this experiment highlights the conclusion that understanding the transmission of a financial shock to the economy depends upon the implications for firm entry.

This finding contrasts with claims elsewhere in the literature that a reduction in the number of new firms can have adverse effects on aggregate employment, if new firms are disproportionately responsible for new job creation (see Foster, Haltiwanger and Syverson, 2012). Our finding provides a counterpoint to this argument that has not been presented previously in the literature. Our finding also is suggestive of limitations of policies aimed at mitigating the impact of recession on aggregate output that work through buffering the failure of firms. It is possible that mitigating the fall in aggregate output might be better served by allowing firms to fail, especially in case where the driving shock works through the reduction in firm collateral value. However, given that we do not conduct welfare analysis, we leave the evaluations of policy implications to future research.

4.4 Role of debt financing

Another key element in explaining the response of firm entry to a financial shock is the fact that firm entry is partly financed by bond issue.[27] To see the importance of endogenous debt financing on firm entry, in this section we consider two model economies, one with a single financial asset of equity ('Equity Only'), and one with both equity and bond trading but bond face value fixed at a constant level ('Constant Bond').

The Equity Only economy in Fig. 4, represented by the (red) solid line, shows responses for the case where firm entry is financed purely by equity issue and current profit, and not by bond issue. The only difference from the benchmark model is that equity is the only financial asset that can be traded in the economy. There is neither bond issuance nor trading. As a result, the model suspends the optimal financing decision with bond issuance (Eq. 9), and the Euler equation of bond purchasing (Eq. 14). We also must re-calibrate the parameter τ to 1.85 to maintain the standard deviation of ne equal to that in the data (2.2% as shown in Table 3).

The Equity Only case in Fig. 4 shows that the shock now leads to a rise in new

[27] Our model implications for steady state values are consistent with the empirical evidence. In our model, among various sources of entry cost financing, debt accounts for 38.86%, equity accounts for 58.55% and cash accounts for the remaining 2.59%.

entry rather than fall. This is despite the fact that the adverse shock still lowers the level of output and employment among incumbent firms. This result resembles the findings of related papers, such as Macnamara (2012), who find it necessary to add in a separate type of financial shock in order to make entry fall. However, we find that we can match the empirical finding of a fall in entry by allowing for bond financing of firm entry. This specification also differentiates us from the recent firm entry literature, which has either not addressed the issue of how sunk costs are financed, or assumed financing by equity issues alone (Bilbiie, Ghironi and Melitz (2012), Bergin and Corsetti (2008)). Our result is also distinct from the few papers that do consider alternative means of entry financing, such as Stebunovs (2008), Cacciatore, Ghironi, and Stebunovs (2015), Notz (2012), Casares and Poutineau (2013), Karasoy (2012), and Uusküla (2015a, b), in that we model firms with a choice between alternative means of financing, and the endogenous shift in this choice implies dynamics in key macro and financial variables that are more consistent with data.[28]

To understand the reason that bond financing is essential to explaining the fall in firm entry after the financial shock, one must understand the firm financing decision and the endogenous change in bond issue. The adverse financial shock induces all firms to shift financing away from cheaper bond financing toward more expensive equity financing, as equity collateral helps relax the newly tightened financial constraint. This is accomplished by deferring dividends to reduce debt payment in the future. For newly entering firms, the financing of their entry costs thus becomes more expensive, and fewer firms will actually choose to enter. The mechanism is similar to that used by Jermann and Quadrini (2012) to explain a fall in output and employment; we find that it is a powerful mechanism to explain the responsiveness of entry to financial conditions.

The power of this mechanism can be demonstrated by considering a version of our model economy where there is no endogenous adjustment in bond issue. In contrast with the preceding experiment, let both bond and equity be traded in the market, but let bond issue be restricted to a certain amount, more specifically, to equal the entry cost. Thus, even if the bond is issued and traded in the economy, it is not

[28] In these papers entry cost is financed externally through a single source of bank lending, and households borrow loans to finance both consumption and investment. However, none of these papers discusses the effects of financial shocks except Karasoy (2012), Uusküla (2015a, b) and Notz (2012). In particular, the first three papers yield the counterfactual finding of a rise in aggregate consumption with the fall in firm entry. In these papers, interest rate enters entry cost directly, and a rising borrowing cost reduces firm entry without lowering aggregate consumption. Notz (2012) does not report impulse responses for a financial shock. When we replicate the Notz model, we find some counterfactual implications, especially the prominent rise in firm equity value in response to an adverse financial shock. Our paper is also different from Stebunovs (2008), Cacciatore, Ghironi, and Stebunovs (2015), Casares and Poutineau (2013), which study the aggregate effect of financial deregulation, a long-run change, while we study the macroeconomic implications of a business-cycle shock.

optimally selected by a firm. The profit maximization problem for a firm now becomes static:

$$\max_{p_{i,t}} d_{i,t} = \frac{p_{i,t}}{P_t} y_{i,t} - w_t l_{i,t}$$

$$s.t.$$

$$y_{i,t} = N_t^{\sigma-1}\left(\frac{p_{i,t}}{P_t}\right)^{-\sigma} Y_t = \tilde{n}_t^{-\gamma} Y_t$$

$$y_{i,t} = A_t l_{i,t}, \qquad \xi_t q_{it} \geq w_t l_{i,t} \qquad b_{i,t} = \bar{K}^E$$

As usual, the first order condition defines the pricing rule: $\frac{p_{i,t}}{P_t} = \frac{\sigma}{\sigma-1}\frac{w_t}{A_t}(1+\mu_t)$, while the first order condition that defines the multiplier associated with the enforcement constraint is replaced by the bond restriction equation: $b_{i,t} = K_t^E$. To make the experiment clean, we fully rule out adjustment in bond issue and hold it constant, by using the calibration where entry costs are constant ($\tau = 0$). So the bond constraint specifies: $b_{i,t} = \bar{K}^E$.

The impulse responses are reported in the (blue) dashed line in Fig. 4, labeled as the case of Constant Bond. In this economy we see a counterfactual rise in the number of entrants after the realization of a negative financial shock. We conclude that removing the endogenous bond financing decision eliminates the power of the adverse financial shock to dampen firm entry. In fact, firm entry actually rises here, mainly in response to a steep fall in wages which raises firm dividends.

5. Conclusions

This paper studies how firm entry responds to financial shocks, and how it critically shapes the propagation of these shocks to the real economy. First, we document empirically that financial shocks in the U.S. are associated with a fall in firm entry. In particular an adverse financial shock induces a hump-shaped fall in new firm creation, as well as a drop in equity prices in the short run that dies out as the firm entry response grows. Second, we propose a DSGE model that combines firm dynamics with endogenous capital restructuring which can explain these facts. Firms finance a time-varying sunk cost of entry by a mix of debt and equity issues, which responds to shocks that tighten a borrowing constraint. A key implication of the model is that when firm entry drops in response to a financial shock, the surviving firms have greater equity value, which helps relax the financial constraint for the aggregate economy. Experiments indicate that this adjustment at the extensive margin of firm entry can serve to buffer the size of the fall in aggregate GDP that otherwise would result from the adverse financial shock. These findings underscore the conclusion that how a financial shock propagates through the real economy depends upon how it affects firm dynamics.

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Table 1 Timeline

Beginning of t	**Before death shock**	**Death shock**[29]	**Beginning of t+1**
(1) Exogenous shocks realise: A_t, ξ_t (2) n_{t-1} producing firms; (3) Five state variables: $n_{t-1}, s_{t-1}\ b_{t-1}, A_t,\ \xi_t$	n_{t-1} **Incumbents:** (1) wage payments made through intra-period loan; (2) financing choice (bond and equity issuance) and revenue realization	Both incumbents (n_{t-1}) and new entrants (n_{et}) surviving with a probability of $1-\lambda$	state variables: $n_t, b_t, A_{t+1}, \xi_{t+1}$ $n_t = (1-\lambda)(n_{t-1} + ne_t)$
	n_{et} **New Entrants:** (1) bond and equity issuance to finance entry; (2) real production and profit distributed to investor		
	Worker: Consumption and bond investment		
	Investor: Consumption and equity investment		

[29] Here, we follow Monacelli, Quadrinni, and Trigari (2011) to specify that the death shock is realised at the end of a period, and a firm hit by a death shock exits from the economy. This assumption of timing is standard in literature, for instance, in Bilbiie, Ghironi and Melitz (2012).

Table 2 Parameterization.

Description	
Parameters calibrated from literature	
Worker Relative risk aversion	$\rho = 2$
Investor Relative risk aversion	$\rho_I = 1$
Worker discount factor	$\beta = 0.995$
Investor discount factor	$\beta_I = 0.985$
Substitution elasticity across varieties	$\sigma = 6$
Probability of death shock	$\lambda = 0.015$
Entry costs	$\overline{K}^E = 1$
Congestion Externality in Entry	$\tau = 2.42$
Weight of labor disutility in utility function	$\kappa = 1$
Inverse of labor supply elasticity	$\psi = 0.5256$
Love of variety	$\gamma = \sigma / (\sigma - 1)$
Parameters related to shocks	
Technology parameter	$\bar{A} = 1$
Enforcement parameter	$\bar{\xi} = 0.16$
Standard deviation: technology shock	$\sigma_A = 0.0045$
Standard deviation: financing shock	$\sigma_\xi = 0.0098$
Persistence: technology shock	$\rho_A = 0.95$
Persistence: financing shock	$\rho_\xi = 0.97$

Table 3 **Calibration of τ and Standard Deviations of Relevant Variables in the Economy with Both Equity Plus Bonds**

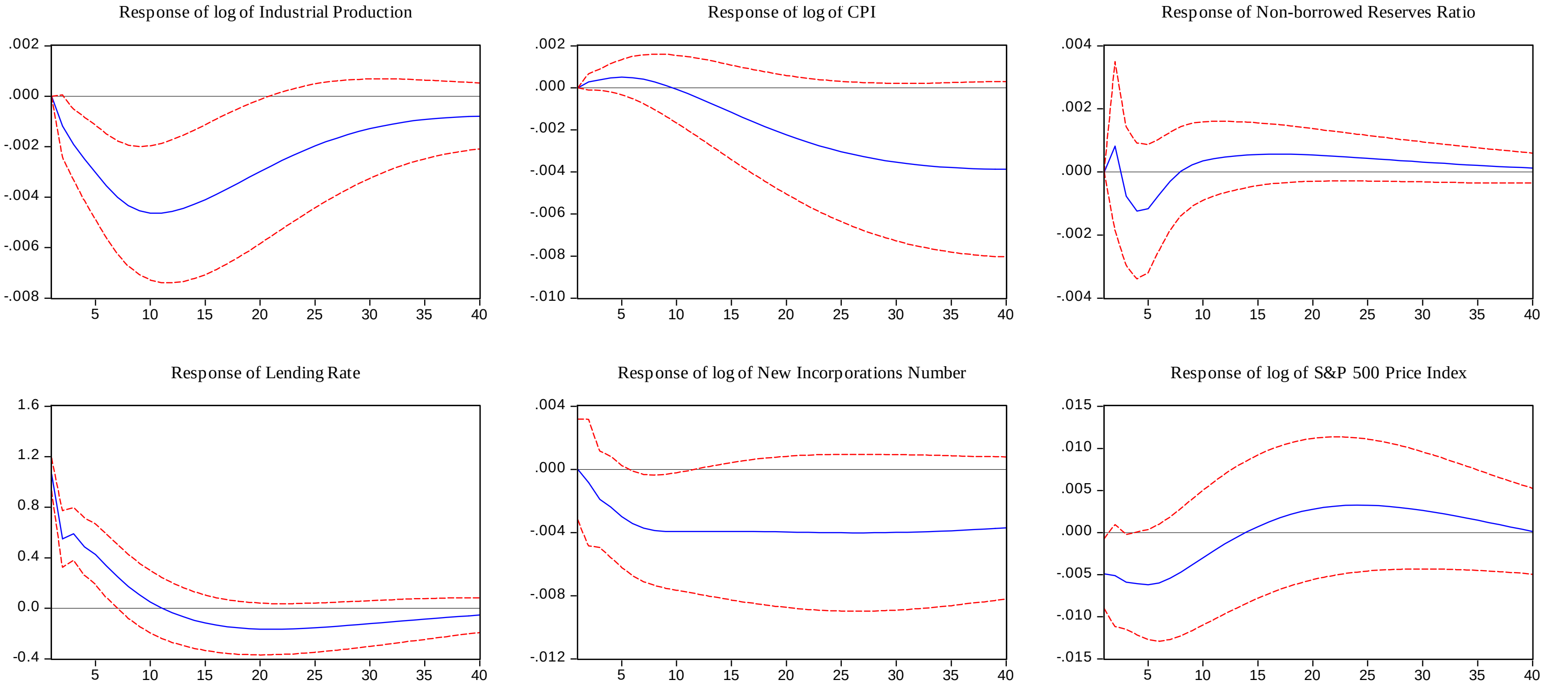
	Benchmark Model (Std. Dev: %)		Equity Only Economy (Std. Dev: %)	
	$\tau = 0$	$\tau = 2.42$	$\tau = 0$	$\tau = 1.85$
ne	5.69	2.20	6.95	2.20
q	0.54	3.37	0.14	1.08
Y	0.85	1.49	0.43	0.36

Table 4 **Moments for Data and Data-Consistent Variables (Benchmark Model Baseline Case)**

	$\sigma_x(\%)$		σ_x / σ_y		$corr(x, x_{-1})$		$corr(x, Y)$	
Variable (x)	Data	***Model***	Data	***Model***	Data	***Model***	Data	***Model***
Output	1.63	1.50	1	1	0.87	0.60	1	1
Aggregate Consumption	1.33	1.33	0.82	0.89	0.87	0.58	0.87	0.99
Aggregate Investment	5.05	4.26	3.10	2.84	0.90	0.67	0.93	0.97
Employment	1.02	1.34	0.63	0.89	0.91	0.59	0.83	0.92
New Firm Number	2.20	2.20	1.35	1.47	0.57	0.93	0.53	0.41
Equity Price	8.33	3.39	5.11	2.26	0.72	0.60	0.33	0.95

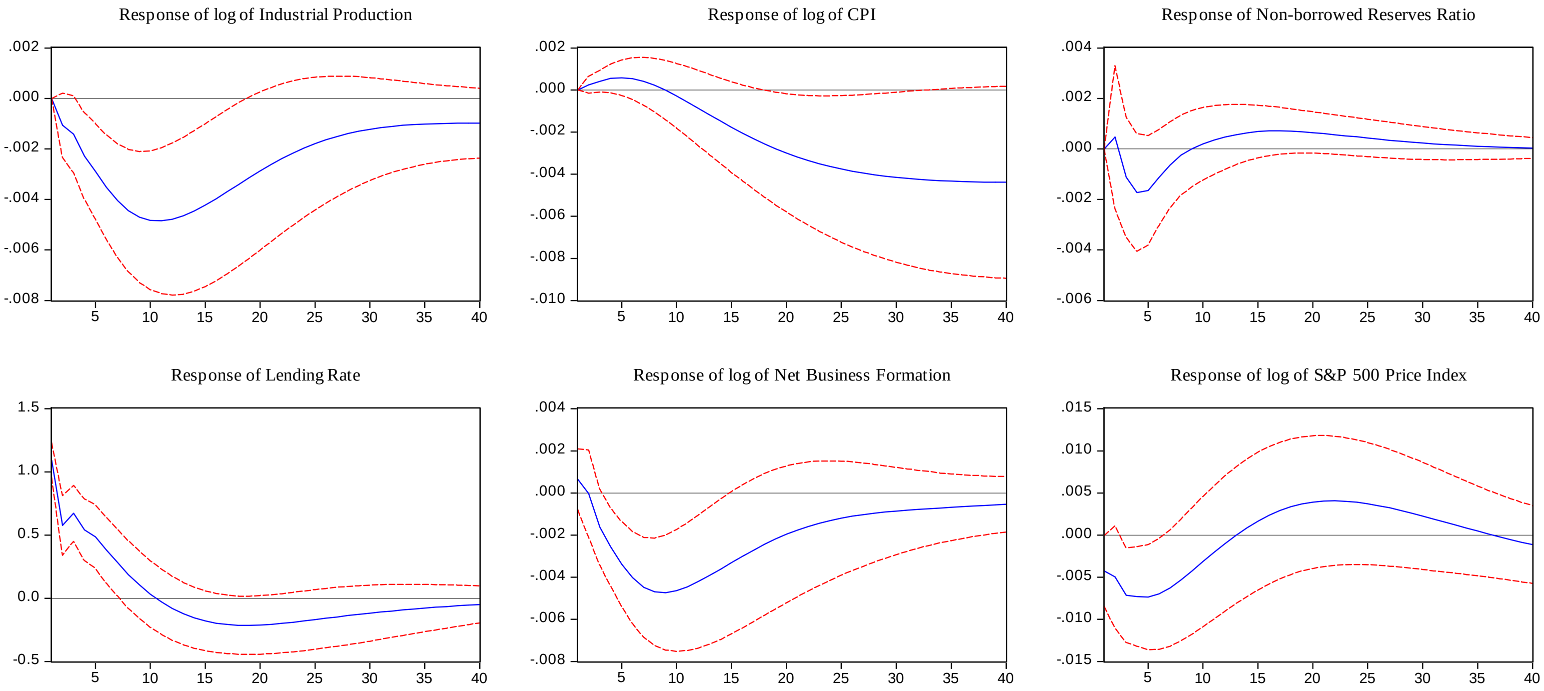
Note: Notations here are: Output (Y_d) Consumption $\left(C_{w,d} + C_{I,d}\right)$, Investment $\left(ne * q_d\right)$, Employment (L), New Firm Number (ne), Equity Price $\left(q_d\right)$, Total Equity Value $(ne+n)q_d$.

Fig. 1a Impulse Responses to Innovation in Interbank Rate, Using New Incorporations Number



Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of new incorporations, and logarithm of S&P500 index.

Fig. 1b Impulse Responses to Innovation in Interbank Rate, Using Net Business Formation



Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1994:4, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of net business formation, and logarithm of S&P500 index.

Fig. 2 Impulse Responses to a Negative Financial Shock in Benchmark Model: Baseline Calibration versus Constant Entry Cost

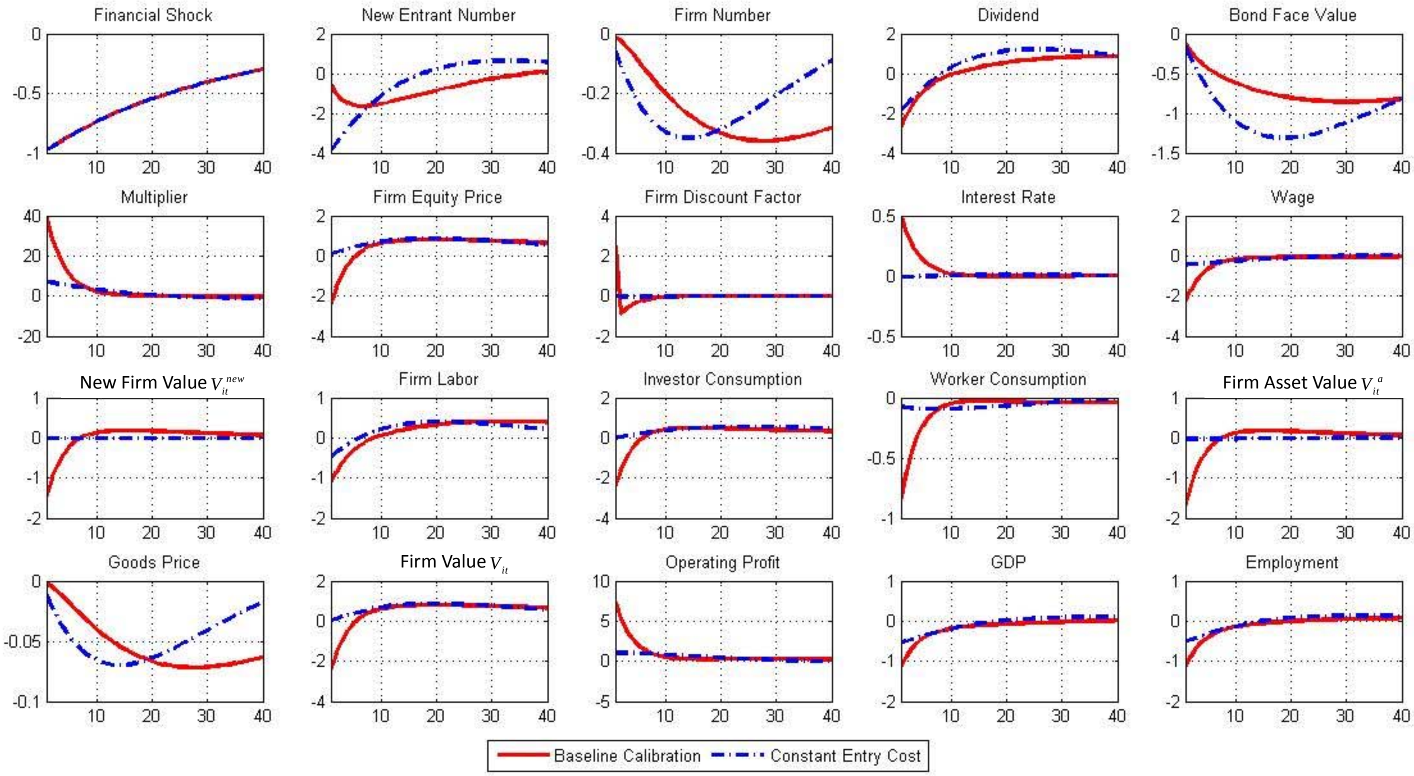
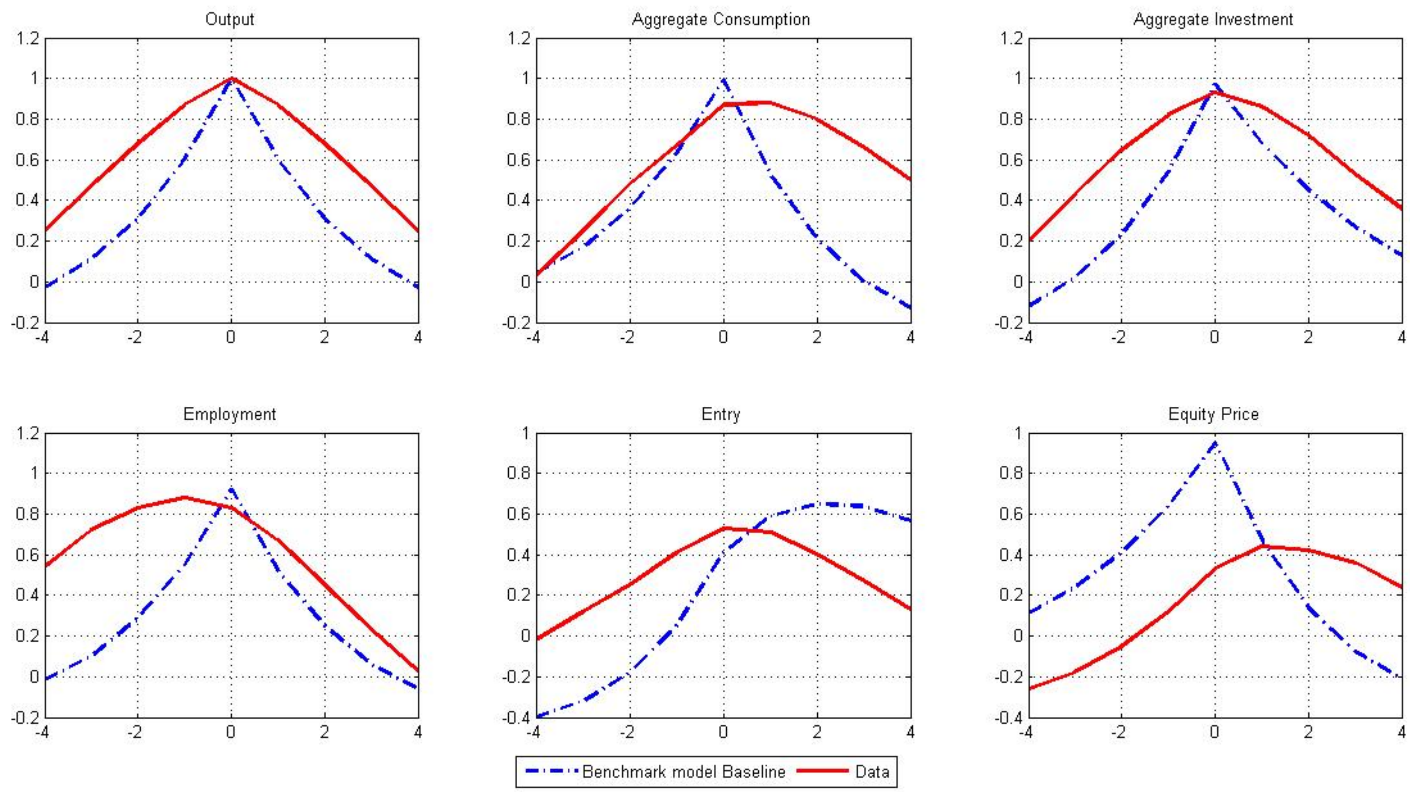
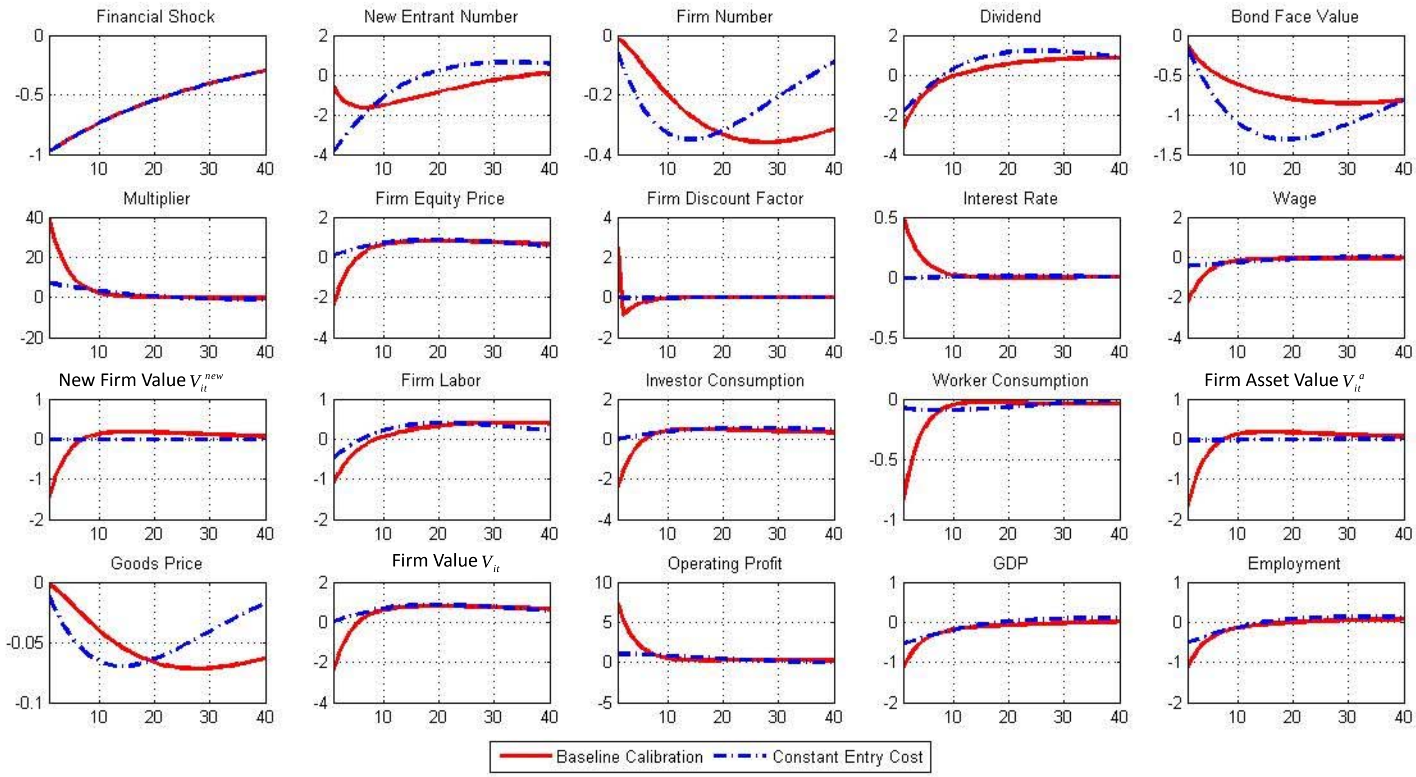


Fig. 3 Data-consistent Correlations with GDP in Benchmark Model Baseline Calibration: Lags, and Leads



Note: These plots report $Corr\left(Y_{t+s}, X_t\right)$ All variables are data-consistent measures except employment (L_t) and entry (ne_t).

Fig. 4 Equity Only Economy versus Constant Bond Economy



Online Supplementary Appendix – not for publication

Appendix A1: Robustness of the empirical evidence

A1.1 Alternative measures of equity prices

The S&P 500 is widely used as a measure of the general level of stock prices. One advantage of the S&P 500 is that the present form began in 1954, which provides a longer time series for our empirical study. But we can also use the NASDAQ Composite and the Wilshire 5000 for robustness checks. These two data series start from 1971:1. The NASDAQ Composite is mainly composed of smaller, newer firms and recently is heavily weighted towards technology and Internet companies. The Wilshire 5000 is the most broadly based index, covering all publicly traded stocks in the U.S. Figs. A1_1 - A1_2 present impulse responses from a system using the NASDAQ Composite, along with each of our two measures of firm entry, in turn; Figs. A1_3 to A1_4 present impulse responses using the Wilshire 5000, again along with each of our two measure of firm entry. Results are consistent in showing a fall in the equity price on impact, regardless of how equity price is measured. Apparently the composition of the index in terms of large or small firms does not affect our empirical result.

A1.2 A financial shock captured by an innovation to TED spread

In the empirical benchmark model, an exogenous financial shock is presented as an innovation to the interbank lending rate, which is a measure of tightness of the prevailing credit condition. To check robustness, the TED spread can also be used as a proxy for the financial condition, capturing the risk premium required for the default risk of an interbank loan. During periods of adverse financial or credit conditions, this spread widens because of high risk of loan defaults.

Figs. A1_5 and A1_6 present the impulse responses to an exogenous financial shock to an increase in the TED spread, which replaces the lending rate in our benchmark VAR model in Section 2. As in our benchmark model, an adverse financial shock discourages the entry: number of new incorporations (Fig. A1_5) and net business formation (Fig. A1_6) decrease, and the effects become significant a few quarters later after the shock. The impact of a shock captured by TED spread on the new incorporations number is more persistent than the impact of a shock coming from an increase in interbank lending rate. The financial shock has an instantly negative effect on the stock prices, which is similar to our baseline results, however, the effect is less persistent.

A1.3 A financial shock captured by an innovation to the financial conditions index

In addition to a single-variable measure of financial conditions, such as interbank lending rate or TED spread, we used a financial conditions index, the National Financial Condition Index (NFCI) constructed by the Chicago Fed, as measuring whether financial conditions have tightened or loosened. NFCI extracts information from 100 financial indicators by Brave and Butter (2011). The index is a high-frequency index with broad coverage of measures of risk, liquidity, and leverage, and is constructed to have an average value of zero and a standard deviation of one over a sample period extending back to 1973. Positive index values of NFCI indicate tighter conditions than on average.

Figs. A1_7 and A1_8 show the impulse responses to a financial shock to an innovation in NFCI. The results are similar to our benchmark findings in Figs. 1a and 1b in the text. A tighter financial condition described by higher values of NFCI has negative effects on both entry and stock prices but with larger magnitudes than those in the benchmark model.

A1.4 Re-ordering the variables in our benchmark VAR model

To do more robustness tests for our benchmark model, we consider different orderings of the variables in the VAR. We find that the results do not depend on the assumptions about whether entry is contemporaneously correlated with other disturbances in the system. Figs. A1_9 and A1_10 present the cases where entry is placed first in the variable list, thus entry is not contemporaneously affected by any other disturbances. Fig. A1_11 and A1_12 present the cases where entry is contemporaneously affected by all the disturbances within a period, placed as last in the variable list. The benchmark results remain robust in these different ordering cases.

We also find that our benchmark findings about the significantly negative response of stock prices to an exogenous financial shock are robust once the stock prices index is placed after the lending rate (or other measures of financial conditions). This is intuitive as stock prices always respond to shocks quickly and shortly, and is also consistent with the literature that asset prices or financial variables are usually placed toward the end of the order in a recursive VAR model (Thorbecke (1997)).

In all the exercises we checked above, the lending rate is always placed after the non-borrowed reserves ratio to disentangle monetary policy effects. In Figs. A1_13 and A1_14, we relax the assumption of ordering the lending rate after the non-borrowed reserve ratio. Our benchmark results are still robust, not depending on whether we purge the disturbance from the non-borrowed reserves ratio.

Appendix A2 Model economy with entry one period ahead of production

In the benchmark model, to facilitate theoretical consistency we assume that a new entrant makes simultaneous decisions on financing, entry, pricing and production. In this appendix, we solve a model with the specification where firms pay the sunk entry cost one period prior to beginning production. See Economy 2 in Appendix Table 1 for the list of equilibrium conditions for this alternative model.

Appendix Fig. A2 reports the impulse responses to an adverse financial shock in this alternative economy. All our results in the benchmark model in Fig.2 continue hold under this alternative specification. In contrast with the benchmark model, this version assumes that new entrants inherit the same financial portfolio mix of debt and equity as incumbent firms, rather than deriving this portfolio as an optimal choice. This assumption is made to maintain the homogeneity among firms, which significantly simplifies model solution.

Appendix A3 Benchmark model with entry cost in units of effective labor

The literature has widely specified entry costs either in units of labor or in units of goods.[1] To examine whether our main findings rely on entry costs specification, here we consider entry costs in units of effective labor, that is, $K_t^E = w_t \frac{\bar{K}^E}{A_t}\left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$. We first consider a flexible wage setting. In this case, the congestion externality parameter is calibrated at $\tau = 1.99$ to match the standard deviation of firm entry in data. The impulse responses are reported in the (blue) dashed line in Appendix Fig. A3. The setting generates real recessions but rising firm entry. This finding is similar to that observed in Lewis (2009), who found a monetary expansionary shock in the Bilbiie, Ghironi, and Melitz (2012) type of framework generates expansion but falling firm entry, and found that wage stickiness was needed to produce rising firm entry.

In order to reduce the volatility in wage movements, following Bergin and Lin (2009), we assume the labor market is monopolistic competitive and wage is determined one period ahead. The labor input into firms is produced with a CES aggregator $L_t = \left[\int_0^1 l_t(h)^{\frac{\sigma_l - 1}{\sigma_l}}\right]^{\frac{\sigma_l}{\sigma_l - 1}}$, where $\sigma_l > 1$ is the elasticity of substitution across differentiated labor types, indexed by h. Firm demand for each type of labor is given by $l_t(h) = \left[w_{t-1}(h)/w_{t-1}\right]^{-\sigma_l} L_t$, where $w_{t-1}(h)$ is the wage received by the worker. The aggregate wage index is given by w_{t-1}. As the worker must set wages one period ahead, each worker first maximises the expected marginal utility $\max_{w_{t-1}} E_{t-1}\left[U(C_{wt}, L_t)\right]$ to choose an optimal wage $w_{t-1}(h)$, and then maximises the lifetime utility

[1] For example, Bollard, Klenow and Li (2014) find that entry costs rise with the level of a country's development as entry is labor-intensive and labor is expensive in productive economies. Cavallari (2013) argues in favor of entry costs in goods units over labor units, as it has beneficial properties in matching certain international business cycle moments. Given that our paper is interested in business cycle properties, here we specify entry costs in units of goods.

to choose optimal consumption $C_{w,t}$ and financial investment b_t. The Euler equation for wage setting is thus given by:

$$w_{t-1}E_{t-1}\left(U_{C_w,t}\right)+\frac{\sigma_l}{\sigma_l-1}E_{t-1}\left(U_{L,t}\right)=0\,.$$

The impulse responses are reported in red solid line in Appendix Fig. A3 where the congestion externality parameter is calibrated at $\tau=3.54$. The economy now generates real recession and falling entry. See Economies 3 and 4 in Appendix Table 1 for the lists of equilibrium conditions.

Appendix A4 Benchmark model with various labor supply elasticity

Chetty, Guren, Manoli, and Weber (2011) found that estimates of ψ (the inverse of labor supply elasticity) around 0.25 are consistent with micro and macro data. Hall (2009) sets the value at $\psi=0.53$, implying a labor supply elasticity of 1.9. To examine how labor supply elasticity affects our mechanism, we check the responses of the economy when the inverse of labor supply elasticity is set at $\psi=0.25$ and 0.5263, which implies labor supply elasticity of 4 and 1.9 (the benchmark value), respectively. The impulse responses are reported in Appendix Fig. A4 where the red solid line represents the baseline case with $\psi=0.5263$ while the blue dashed line with $\psi=0.25$. We find that our results are similar across the two cases, with the more elastic labor supply generating a somewhat more severe real recession. This is intuitive. When labor supply is more elastic, employment drops more for a certain amount of fall in wages. This can be seen from the worker's Euler equation on labor supply (13): when labor supply becomes more elastic (falling ψ), worker's marginal disutility (κL_t^{ψ}) falls from supplying one additional unit of labor, which implies less wage compensation required for keeping marginal utility of consumption constant. The large drop in employment would lead to a more severe recession on real output and a more depressed market for potential entrants.

Appendix A5 Firm Exit Rate versus Job Destruction Rate

The firm exit rate has been estimated in the literature using various choices of data. Using the Annual Survey of Manufacturers (ASM, from 1972 through 1997) of the Longitudinal Research Database (LRD) compiled by the U.S. Bureau of the Census, Lee and Mukoyama (2015) found an average annual exit rate of 5.5% (ranging from 5.1% in bad years to 5.6% in good years) and an annual job destruction rate of 10.02% (ranging from 10.72% in bad years and 9.38% in good years). Using the Census of Manufacturers (CM) dataset of the LRD, Dunne, Roberts, and Samuelson (1988, 1989) found an average exit rate varying from 30.8% to 39.0% over a five year horizon, which implies average annual exit rates of 6.16% to 7.8%, and an annual job destruction rate of 12.84% for the period of 1977-1982.

In Appendix Fig. A5, we range the death rate in our model from 0.015 in the benchmark case to 0.025 to capture the average annual firm exit of 6% and average annual job destruction rate of 10%. The findings in the baseline calibration of the benchmark model are not affected, though the recession is less severe when $\lambda = 0.025$ as fewer firms stay in the economy, making capital restructuring more flexible in driving up firm equity value.

Appendix A6 Benchmark Model with Various Variety Effect

Discussion in Section 4.2 suggests the potential role of the variety effect in determining the path of dividends, which plays a critical role in our mechanism. In particular, Eq. (1) suggests the demand of an individual variety can be decomposed into two components: $y_{i,t} = \left(\tilde{n}_t^{1-\gamma}\right)\left(\frac{Y_t}{\tilde{n}_t}\right)$, where $\frac{Y_t}{\tilde{n}_t}$ captures the scale effect, defined as the aggregate demand divided by number of varieties in the economy, while $\tilde{n}_t^{1-\gamma}$ is the variety effect as defined in Bilbiie, Ghironi and Melitz (2012), captured by the relative price of individual variety to the consumer price level, that is, $p_{it}/P_t = \tilde{n}_t^{\gamma-1}$ (Eq. 2).

In our benchmark model, the economy responds to a negative financial shock with falling firm entry. Under the baseline calibration where $\gamma = \frac{\sigma}{\sigma - 1} > 1$, falling entry would imply rising demand for an individual variety, but also generate a falling welfare effect that is reflected in the decrease in the relative price of an individual variety (p_{it}/P_t), as the opportunity cost of creating a new firm in terms of forgone consumption is lower with fewer varieties. This is because when there are fewer varieties, a household must spend more to derive the same amount of welfare, ceteris paribus. Therefore, the welfare-consistent measure of the price index rises and the relative price of each variety falls. In addition to this variety effect, falling entry is also accompanied by a scale effect, as falling entry gradually translates into a decrease in the number of firms and raises average aggregate demand facing an individual firm ($\frac{Y_t}{\tilde{n}_t}$). As a result, profits per variety rise with the increase in demand per variety. Therefore in the baseline calibration where $\gamma = \frac{\sigma}{\sigma - 1} > 1$, we expect that falling opportunity cost of creating a new variety, together with the rising demand for each individual variety would attract potential entrants, creating a buffer in the drop of firm entry and in the slowdown in the aggregate economy in response to adverse financial shocks.

However, when the variety effect does not exist, for instance, when $\gamma = 1$ which fixes the opportunity cost of creating a new variety at a constant, we would expect a larger drop in the entry margin.

To examine how in particular the variety effect contributes to firm entry and economic adjustment, Appendix Fig. A6 compares two cases: the baseline case with $\gamma = \frac{\sigma}{\sigma - 1} > 1$ in (red) solid line, and the no-variety-effect case with $\gamma = 1$ in (blue) dashed line. The figure confirms our expectation that, as the absence of variety effect eliminates the channel of opportunity cost adjustment, we see a slightly greater fall in firm entry in the no-variety effect case. However, the difference is small.

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Appendix Table 1: Equilibrium Conditions in Four Economies

	Benchmark Economy: New Entrants Entry Simultaneously With Production, Entry Cost in Goods	**Economy 2: New Entrants Entry One Period Ahead Of Production, Entry Cost in Goods**
Demand and CPI	(1) $y_{i,t} = N_t^{\sigma-1}\left(\frac{p_{i,t}}{P_t}\right)^{-\sigma} Y_t = \tilde{n}_t^{-\gamma} Y_t$ (2) $P_t = \frac{1}{N_t}\left(\int_0^{\tilde{n}_t} p_{i,t}^{1-\sigma} di\right)^{\frac{1}{1-\sigma}} = \tilde{n}_t^{1-\gamma} p_{it}$, $\tilde{n}_t \equiv n_{t-1} + ne_t$	$y_{i,t} = N_t^{\sigma-1}\left(\frac{p_{i,t}}{P_t}\right)^{-\sigma} Y_t = n_t^{-\gamma} Y_t$ $P_t = \frac{1}{N_t}\left(\int_0^{n_t} p_{i,t}^{1-\sigma} di\right)^{\frac{1}{1-\sigma}} = n_t^{1-\gamma} p_{it}$
Firm Dynamics	(3) $n_t = (1-\lambda)(n_{t-1} + ne_t)$	$n_t = (1-\lambda)(n_{t-1} + ne_t)$
Enforcement Constraint	(4) $\xi_t E_t(m_{t+1} V_{i,t+1}) \geq w_t l_{i,t}$	$\xi_t E_t(m_{t+1} V_{i,t+1}) \geq w_t l_{i,t}$
Incumbents	(5) $y_{i,t} = A_t l_{i,t}$ (6) $d_{i,t} = \frac{p_{i,t}}{P_t} y_{i,t} - w_t l_{i,t} - \left(b_{it-1} - \frac{b_{it}}{R_t}\right)$ (7) $V_{i,t}(b_{it-1}) = \max_{p_{i,t}, b_{it}} \{d_{i,t} + E_t(m_{t+1} V_{i,t+1}(b_{it}))\}$ (8) $\frac{p_{i,t}}{P_t} = \frac{\sigma}{\sigma-1}\frac{w_t}{A_t}(1+\mu_t)$ (9) $\mu_t = \frac{\frac{1}{R_t} - E_t m_{t+1}}{\xi_t E_t m_{t+1}}$	$y_{i,t} = A_t l_{i,t}$ $d_{i,t} = \frac{p_{i,t}}{P_t} y_{i,t} - w_t l_{i,t} - \left(b_{it-1} - \frac{b_{it}}{R_t}\right)$ $V_{i,t}(b_{it-1}) = \max_{p_{i,t}, b_{it}} \{d_{i,t} + E_t(m_{t+1} V_{i,t+1}(b_{it}))\}$ $\frac{p_{i,t}}{P_t} = \frac{\sigma}{\sigma-1}\frac{w_t}{A_t}(1+\mu_t)$ $\mu_t = \frac{\frac{1}{R_t} - E_t m_{t+1}}{\xi_t E_t m_{t+1}}$

New Entrants	(10) $V_{it}^{new} = \pi_{it}^{new} + \frac{b_{it}^{new}}{R_t} + E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right),$ (11) $K_t^E = V_{it}^{new}$ (12) $K_t^E = \bar{K}^E \left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$	$V_{it}^{new} = \frac{b_{it}^{new}}{R_t} + E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right),$ $K_t^E = V_{it}^{new}$ $K_t^E = \bar{K}^E \left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$
Worker	(13) $U_{C_w,t}w_t + U_{L,t} = 0$ (14) $\beta\left(1-\lambda\right)E_t\left[U_{C_w,t+1}R_t\right] = U_{C_w,t}$	$U_{C_w,t}w_t + U_{L,t} = 0$ $\beta\left(1-\lambda\right)E_t\left[U_{C_w,t+1}R_t\right] = U_{C_w,t}$
Investor	(15) $C_{It} + \left(n_{t-1} + ne_t\right)q_t s_t \leq n_{t-1}s_{t-1}\left(q_t + d_t\right)$ (16) $\beta_I\left(1-\lambda\right)E_t\left[U_{cI,t+1}\left(q_{t+1} + d_{t+1}\right)\right] = U_{cI,t}q_t$	$C_{It} + \left(n_t + ne_t\right)q_t s_t \leq n_t s_{t-1}\left(q_t + d_t\right)$ $\beta_I\left(1-\lambda\right)E_t\left[U_{cI,t+1}\left(q_{t+1} + d_{t+1}\right)\right] = U_{cI,t}q_t$
Market Clearing	(17) $L_t = \left(n_{t-1} + ne_t\right)l_t$ (18) $Y_t = C_{wt} + C_{It} + ne_t K_t^E$	$L_t = n_t l_t$ $Y_t = C_{wt} + C_{It} + ne_t K_t^E$

	Economy 3: Economy with Entry Cost Specified in Labor Units, Flexible Wage	Economy 4: Economy with Entry Cost Specified in Labor Units, Sticky Wage
Demand and CPI	(1) $y_{i,t} = N_t^{\sigma-1}\left(\frac{p_{i,t}}{P_t}\right)^{-\sigma} Y_t = \tilde{n}_t^{-\gamma} Y_t$ (2) $P_t = \frac{1}{N_t}\left(\int_0^{\tilde{n}_t} p_{i,t}^{1-\sigma} di\right)^{\frac{1}{1-\sigma}} = \tilde{n}_t^{1-\gamma} p_{it}$, $\tilde{n}_t \equiv n_{t-1} + ne_t$	$y_{i,t} = N_t^{\sigma-1}\left(\frac{p_{i,t}}{P_t}\right)^{-\sigma} Y_t = \tilde{n}_t^{-\gamma} Y_t$ $P_t = \frac{1}{N_t}\left(\int_0^{\tilde{n}_t} p_{i,t}^{1-\sigma} di\right)^{\frac{1}{1-\sigma}} = \tilde{n}_t^{1-\gamma} p_{it}$, $\tilde{n}_t \equiv n_{t-1} + ne_t$
Firm Dynamics	(3) $n_t = (1-\lambda)(n_{t-1} + ne_t)$	$n_t = (1-\lambda)(n_{t-1} + ne_t)$
Enforcement Constraint	(4) $\xi_t E_t(m_{t+1} V_{i,t+1}) \geq w_t l_{i,t}$	$\xi_t E_t(m_{t+1} V_{i,t+1}) \geq w_{t-1} l_{i,t}$
Incumbents	(5) $y_{i,t} = A_t l_{i,t}$ (6) $d_{i,t} = \frac{p_{i,t}}{P_t} y_{i,t} - w_t l_{i,t} - \left(b_{it-1} - \frac{b_{it}}{R_t}\right)$ (7) $V_{i,t}(b_{it-1}) = \max_{p_{i,t}, b_{it}} \{d_{i,t} + E_t(m_{t+1} V_{i,t+1}(b_{it}))\}$ (8) $\frac{p_{i,t}}{P_t} = \frac{\sigma}{\sigma-1}\frac{w_t}{A_t}(1+\mu_t)$ (9) $\mu_t = \frac{\frac{1}{R_t} - E_t m_{t+1}}{\xi_t E_t m_{t+1}}$	$y_{i,t} = A_t l_{i,t}$ $d_{i,t} = \frac{p_{i,t}}{P_t} y_{i,t} - w_{t-1} l_{i,t} - \left(b_{it-1} - \frac{b_{it}}{R_t}\right)$ $V_{i,t}(b_{it-1}) = \max_{p_{i,t}, b_{it}} \{d_{i,t} + E_t(m_{t+1} V_{i,t+1}(b_{it}))\}$ $\frac{p_{i,t}}{P_t} = \frac{\sigma}{\sigma-1}\frac{w_{t-1}}{A_t}(1+\mu_t)$ $\mu_t = \frac{\frac{1}{R_t} - E_t m_{t+1}}{\xi_t E_t m_{t+1}}$

New Entrants	(10) $V_{it}^{new} = \pi_{it}^{new} + \frac{b_{it}^{new}}{R_t} + E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$, (11) $V_{it}^{new} = K_t^E$ (12) $K_t^E = w_t \frac{\bar{K}^E}{A_t}\left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$	$V_{it}^{new} = \pi_{it}^{new} + \frac{b_{it}^{new}}{R_t} + E_t\left(m_{t+1}V_{it+1}\left(b_{it}^{new}\right)\right)$, $V_{it}^{new} = K_t^E$ $K_t^E = w_{t-1} \frac{\bar{K}^E}{A_t}\left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$
Worker	(13) $w_t U_{C_w,t} + U_{L,t} = 0$ (14) $\beta(1-\lambda)E_t\left[U_{C_w,t+1}R_t\right] = U_{C_w,t}$	$w_{t-1}E_{t-1}\left(U_{C_w,t}\right) + \frac{\sigma_l}{\sigma_l - 1}E_{t-1}\left(U_{L,t}\right) = 0$ $\beta(1-\lambda)E_t\left[U_{C_w,t+1}R_t\right] = U_{C_w,t}$
Investor	(15) $C_{It} + \left(n_{t-1} + ne_t\right)q_t s_t \le n_{t-1}s_{t-1}\left(q_t + d_t\right)$ (16) $\beta_I(1-\lambda)E_t\left[U_{cI,t+1}\left(q_{t+1} + d_{t+1}\right)\right] = U_{cI,t}q_t$	$C_{It} + \left(n_{t-1} + ne_t\right)q_t s_t \le n_{t-1}s_{t-1}\left(q_t + d_t\right)$ $\beta_I(1-\lambda)E_t\left[U_{cI,t+1}\left(q_{t+1} + d_{t+1}\right)\right] = U_{cI,t}q_t$
Market Clearing	(17) $L_t = \left(n_{t-1} + ne_t\right)l_t + ne_t \frac{\bar{K}^E}{A_t}\left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$ (18) $Y_t = C_{wt} + C_{It}$	$L_t = \left(n_{t-1} + ne_t\right)l_t + ne_t \frac{\bar{K}^E}{A_t}\left(\frac{ne_t}{ne_{t-1}}\right)^{\tau}$ $Y_t = C_{wt} + C_{It}$

Appendix Table 2 Calibration of τ and Standard Deviations of Relevant Variables

	Productivity shock only			
	Benchmark Model (Std. Dev: %)		**Equity Only Economy (Std. Dev: %)**	
	$\tau=0$	$\tau=0.31$	$\tau=0$	$\tau=0.025$
ne	2.35	2.20	2.28	2.20
q	0.15	0.49	0.05	0.05
Y	0.43	0.51	0.26	0.27
	Financial shock only			
	Benchmark Model (Std. Dev: %)		**Equity Only Economy (Std. Dev: %)**	
	$\tau=0$	$\tau=2.04$	$\tau=0$	$\tau=1.73$
ne	5.20	2.20	6.56	2.20
q	0.52	2.95	0.13	1.01
Y	0.74	1.28	0.34	0.13

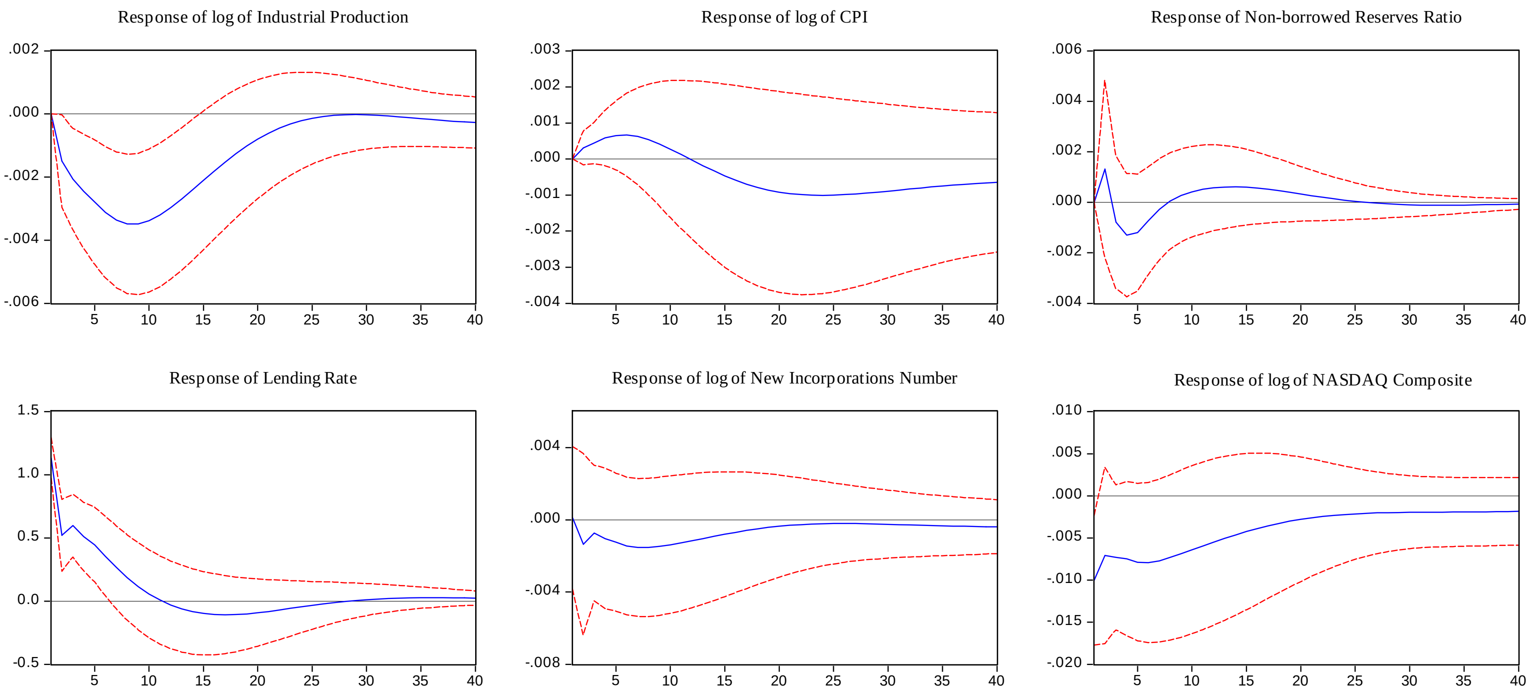
Appendix Table 3 Moments for Data and Data-Consistent Variables (Benchmark Model Baseline Case)

	Productivity shock only							
	$\sigma_x(\%)$		σ_x/σ_y		$corr(x,x_{-1})$		$corr(x,Y)$	
Variable (x)	Data	***Model***	Data	***Model***	Data	***Model***	Data	***Model***
Output	1.63	*0.51*	1	*1*	0.87	*0.70*	1	*1*
Aggregate Consumption	1.33	*0.30*	0.82	*5.89*	0.87	*0.51*	0.87	*0.93*
Aggregate Investment	5.05	*2.51*	3.10	*4.92*	0.90	*0.85*	0.93	*0.95*
Employment	1.02	*0.10*	0.63	*0.20*	0.91	*0.87*	0.83	*-0.65*
New Firm Number	2.20	*2.20*	1.35	*4.31*	0.57	*0.90*	0.53	*0.89*
Equity Price	8.33	*0.49*	5.11	*0.96*	0.72	*0.49*	0.33	*0.88*
	Financial shock only							
	$\sigma_x(\%)$		σ_x/σ_y		$corr(x,x_{-1})$		$corr(x,Y)$	
Variable (x)	Data	***Model***	Data	***Model***	Data	***Model***	Data	***Model***
Output	1.63	*1.29*	1	*1*	0.87	*0.59*	1	*1*
Aggregate Consumption	1.33	*1.13*	0.82	*0.88*	0.87	*0.57*	0.87	*0.98*
Aggregate Investment	5.05	*3.89*	3.10	*3.02*	0.90	*0.68*	0.93	*0.96*
Employment	1.02	*1.29*	0.63	*1.00*	0.91	*0.59*	0.83	*1.00*
New Firm Number	2.20	*2.20*	1.35	*1.71*	0.57	*0.93*	0.53	*0.43*
Equity Price	8.33	*2.97*	5.11	*2.30*	0.72	*0.59*	0.33	*0.94*

Appendix Table 4. Variance Decomposition (In Percent)

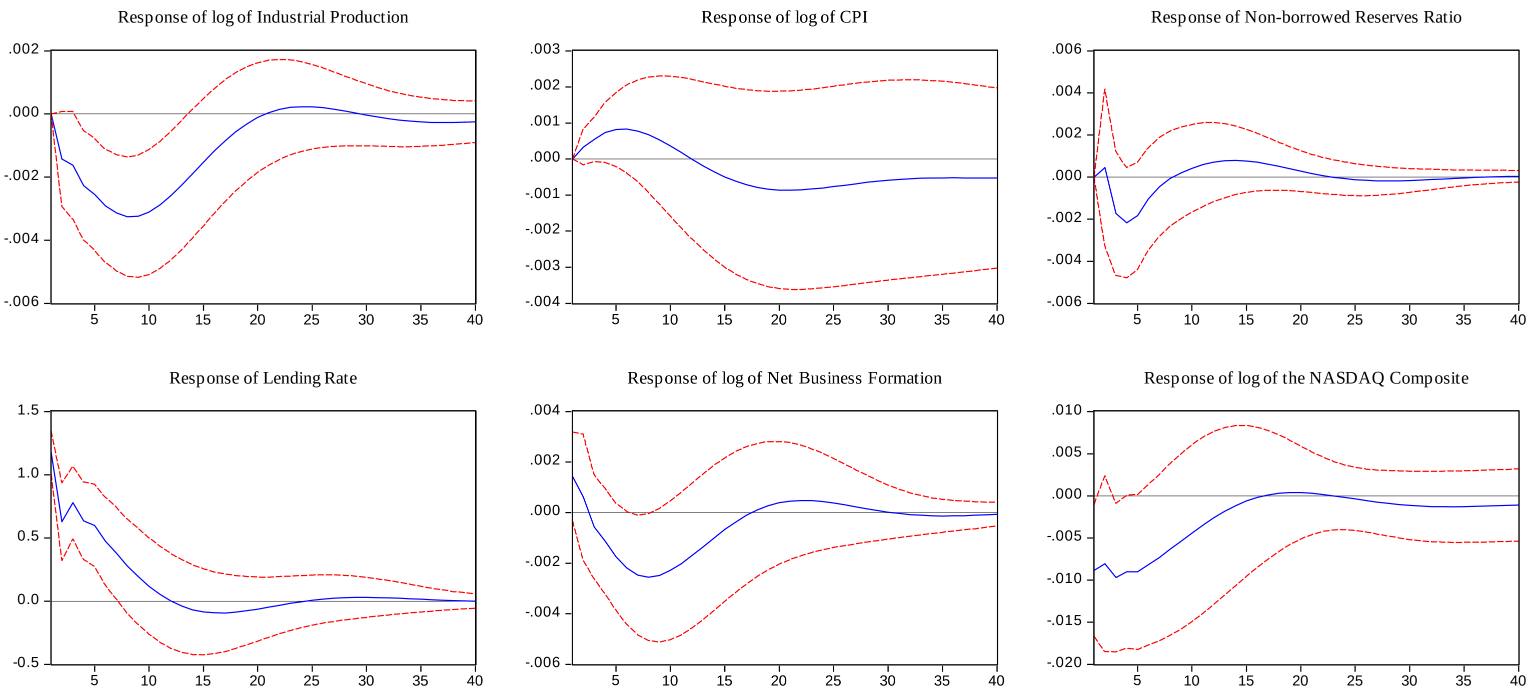
Variables	Period 0		Period 1:		Period 2:		Period 3:		Period 4:		Period 5:		Period 6:		Period 7:		Period 8:		Period 9:		Period 10:	
	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin	tfp	Fin
output (Y)	21.7	78.29	21.4	78.59	22.93	77.07	24.38	75.62	25.74	74.26	27.02	72.98	28.2	71.8	29.3	70.7	30.33	69.67	31.28	68.72	32.18	67.82
aggregate consumption (AC)	22.17	77.83	22.36	77.64	24.1	75.9	25.73	74.27	27.18	72.82	28.45	71.55	29.54	70.46	30.47	69.53	31.25	68.75	31.93	68.07	32.52	67.48
aggregate investment (INV)	19.1	80.9	18.32	81.68	19.97	80.03	21.64	78.36	23.33	76.67	25.01	74.99	26.68	73.32	28.31	71.69	29.91	70.09	31.47	68.53	32.97	67.03
equity price (qi)	16.38	83.62	18.32	81.68	20	80	21.58	78.42	22.93	77.07	23.92	76.08	24.53	75.47	24.75	75.25	24.64	75.36	24.27	75.73	23.72	76.28
output(Yd)	21.71	78.29	21.41	78.59	22.94	77.06	24.39	75.61	25.76	74.24	27.02	72.98	28.19	71.81	29.26	70.74	30.25	69.75	31.16	68.84	31.99	68.01
aggregate consumption (Acd)	22.16	77.84	22.36	77.64	24.12	75.88	25.74	74.26	27.19	72.81	28.43	71.57	29.47	70.53	30.32	69.68	31	69	31.54	68.46	31.97	68.03
aggregate investment (INVd)	19.09	80.91	18.32	81.68	19.97	80.03	21.64	78.36	23.33	76.67	25.01	74.99	26.67	73.33	28.31	71.69	29.9	70.1	31.45	68.55	32.95	67.05
employment（L）	1.68	98.32	1.61	98.39	1.34	98.66	1.16	98.84	1.05	98.95	0.99	99.01	0.97	99.03	0.97	99.03	0.97	99.03	0.98	99.02	0.99	99.01
new entrants (ne)	20.78	79.22	18.32	81.68	19.29	80.71	20.27	79.73	21.26	78.74	22.27	77.73	23.28	76.72	24.29	75.71	25.31	74.69	26.32	73.68	27.32	72.68
equity price (qid)	16.39	83.61	18.32	81.68	20	80	21.58	78.42	22.9	77.1	23.87	76.13	24.43	75.57	24.57	75.43	24.37	75.63	23.9	76.1	23.23	76.77

Appendix Fig. A1_1 Impulse Responses to Innovation in Lending Rate, Using NASDAQ Composite and New Incorporations Number



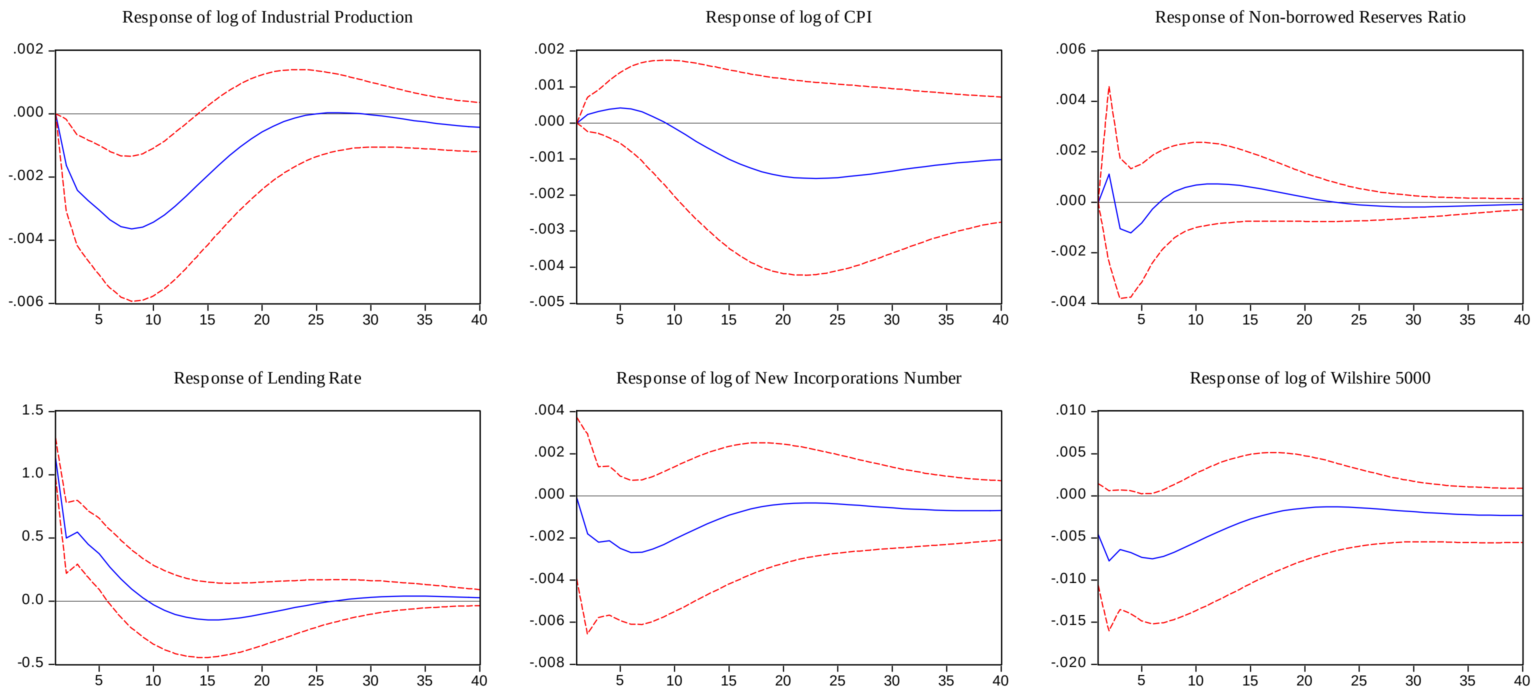
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1971:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of new incorporations, and logarithm of the NASDAQ composite.

Appendix Fig. A1_2 Impulse Responses to Innovation in Lending Rate,
Using NASDAQ Composite and Net Business Formation



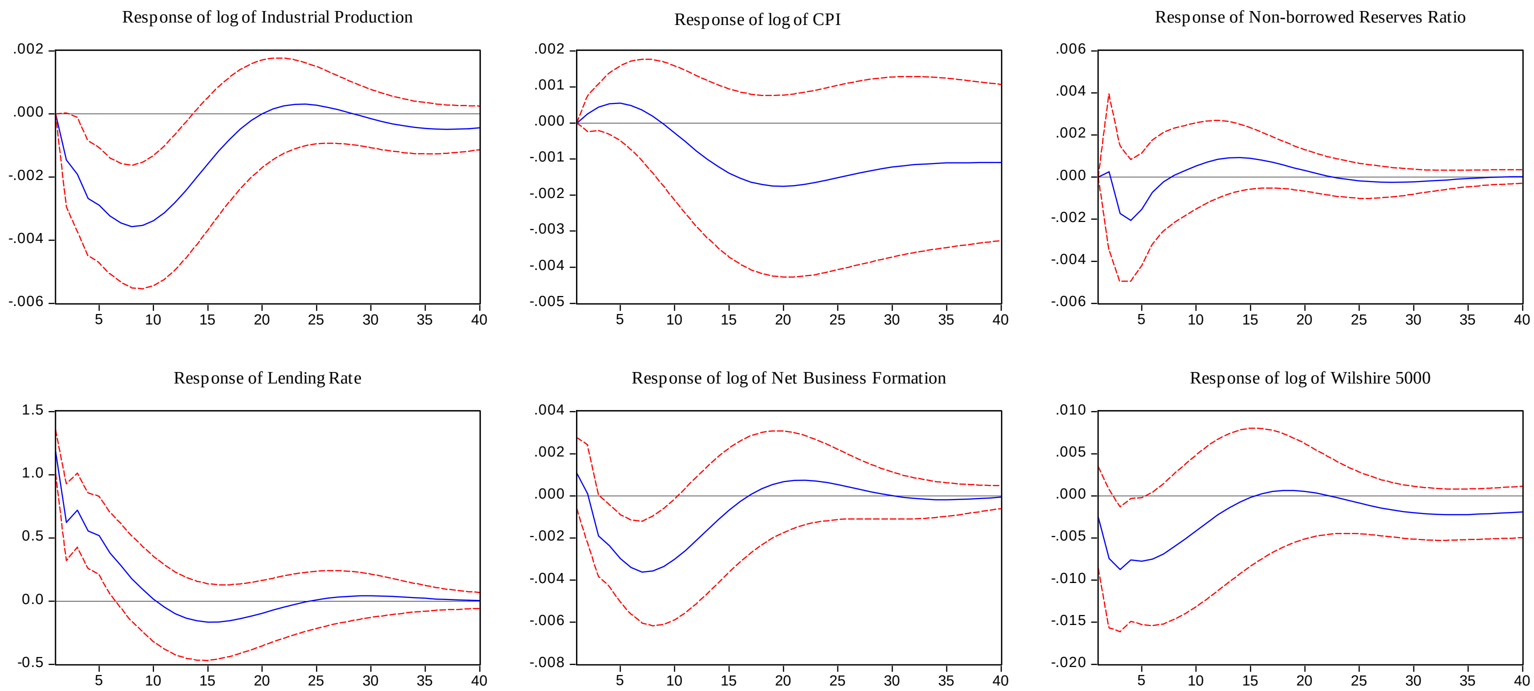
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1971:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of net business formation, and logarithm of the NASDAQ composite.

Appendix Fig. A1_3 Impulse Responses to Innovation in Lending Rate, Using Wilshire 5000 and New Incorporations Number



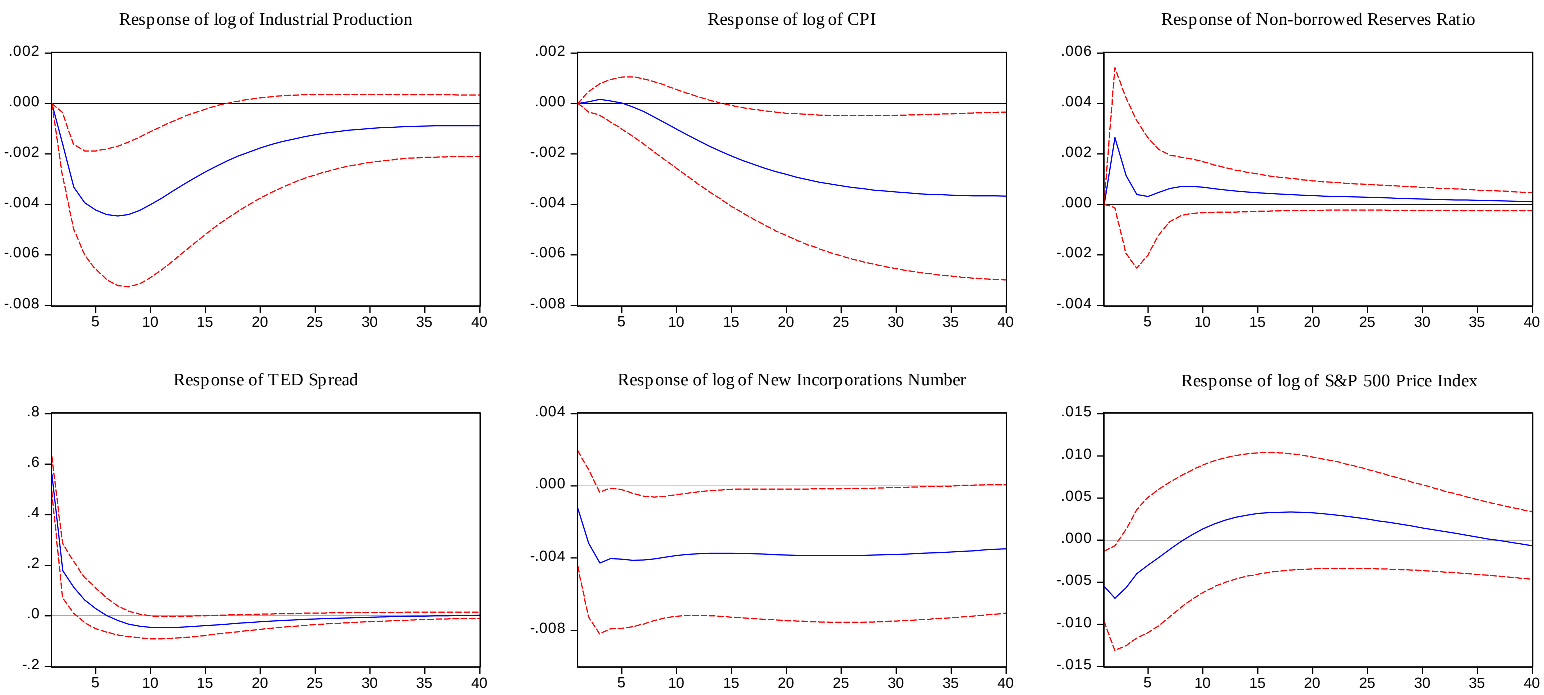
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1971:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of new incorporations, and logarithm of the Wilshire 5000.

Appendix Fig. A1_4 Impulse Responses to Innovation in Lending Rate, Using Wilshire 5000 and Net Business Formation



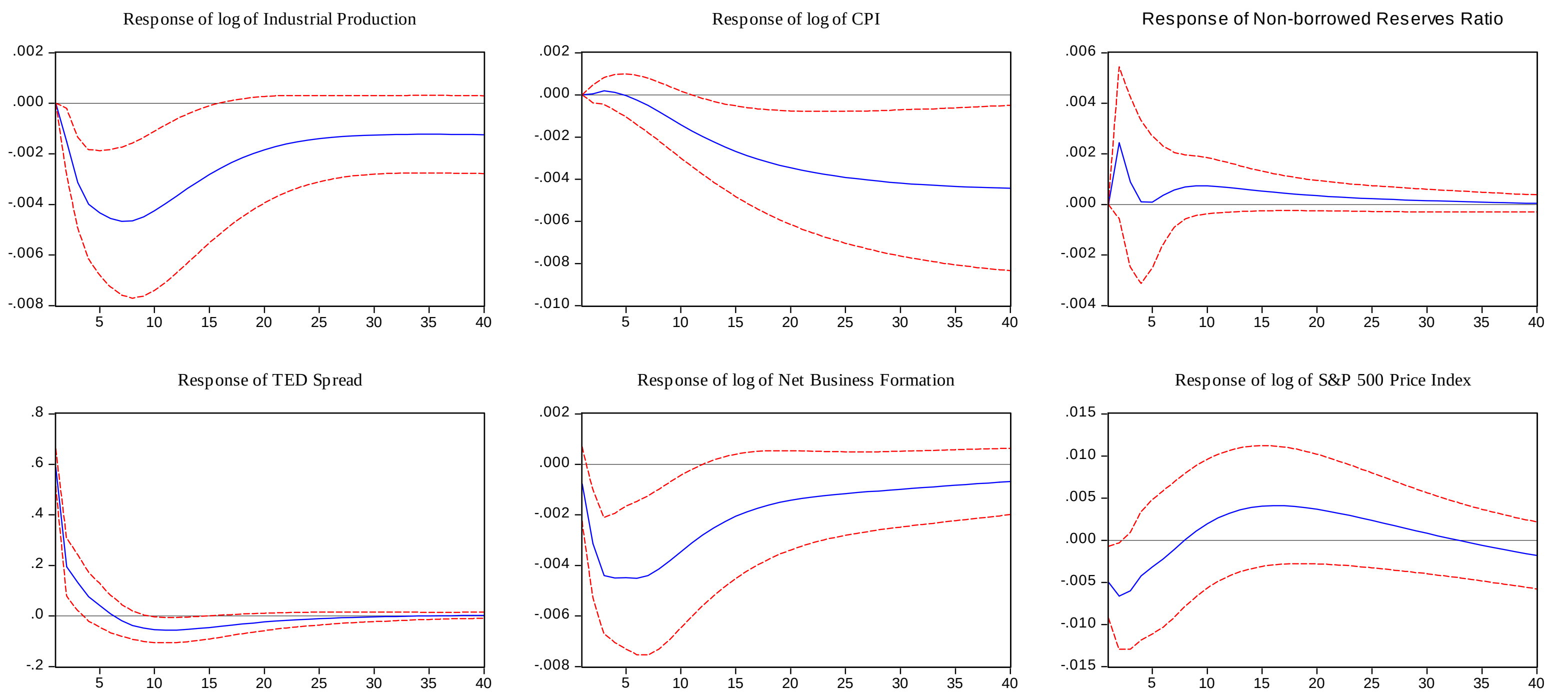
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1971:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of net business formation, and logarithm of the Wilshire 5000.

Appendix Fig. A1_5 Impulse Responses to Innovation in TED Spread, Using New Incorporations Number



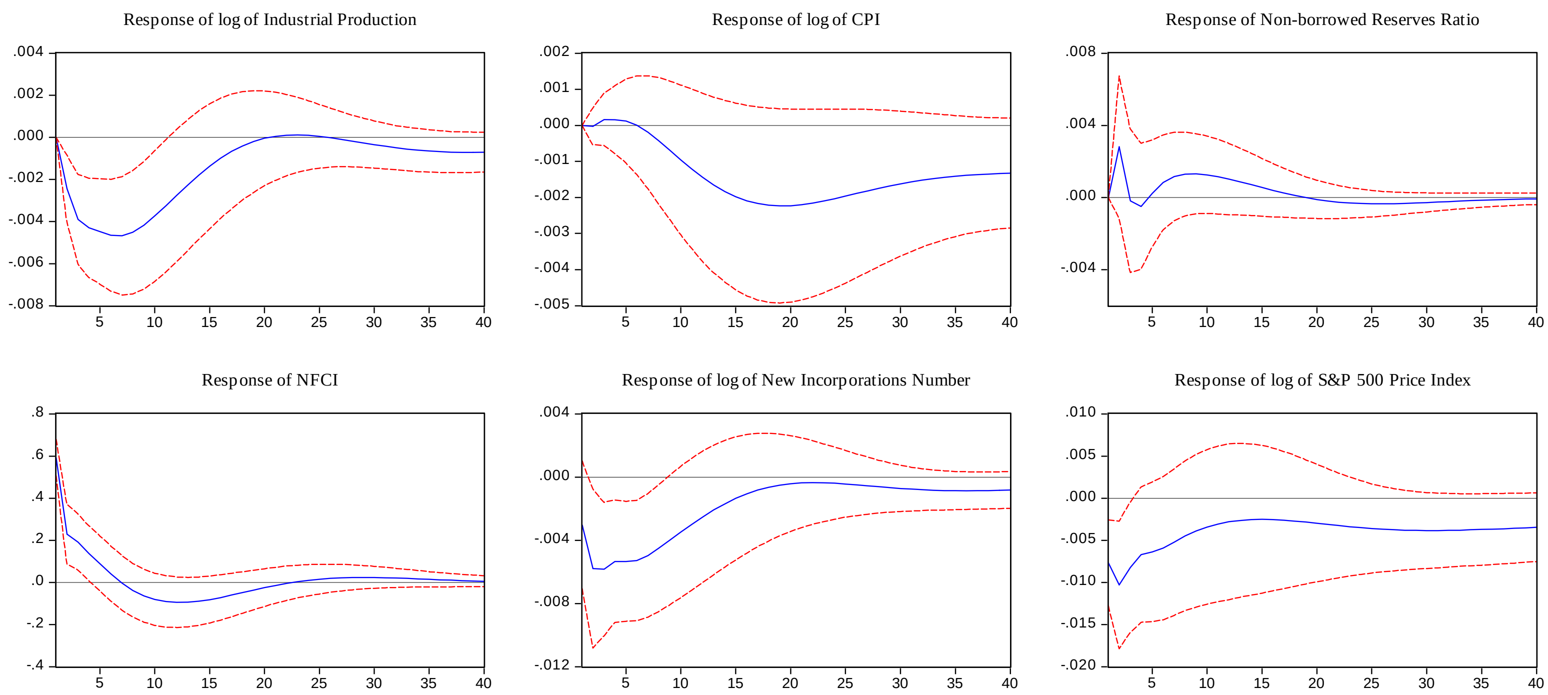
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, TED spread, logarithm of new incorporations, and logarithm of S&P500 index.

Appendix Fig. A1_6 Impulse Responses to Innovation in TED Spread, Using Net Business Formation



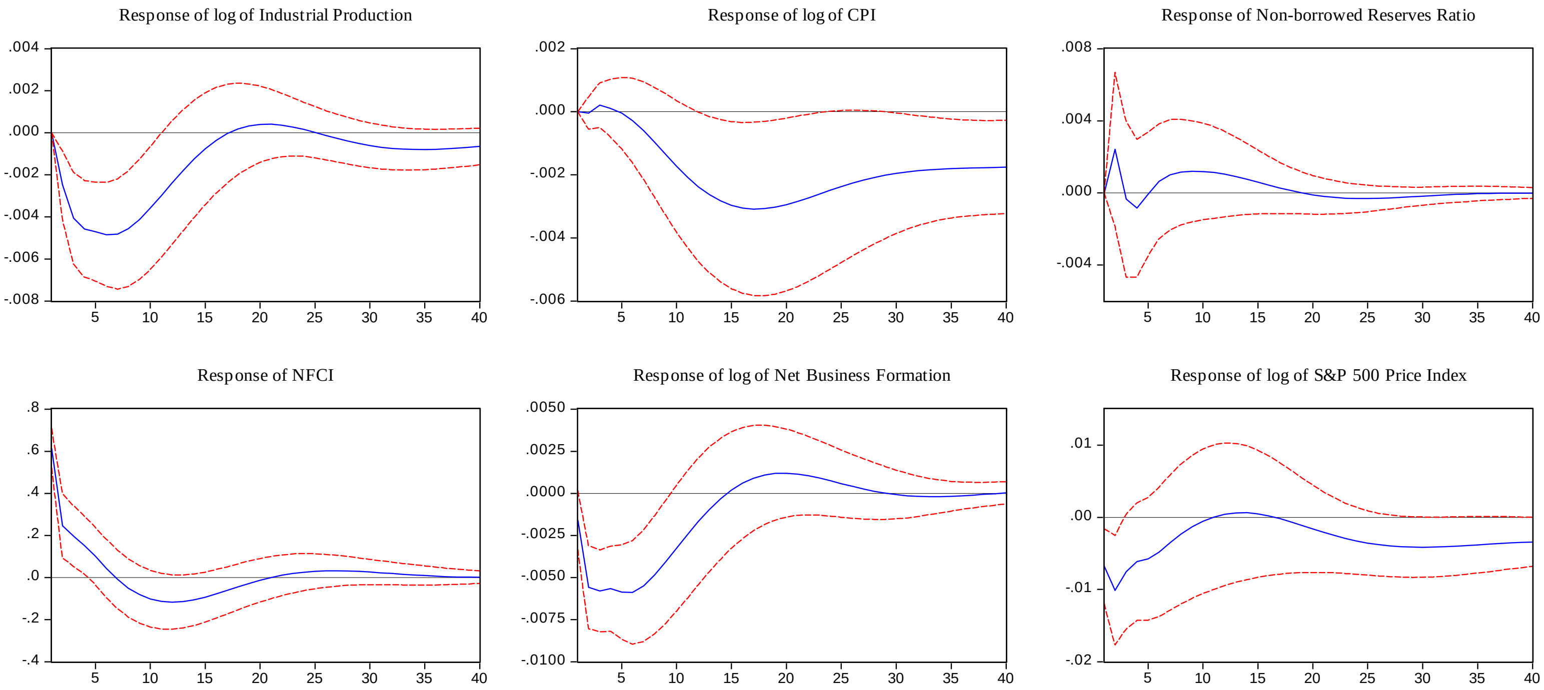
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1994:4, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, TED spread, logarithm of net business formation, and logarithm of S&P500 index.

Appendix Fig. A1_7 Impulse Responses to Innovation in NFCI, Using New Incorporations Number



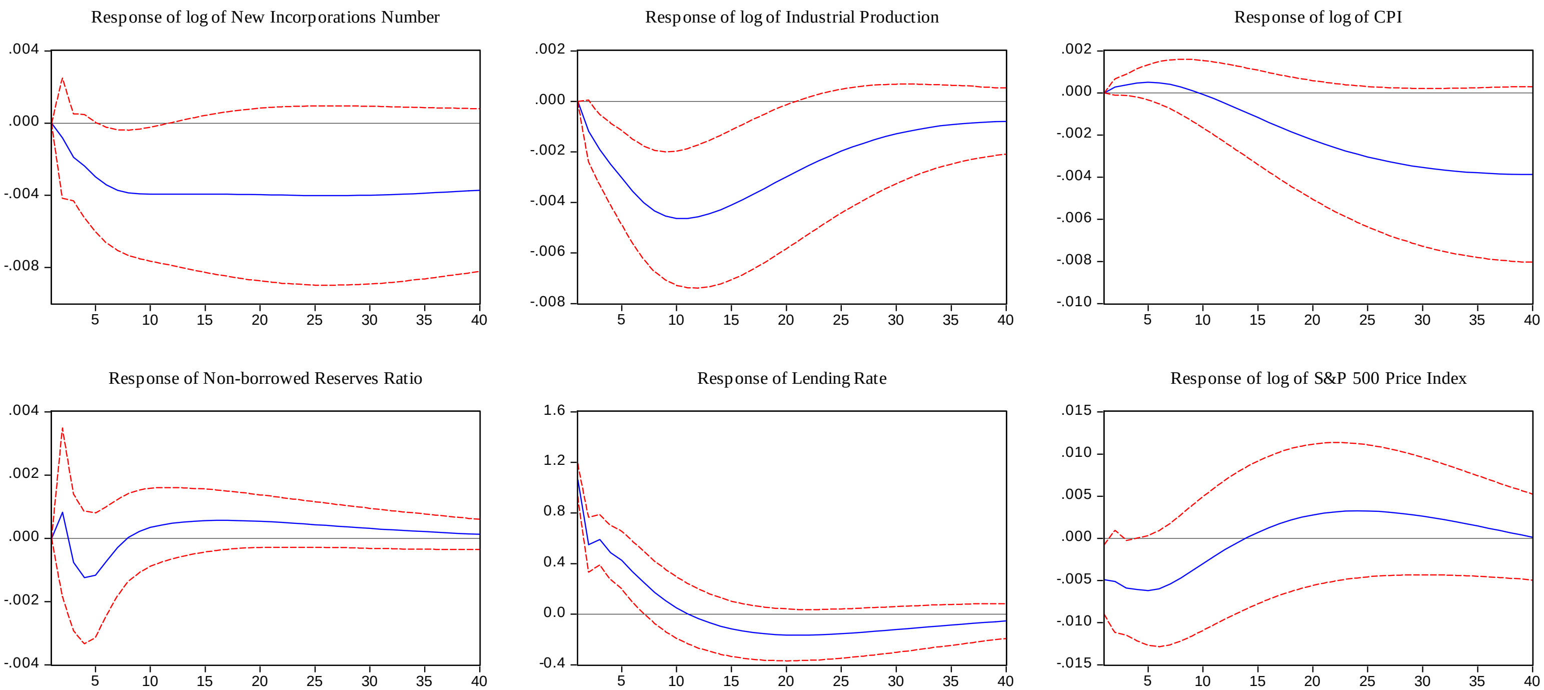
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1973:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, National Financial Conditions Index, logarithm of new incorporations, and logarithm of S&P500 index.

Appendix Fig. A1_8 Impulse Responses to Innovation in NFCI, Using Net Business Formation



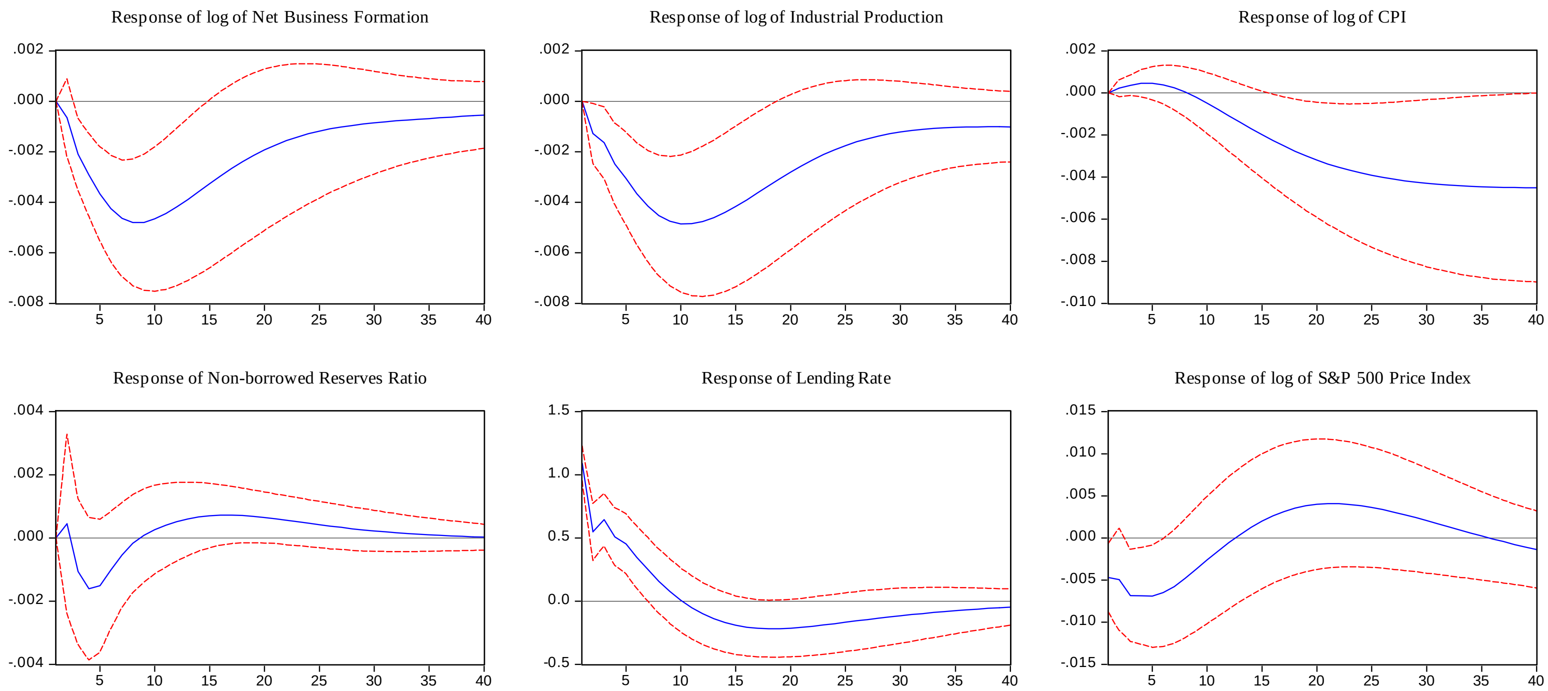
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1973:1 to 1994:4, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, National Financial Conditions Index, logarithm of net business formation, and logarithm of S&P500 index.

Appendix Fig. A1_9 Impulse Responses to Innovation in Interbank Rate, Using New Incorporations Number Ordered First



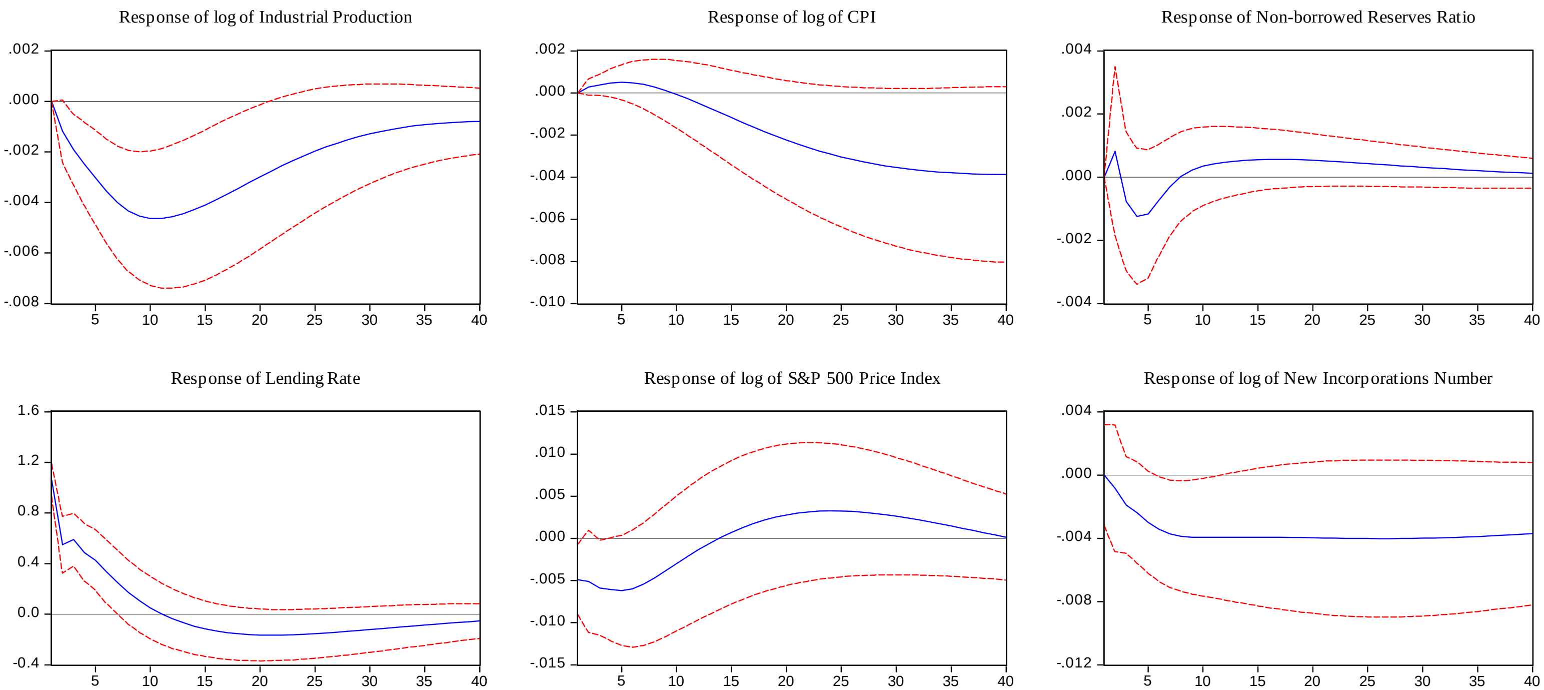
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1996:3, with variables in the following order: the logarithm of new incorporations, logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, and logarithm of S&P500 index.

Appendix Fig. A1_10 Impulse Responses to Innovation in Interbank Rate, Using Net Business Formation Ordered First



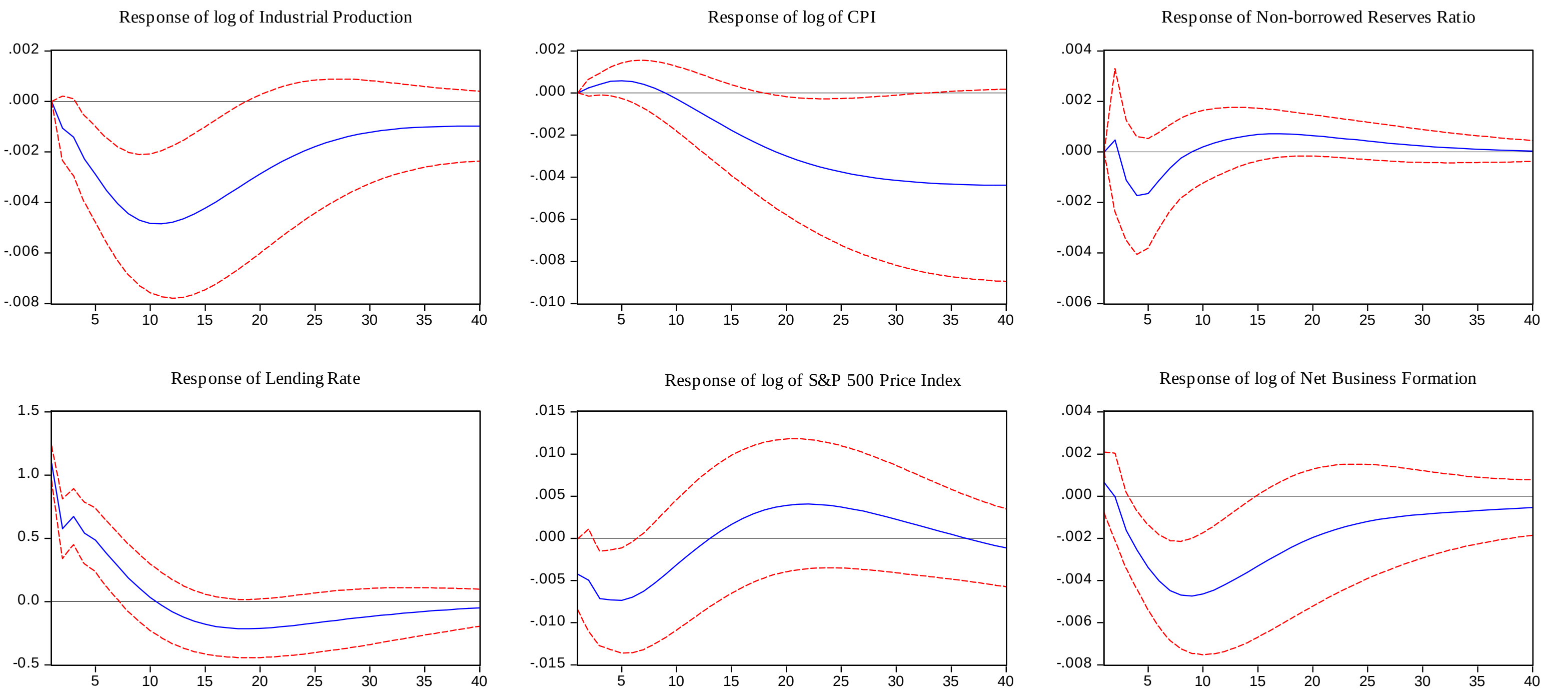
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1994:4, with variables in the following order: the logarithm of net business formation, logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, and logarithm of S&P500 index.

Appendix Fig. A1_11 Impulse Responses to Innovation in Interbank Rate, Using New Incorporations Number Ordered Last



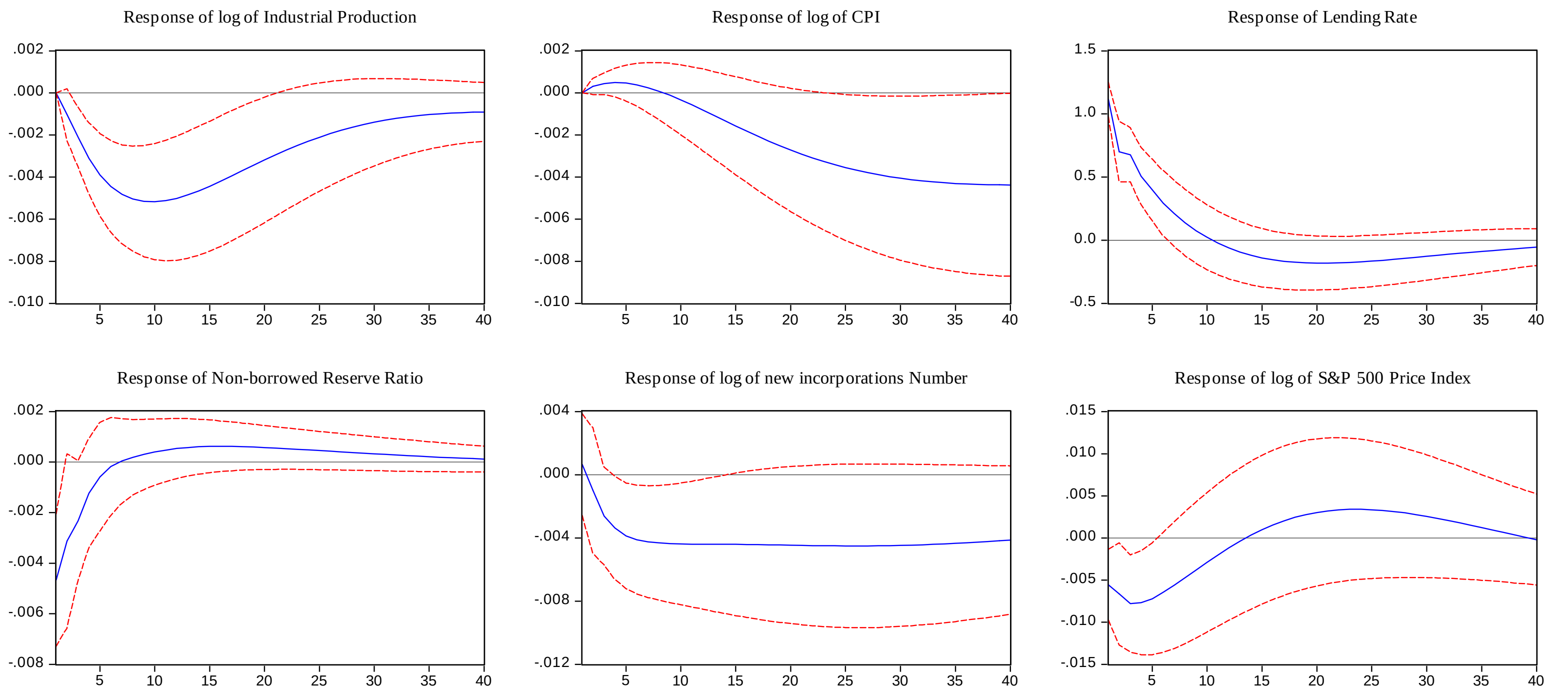
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of S&P500 index, and logarithm of new incorporations.

Appendix Fig. A1_12 Impulse Responses to Innovation in Interbank Rate, Using Net Business Formation Ordered Last



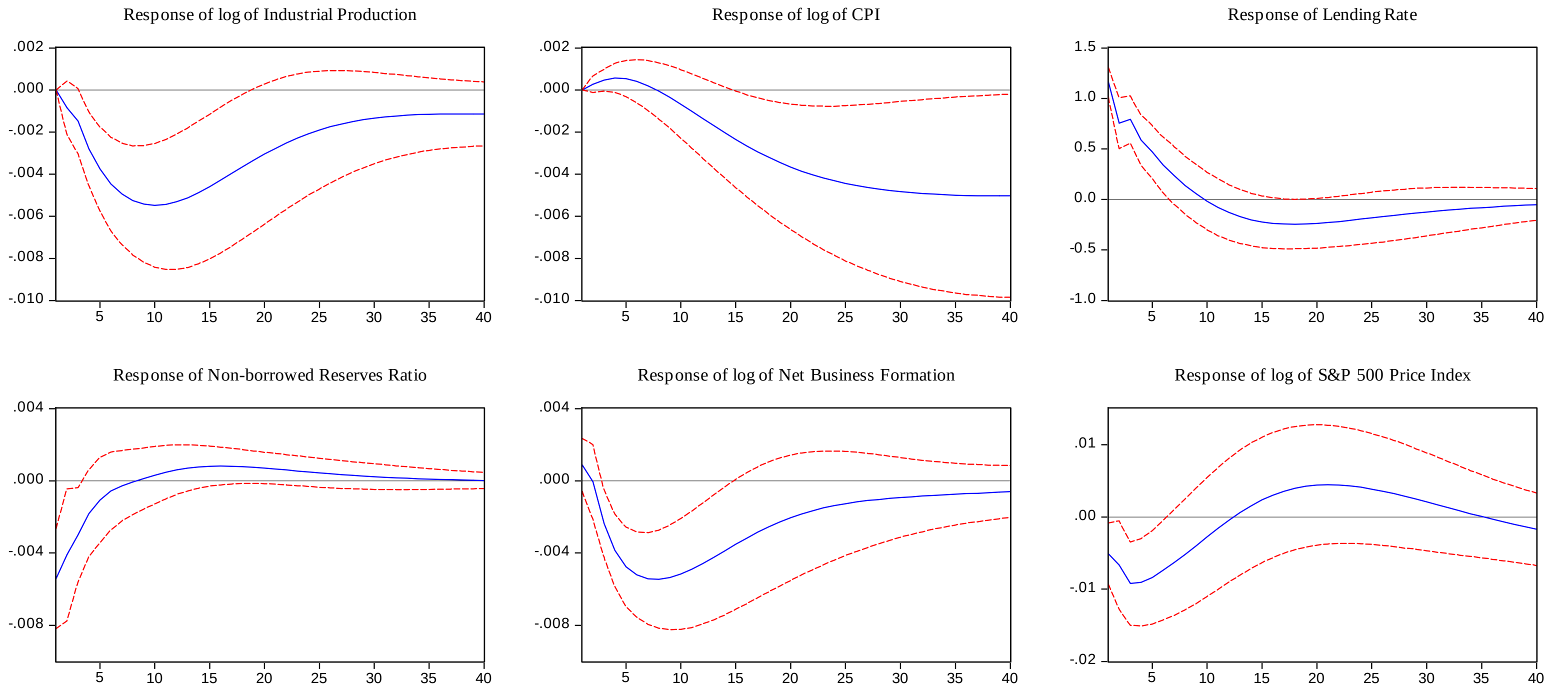
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1994:4, with variables in the following order: the logarithm of industrial production, logarithm of CPI, non-borrowed reserves ratio, 3-month interbank lending rate, logarithm of S&P500 index, and logarithm of net business formation.

Appendix Fig. A1_13 Impulse Responses to Innovation in Interbank Rate, Using New Incorporations Number, Ordering Lending Rate Before Non-borrowed Reserve Ratio



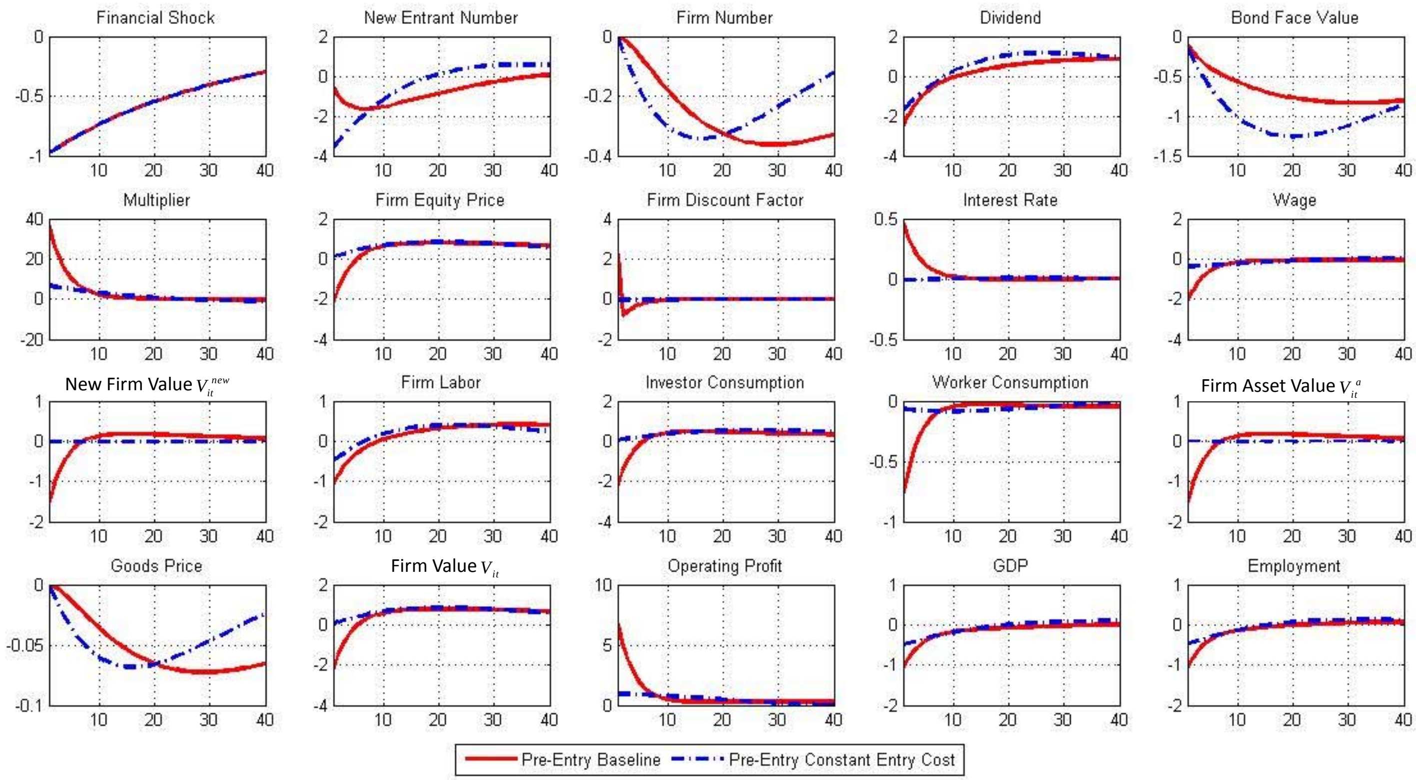
Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1996:3, with variables in the following order: the logarithm of industrial production, logarithm of CPI, 3-month interbank lending rate, non-borrowed reserves ratio, logarithm of new incorporations, and logarithm of S&P500 index.

Appendix Fig. A1_14 Impulse Responses to Innovation in Interbank Rate, Using Net Business Formation, Ordering Lending Rate Before Non-borrowed Reserve Ratio

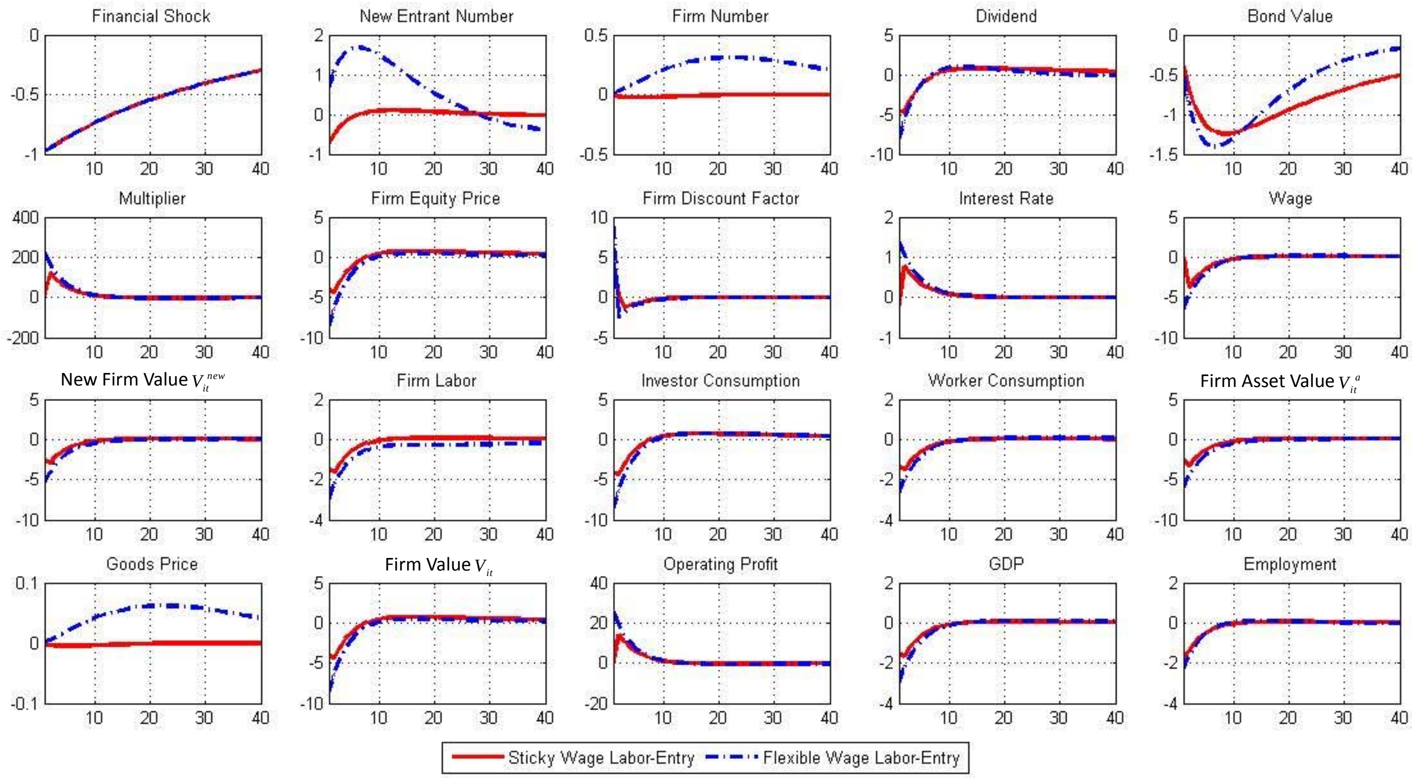


Note: Impulse responses generated from a 6-variable VAR model at quarterly frequency from 1963:1 to 1994:4, with variables in the following order: the logarithm of industrial production, logarithm of CPI, 3-month interbank lending rate, non-borrowed reserves ratio, logarithm of net business formation, and logarithm of S&P500 index.

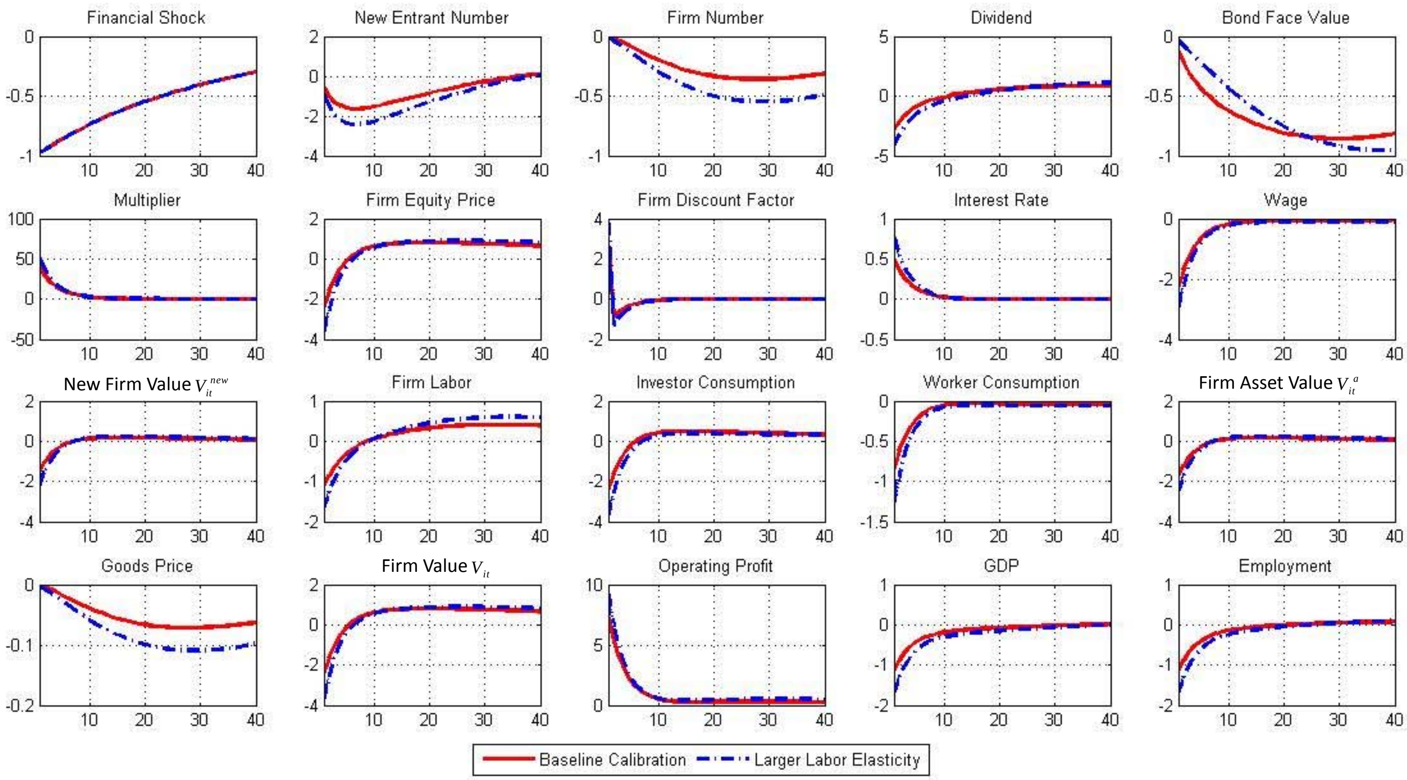
Appendix Fig. A2 Model Economy with Entry One Period Ahead of Production



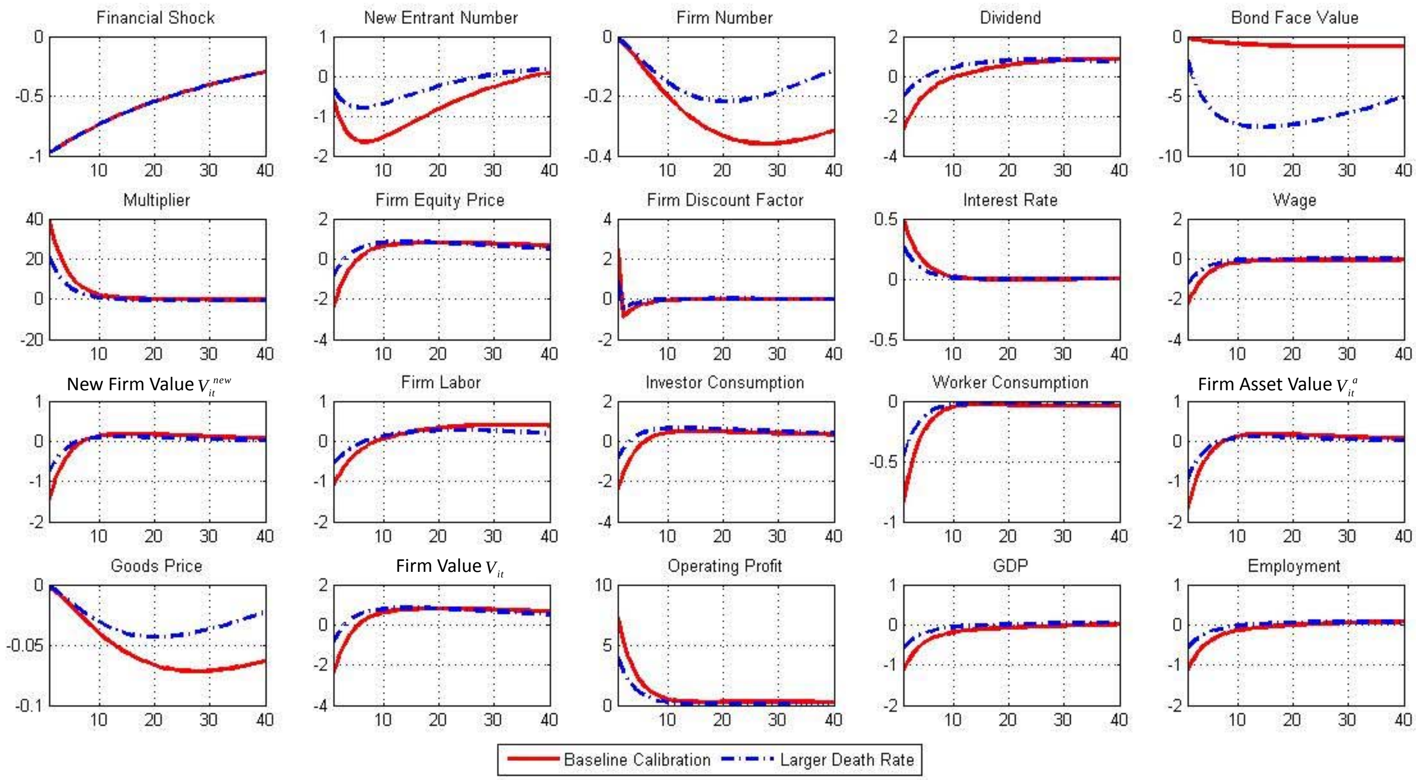
Appendix Fig. A3 Benchmark Model with Entry Costs in Labor Units: Flexible Wage versus Sticky Wage



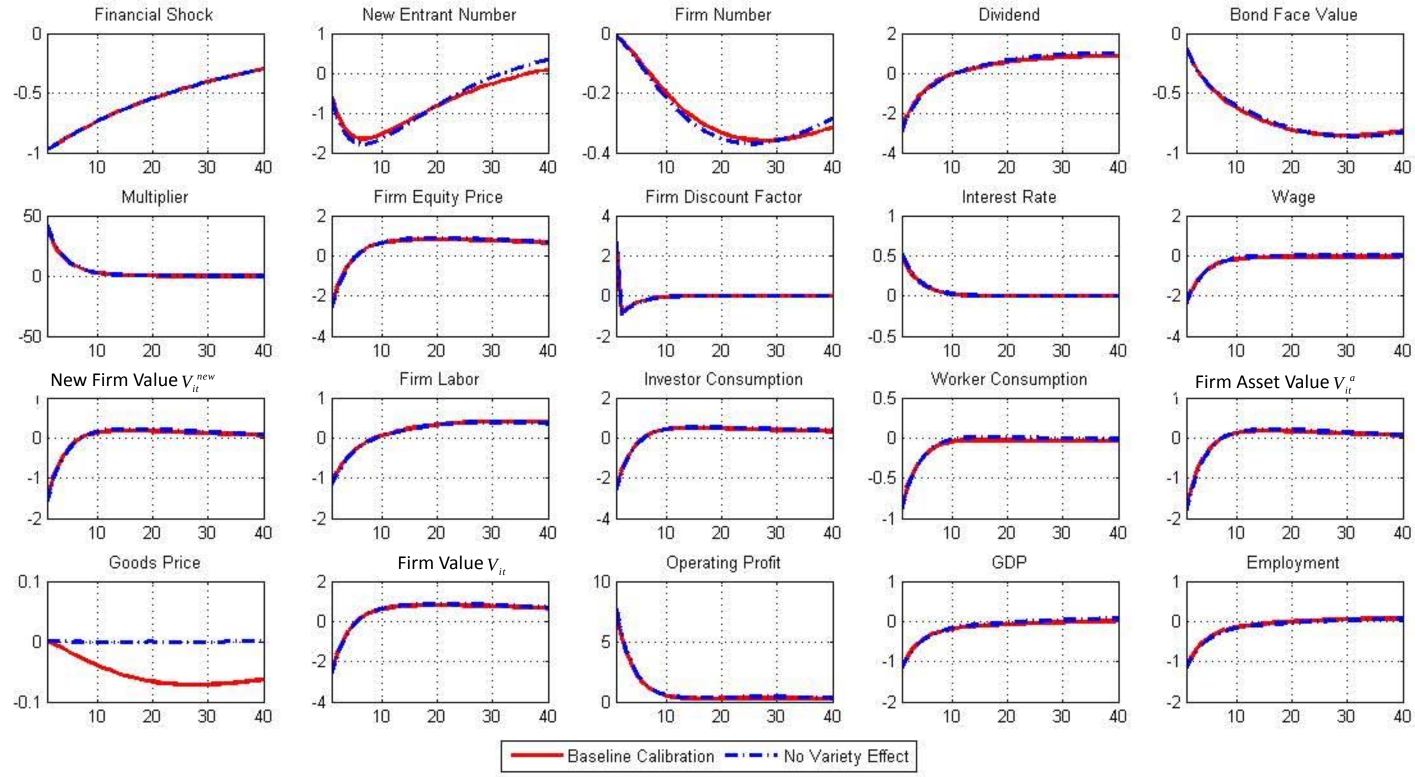
Appendix Fig. A4 Benchmark Model with Various Labor Supply Elasticity



Appendix Fig. A5 Benchmark Model with Various Death Rate



Appendix Fig. A6 Benchmark Model with Various Variety Effect



Appendix Fig. A7 Equity Price When Discount Factor is not Responsive to Exogenous Shock