Macroeconomic implications of insolvency regimes*

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Abstract

The impact of creditor and debtor rights following firm insolvency are studied in a firm dynamics model where defaulting firms choose between restructuring or exit. The model accounts for differing effects of productivity shocks across economies that differ in the credit/debtor rights. Following a negative shock labour productivity falls sharply in a creditor-friendly regime such as the UK while in a debtor-friendly regime such as the US, there is a larger employment response. This paper suggests a possible explanation for the different employment and labour productivity response in the UK and US since the financial crisis.

Keywords: Bankruptcy, Insolvency, Firm Financing

JEL codes: D21; E22; G33

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1 Introduction

In the aftermath of the 2007/2008 financial crisis output in both the UK and the US fell considerably. Real GDP fell by 5.88 percent in the UK between 2007Q4-2009Q2 while real GDP fell by 4.24 percent in the US over the same period. Despite UK output falling further than in the US, the UK labour market remained surprisingly resilient, as employment fell by 1.65 percent between 2007Q4-2009Q2 compared to the US where employment decreased by 5.34 percent. The key driver of the fall in UK output was labour productivity, which fell 3.3 percent. In the US, labour productivity actually increased by 2.3 percent.[1]

This paper suggests a link between labour productivity and a country's insolvency regime. It is well documented, for example by Djankov et al. (2008), that the UK insolvency regime is more creditor-friendly than in other countries, including the US. The UK insolvency regime features two main procedures, administration and liquidation. The stated aim of administration is to maintain the firm as a going concern and is similar in principle to the US Chapter 11 procedure. The key difference is in the control firm ownership maintains once insolvency begins. In the US, Chapter 11 allows firm management to remain in place and a court arbitrates between debtor and creditor. In the UK, administration replaces management with a professional 'insolvency practitioner' or 'administrator'. The administrator has full control of the business during administration. Liquidation on the other hand is a simple winding-up process, similar to the US Chapter 7 procedure where the firm ceases trading and the assets of the firm are sold off to satisfy creditors as much as possible. The incentives of firm management to default on its debt will depend on the insolvency regime in place and may impact on the firm's production decisions through the interest rate on firm debt.

[1] UK data is from the UK Office of National Statistics (ONS), US GDP data is from the US Bureau of Economic Analysis (BEA), US productivity and unemployment data from the US Bureau of Labor Statistics (BLS). Labour productivity for the UK is measured as output per hour worked for the whole economy. Labour productivity for the US is output per hour worked for the non-farm business sector.

I model the UK insolvency regime using a firm dynamics model in the spirit of Hopenhayn (1992) with the addition of financial frictions. Firms have access to both equity and debt. Equity is subject to exogenous issuance costs as in Gomes (2001) while debt is modeled using the costly-state verification framework of Townsend (1979). I allow for the firm to endogenously choose between two insolvency procedures. The first, restructuring, like administration in the UK and Chapter 11 in the US, allows the firm to continue subject to agreement between the parties. The second, liquidation, as in the UK and the US through Chapter 7, involves firm exit. If the firm chooses to restructure its debt, the firm and lender must bargain over the proceeds from restructuring. I distinguish between a creditor-friendly regime such as the UK and a debtor-friendly regime such as the US through the firm's bargaining power during restructuring. Defaulting is costly and leads to a loss of efficiency. In particular, the cost of holding capital increases for high-risk firms. In the model, I find that more borrowing constrained firms have a lower capital-to-labour ratio and thus have lower labour productivity.

I calibrate this model to UK aggregate data and find that the creditor-friendly bankruptcy regime features higher output in steady-state. This result is driven by firms having greater access to debt in the creditor-friendly regime which in turn implies lower barriers to entry for firms and higher employment in the steady state. In order to explore the dynamics of the model, I analyse an unanticipated aggregate productivity shock. The model finds a response to shocks that are largely consistent with the UK and the US following the financial crisis. Specifically, employment falls most in the debtor-friendly regime while labour productivity falls more in the creditor-friendly regime. A debtor-friendly insolvency regime, while more costly in the steady-state allows firms to remain less borrowing constrained following a large aggregate shock and as a consequence these firms hold more capital relative to their counterparts in a creditor-friendly regime.

In order to further establish the link between firm behaviour and labour productivity since the financial crisis, Figure 1 and Figure 2 show the change in the number of firms, employment by these firms and the ratio of employment

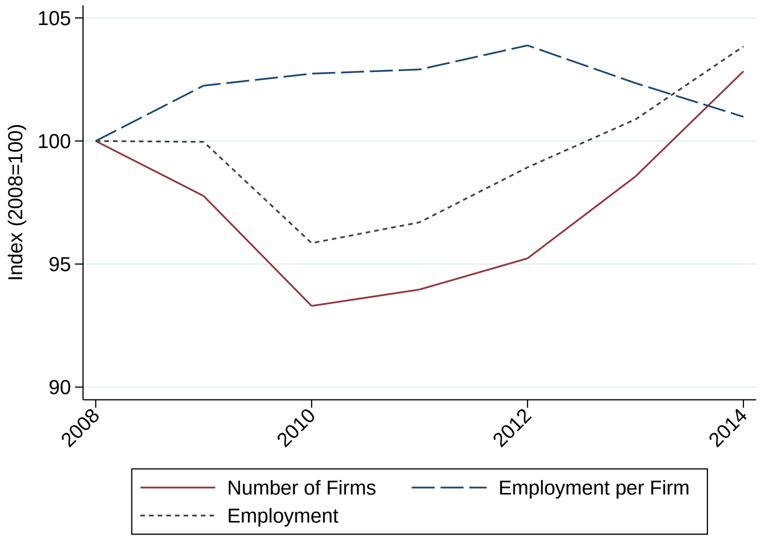


Figure 1: UK employment per firm since the financial crisis: Index of the total number of firms, total employment associated with those firms and the average employment per firm, 2008=100. Source: Eurostat

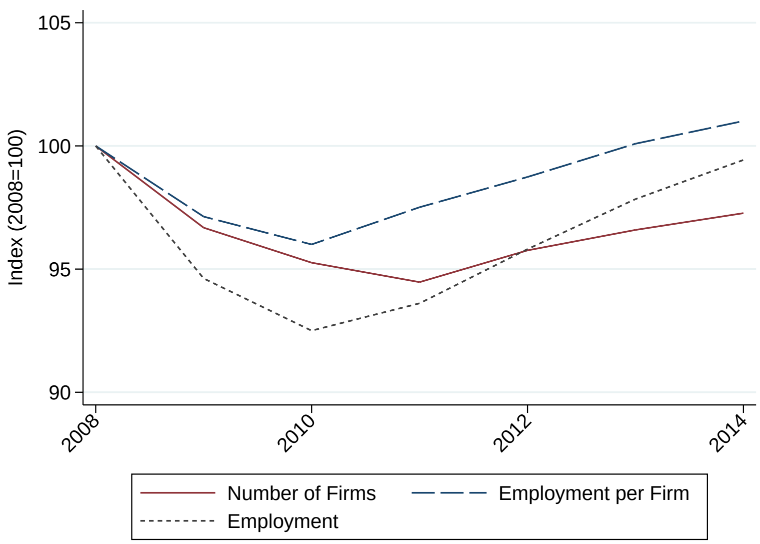


Figure 2: US employment per firm since the financial crisis: Index of the total number of firms, total employment associated with those firms and the average employment per firm, 2008=100. Source: Business Dynamic Statistics.

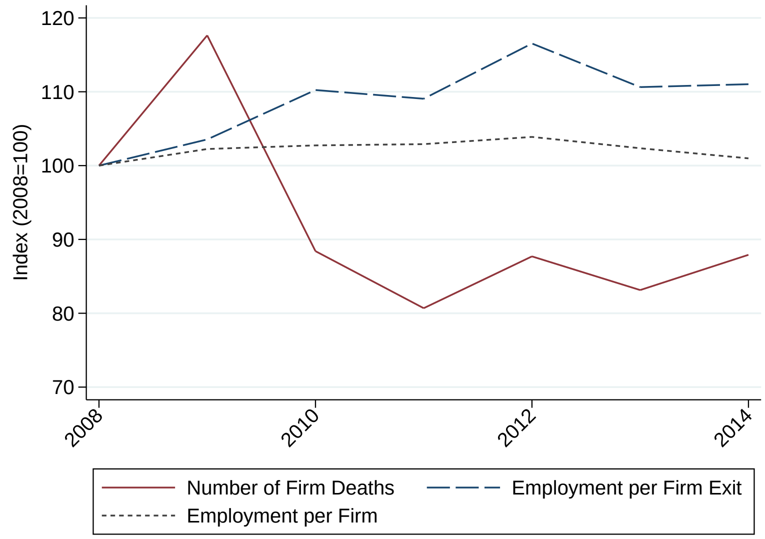


Figure 3: Size of UK firm exits since the financial crisis: Index of the total number of firm deaths, total employment associated with exiting firms and the average employment per firm, 2008=100. Source: Eurostat

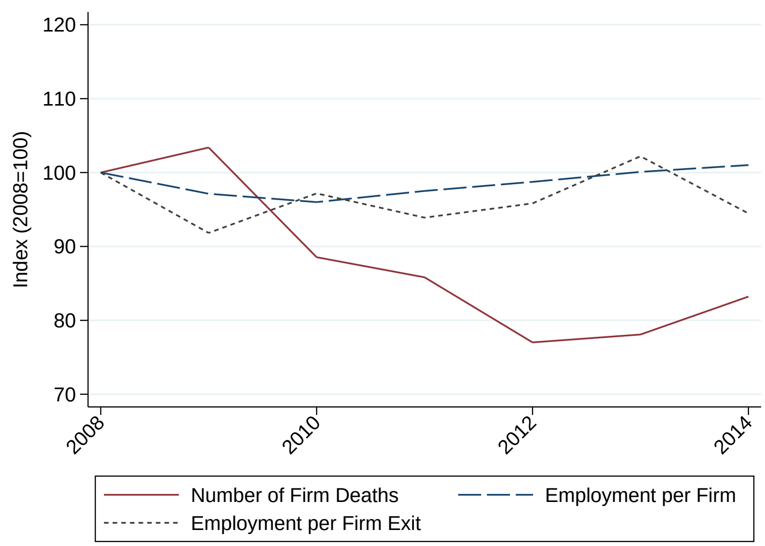


Figure 4: Size of US firm exits since the financial crisis: Index of the total number of firm deaths, total employment associated with exiting firms and the average employment per firm, 2008=100. Source: Business Dynamic Statistics.

to number of firms for the UK and US respectively. The key takeaway from these graphs is that following the financial crisis, the number of firms in the UK fell more, in percentage terms than employment. This results in a higher employment per firm, which is a crude measure of the average firm size. In the US this result is reversed, employment fell more than the number of firms and the average firm size fell. I consider two possible explanations for this behaviour. First, that the firms that exited the economy in the US tended to be larger compared to the UK. This would cause the average size of the firms remaining to fall. A second explanation is that continuing firms in the US reduced their employment to a much greater extent than in the UK, that is firms adjusted the intensive margin of employment more in the US than in the UK. In Figures 3 and 4 I examine whether these differences derive from selection effects, exit of larger firms in the US relative to the UK, or from adjustment of employment at the intensive margin. I find that the size of exiting firms increased marginally in both the UK and the US between 2008 and 2014. This suggests that the differences in employment are driven by incumbent firms adjusting their workforce. This paper presents a possible mechanism through which this can occur, driven by differences between the bankruptcy regimes in the UK and US.

Related Literature

This paper is related to the large literature that explores the interaction between financial frictions and firm dynamics. The firm dynamics build on Hopenhayn (1992), where firms are heterogeneous, face idiosyncratic productivity shocks and pay fixed costs to both enter and to continue production. Entry in this paper follows that of Clementi and Palazzo (2016); the mass of potential entrants is fixed and the free entry condition pins down the productivity of the marginal entrant. With the potential number of entrants fixed, the wage is sensitive to fluctuations in employment and allows for interesting transition dynamics in a model with no aggregate uncertainty. The addition of financial frictions to heterogeneous firm models has been explored by Cooley and Quadrini (2001) and Covas and Haan (2012) amongst others.

This paper is related to the literature of credit markets. Specifically, it is related to models of debt such as the costly-state verification framework proposed by Townsend (1979) and featured in the work of Bernanke and Gertler (1989), Carlstrom and Fuerst (1997), Bernanke et al. (1999) and others. Additionally, it is related to models of exogenous equity finance such as Gomes (2001), Cooley and Quadrini (2001) and Covas and Haan (2012). Papers on debt insolvency are less numerous, however Corbae and D'Erasmo (2017) also study the choice between restructuring and liquidation in the context of a heterogeneous firms model, focusing on the US system of Chapter 11 and Chapter 7. The main difference between this paper and theirs is the treatment of the labour market. They assume a fixed supply of inelastically supplied labour and model firm entry as in Hopenhayn (1992) where the free-entry condition pins down the equilibrium wage. This rules out the possibility of aggregate employment dynamics as without aggregate shocks, the wage remains constant and entry adjusts to clear the market. In my paper, I extend the existing literature on insolvency by assuming that households supply labour elastically and the mass of potential entrants is held fixed. This allows for fluctuations in both the wage and employment in response to unanticipated aggregate shocks. Another paper investigating the implications of creditor rights in insolvency on firm behaviour is Acharya et al. (2011) who study a model featuring two insolvency regimes, an 'equity-friendly system' as in the US and a 'debt-friendly-system' as in the UK and find that the insolvency regime impacts the leverage ratio. In related work, Acharya et al. (2011) study empirically the difference in insolvency regimes across countries and find having strong creditor rights in a country leads firms to reduce risk and become more reluctant to borrow. Insolvency and restructuring are key elements of firm exit and as such, this paper relates to the literature of firm entry and exit such as Lee and Mukoyama (2015), Macnamara (2015) and Clementi and Palazzo (2016). In addition, Macnamara (2015) studies the impact of exiting firms being able to re-enter the market, which is distinct from but related to firm restructuring.

This paper is also related to the literature on labour productivity, especially on the literature that focuses on the UK 'productivity puzzle'. Blundell et al. (2014) set out the empirical evidence underlying the 'productivity puzzle' and explore some of the possible causes behind it. Pessoa and Reenen (2014) argue that the UK productivity puzzle can be attributed to the fall in real wages resulting in substitution away from capital and towards labour. Clymo (2017) constructs a theoretical model that explains the differences in the UK and US response to the financial crisis, taking the wage behaviour of both countries as given. Goodridge et al. (2018) on the other hand suggest that the UK labour productivity puzzle is in fact a TFP puzzle. This paper is not meant to provide a theory of the UK's low productivity, but rather to highlight the UK's insolvency regime as a possible contributing factor and to investigate the extent to which this is the case.

2 Model

Consider a discrete time general equilibrium model with a representative household and heterogeneous firms facing financial frictions. Firms are owned by households and produce a homogeneous good using two inputs; capital (k) and labor (n). Firms fund their costs of production through internal funds and two sources of external funding: equity (e) and debt (b). Issuing equity is subject to an external issuance cost while debt finance occurs through a one-period contract with competitive risk-neutral financial intermediaries. Debt is risky and firms can default on their debt. A firm that defaults on its debt faces an endogenous choice between two forms of insolvency; debt restructuring and liquidation. A firm that enters liquidation ceases trading and is forced to exit, firms receive nothing and financial intermediaries receive the revenue of the firm less a liquidation cost. A firm that restructures its debt remains in the market and is able to produce in the following period. The payoffs following a restructuring is the result of bargaining between the firm and the bank. There is a representative household that maximises lifetime utility. Household income is derived from labour income, asset holdings, and dividends from

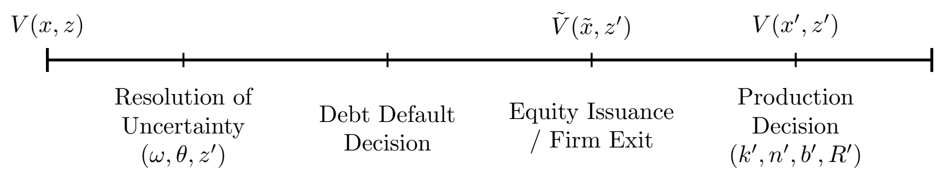


Figure 5: Timing of the model

firms.

2.1 Firms

Firms enter the period with net worth x. The inputs of capital (k) and labour (n) are decided one period in advance. At the beginning of the period the firm's revenue for the period is realised. Following the realisation of their revenue, firms decide whether or not to default on their debt and if a firm defaults, it chooses whether to enter insolvency or liquidation. Next, firms issue equity (e) or dividends and choose whether to produce in the following period. Finally, firms that choose to produce next period choose next period's capital (k'), labour (n') and the terms of debt financing (b',R') for the next period. With R' the interest rate charged by the bank. Figure 5 summarises the timing of a firm's problem. The timing of the firm's problem closely follows Cooley and Quadrini (2001).

In order to produce, firms must also pay a fixed cost of production $c_f > 0$. Firms that have positive net worth following the default decision are able to exit following the issuance of a final dividend. Each firm produces a homogeneous output according to a decreasing returns to scale production function. The firm's production technology is given by

$$y = z\omega\left(k^{1-\alpha}n^{\alpha}\right)^{v} \qquad \alpha \in (0,1)\,,\ v \in (0,1)\,. \tag{1}$$

Firm-specific productivity consists of a persistent component z and a transitory component ω. There is no aggregate uncertainty in the model. The persistent productivity component $z \in (0, \infty)$ follows an AR(1) process

$$\ln z' = \rho_z \ln z + \varepsilon_z', \tag{2}$$

where $\varepsilon_z' \sim N(\mu_{\varepsilon,z}, \sigma_{\varepsilon,z})$. The transitory productivity component is realised at the beginning of the period, after k, n and b have been chosen. It is assumed to be iid across firms and across time, orthogonal to ε_z, and with values $\omega \in \Omega \subset \mathbb{R}_+$ drawn from a distribution with cdf $G(\cdot)$.

The persistent component of productivity z' is observed at the end of the current period, before the firm decides if it will default on b and before the financing and production decisions of the next period are chosen.

At the beginning of each period, a firm is characterised by its net worth x and the realisation of its persistent productivity level z. Firms are risk-neutral and maximise the present discounted value of future dividends; firms discount dividends using the discount factor $(1+r)^{-1}$ where $1+r$ is the risk-free interest rate which remains constant over time. The present discounted value of future dividends for a firm with persistent productivity z and net worth x is denoted by $V(x, z)$. I denote the implicit opportunity cost of a firm with persistent productivity z' exiting as $\bar{x}(z')$ which is defined through the following equation

$$V(\bar{x}(z'), z') = 0. \tag{3}$$

As firms with zero net worth are able to exit the economy without incurring the fixed cost of production it follows that $V(0, z') \geq 0$ and the cost of exit will be weakly negative $\bar{x}(z') \leq 0$ for all values of z'.

In addition to using internal funding, firms are able to issue equity e and obtain debt financing b. Issuing equity is subject to an exogenously given cost function which is increasing in the amount of equity issued. The issuance cost function is given as

$$\psi(e) = \begin{cases} \frac{1}{2}\psi_0 e^2 & e \geq 0 \\ 0 & e < 0. \end{cases} \tag{4}$$

The assumption of quadratic equity issuance is also made in Covas and Haan (2012). An implication of the equity issuance cost is that a firm issuing a negative quantity of equity is equivalent to a dividend issuance and I economise on notation by allowing e to capture both equity issuance ($e > 0$) and dividend issuance ($e < 0$). The firm must purchase both capital and labour before production occurs. The firm's budget constraint is

$$b' + e + \tilde{x} = k' + \frac{1}{1+r}\left(wn' + c_f\right). \tag{5}$$

The term $\tilde{x}$ is the firm's end-of-period net worth after the realisation of revenues but before the firm issues equity, w is the aggregate wage and $1+r$ is the risk-free interest rate which is assumed to be constant across time. The last term in the firm's budget constraint reflects the requirement that firms have sufficient funds available to pay both workers and the fixed cost of production next period.

2.2 Financial Intermediaries

Firms borrow from competitive, risk-neutral financial intermediaries. The opportunity cost for financial intermediaries of lending to firms is equal to the risk-free interest rate $(1+r)$. Financial intermediaries maximise their expected profits from lending. In equilibrium, free entry of financial intermediaries implies that they break even in expectation. A firm that repays its debt has the following end-of-period net worth

$$\tilde{x}_R\left(\omega, k, n, Rb; z\right) = z\omega\left(k^{1-\alpha}n^{\alpha}\right)^{v} + \left(1-\delta\right)k - Rb. \tag{6}$$

The variable δ is the capital depreciation rate which is a common parameter across firms. If a firm defaults on its debt it must choose to enter either liquidation or insolvency. A firm that enters liquidation is forced to exit and forfeit any current revenue and expected future earnings. The bank receives the firm's resources after production less a dead-weight loss equal to a fraction

$(1-\underline{\theta}) \in (0,1)$ of the firm's resources after production. The total cost of liquidation consists of both the dead-weight loss of net worth from liquidation and the forced closure of the firm. It follows from equation (3) that the firm is indifferent between shutting down and receiving nothing and continuing with net worth $\bar{x}(z') \leq 0$, thus in terms of net worth, the total cost of liquidation can be written as

$$(1-\underline{\theta})\left(z\omega\left(k^{1-\alpha}n^{\alpha}\right)^{v} + (1-\delta)k\right) - \bar{x}(z'). \tag{7}$$

Liquidation in this model is similar to the default costs in the costly state verification of Townsend (1979). Part of the firm's end of period net worth comes from selling its undepreciated capital at the end of the period; the liquidation cost includes a fire-sale cost on this transaction. A liquidated firm makes the following payment to financial intermediaries

$$T_L(\omega,k,n;z) = \underline{\theta}\left(z\omega\left(k^{1-\alpha}n^{\alpha}\right)^{v} + (1-\delta)k\right). \tag{8}$$

A firm that restructures its debt does not exit and the firm bargains with the bank over the resources after production less a dead-weight loss that results from restructuring. This dead weight loss is

$$(1-\theta)zE[\omega]\left(k^{1-\alpha}n^{\alpha}\right)^{v} + (1-\underline{\theta})(1-\delta)k, \tag{9}$$

where $\theta \in \Theta \subset [0,1]$ is a firm specific recovery rate drawn from cdf $H(\theta)$ known before the firm decides on whether to default on its debt. The recovery rate θ is realised at the same time as ω andz', before the firm's default decision but after the debt contracts have been finalised.

Two features of the restructuring cost are worth emphasising. First, the restructuring cost depends on the expected value of the revenue shock rather than the realisation of ω which adds a fixed cost element to the restructuring cost. As the liquidation cost is decreasing in the realisation of ω this ensures that, everything else equal, a lower realisation of ω makes it more likely that a firm chooses liquidation over restructuring. Second, the cost of restructuring features the same fire-sale cost on undepreciated capital as in the liquidation case, this is a simplifying assumption.

A firm that begins the restructuring process can be forced into liquidation by either the firm or the bank and therefore both parties take their payoffs from firm liquidation as their outside option and any remaining surplus is then bargained between the firm and the bank. A defaulting firm will restructure only if there is a positive surplus obtained over firm liquidation. The surplus from restructuring over liquidation is

$$S_B\left(\theta,\omega,z',k,n;z\right)=\left(\left(1-\underline{\theta}\right)\omega-\left(1-\theta\right)E\left[\omega\right]\right)z\left(k^{1-\alpha}n^{\alpha}\right)^{v}-\bar{x}\left(z'\right). \quad (10)$$

The surplus from restructuring over liquidation is simply the cost of liquidation, equation (7), less the cost of restructuring, equation (9). It follows that this surplus will be positive in situations where restructuring is less costly than liquidation.

The firm's bargaining weight is denoted by $\phi\in[0,1]$ and is a key parameter in our modeling of insolvency regimes. High values of ϕ close to one imply that the bargaining power lies mostly with the firm and the insolvency regime is a more debtor-friendly regime such as the US while low values of ϕ close to zero would mean the bargaining power lies with the bank and the insolvency regime is a creditor-friendly regime such as the UK.[2] A firm that restructures will begin the next period with the following cash-in-hand

$$\tilde{x}_B\left(\theta,\omega,z',k,n;z\right)=\phi S_B\left(\theta,\omega,z',k,n;z\right)+\bar{x}\left(z'\right). \quad (11)$$

A restructured firm makes the following payment to financial intermediaries

$$T_B\left(\theta,\omega,z',k,n;z\right)=\left(1-\phi\right)S_B\left(\theta,\omega,z',k,n;z\right)+\underline{\theta}\left(z\omega\left(k^{1-\alpha}n^{\alpha}\right)^{v}+\left(1-\delta\right)k\right), \quad (12)$$

[2] In this model, firms and banks are assumed to receive a fixed share of the benefit of restructuring a firm rather than liquidating it. Due to the non-linearity of the firm's value function, this will not correspond to the solution to the Nash Bargaining problem with weight ϕ, but does greatly simplify the model.

where the first term is the financial intermediaries share of the surplus from restructuring, while the second term is the bank's payoff from liquidation which is also the bank's outside option as they are able to refuse to restructure a firm's loan and instead force the firm into liquidation.

2.3 Households

There is a risk-neutral representative household that discounts the future at rate $\beta \in (0,1)$ and maximises the following utility function

$$\sum_{t=0}^{\infty} \beta^t \left[C_t + \gamma \left(\frac{N_t^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \right) \right], \quad \gamma > 0,\ \eta > 0, \tag{13}$$

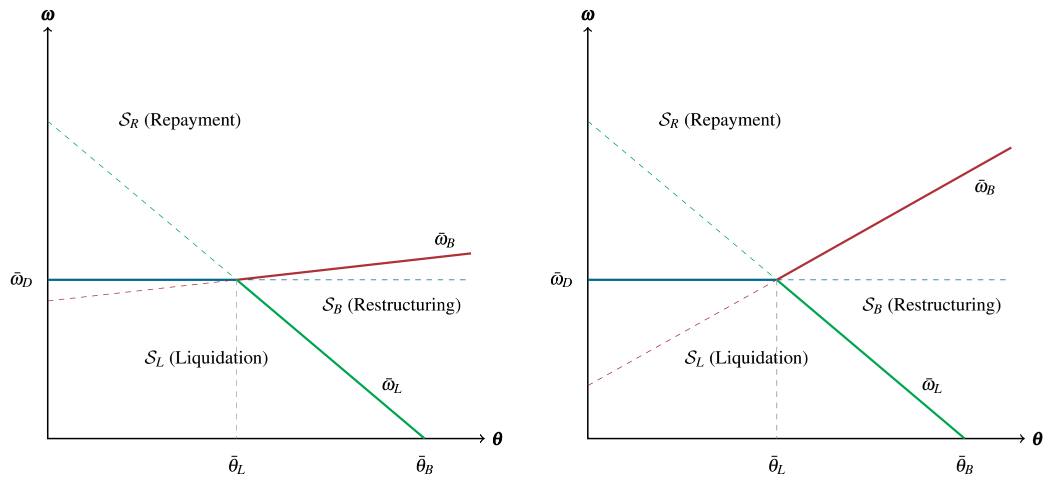
where C_t is aggregate consumption and N_t is the aggregate labour supplied by the household and the parameter η is the Frisch elasticity. Households own both firms and financial intermediaries and buy risk-free bonds B_t from financial intermediaries which are used to lend to firms. They maximise the discounted present value of utility subject to the following budget constraint

$$C_t + B_{t+1} + \int s_{jt+1} p_{jt} dj = w_t N_t + (1+r_t) B_t + \Pi_t^B + \int s_{jt} (d_{jt} + p_{jt}) dj, \tag{14}$$

where p_{jt}, d_{jt} and s_{jt} denote the price, dividends and fraction of shares in firm j owned by the household and Π_t^B denotes the profits of financial intermediaries.

As households are risk-neutral, the risk-free interest rate will be constant across time and firms and households discount the future at the same rate. The first order conditions for the household labour supply is given by

$$\gamma N_t^{\frac{1}{\eta}} = w_t. \tag{15}$$



(a) Low ϕ (b) High ϕ

Figure 6: Firm's debt resolution decision

3 Equilibrium

3.1 Debt Resolution

At the beginning of every period, a firm that borrowed in the previous period must make a decision between repayment, and default. If the firm defaults it must decide between filing for restructuring or liquidating the firm. The default decision the firm makes at the beginning of the next period will impact the interest rate the firm is charged on debt in the current period.

Figure 6 is an illustration of the firm's debt resolution decision in (θ, ω)-space for a hypothetical (z', k, n, Rb, z). The space can be partitioned into three areas. When the realisation of the revenue shock ω is high and the value of restructuring (θ) isn't too high, the firm will repay its loan. If the revenue shock ω is low and the value of restructuring θ is also low, the firm will choose liquidation. Finally, if ω isn't too high but the value of restructuring θ is high, the firm will choose restructuring over both liquidation and repaying its loan. The firm share of restructuring, ϕ is also key to the firm's debt resolution decision. Panel a) shows the case where ϕ is low and hence the restructuring area is small while panel b) shows the case where ϕ is high and hence the restructuring area is larger. Also note that firms will only choose liquidation over restructuring if the surplus from restructuring is negative, as a result, a change in ϕ doesn't impact the boundary between the restructuring and liquidation regions.

More formally, we can separate the space into three subsets. The first subset $\mathcal{S}_R(z', k, n, Rb; z)$ is the region where the firm will repay its debt. The second subset $\mathcal{S}_B(z', k, n, Rb; z)$ is the region where the firm will default on its debt and restructure its debt. The final subset $\mathcal{S}_L(z', k, n, Rb; z)$ is the region where the firm will default on its debt and will liquidate the firm. Formally these regions are defined as follows

$$\begin{aligned}\mathcal{S}_R(z', k, n, Rb; z) = \{ & (\theta, \omega) \in \Theta \times \Omega : x_R(\theta, \omega, z', k, n, Rb; z) \geq x_B(\theta, \omega, z', k, n; z), \\ & x_R(\omega, z', k, n, Rb; z) \geq \bar{x}(z') \}, \end{aligned} \tag{16}$$

$$\begin{aligned}\mathcal{S}_B(z', k, n, Rb; z) = \{ & (\theta, \omega) \in \Theta \times \Omega : x_R(\theta, \omega, z', k, n, Rb; z) < x_B(\theta, \omega, z', k, n; z), \\ & x_B(\theta, \omega, z', k, n; z) \geq \bar{x}(z') \}, \end{aligned} \tag{17}$$

$$\begin{aligned}\mathcal{S}_L(z', k, n, Rb; z) = \{ & (\theta, \omega) \in \Theta \times \Omega : x_R(\theta, \omega, z', k, n, Rb; z) < x_B(\theta, \omega, z', k, n; z), \\ & x_B(\theta, \omega, z', k, n; z) < \bar{x}(z') \}. \end{aligned} \tag{18}$$

The boundaries of these sets can be characterised by cutoffs of θ and $\bar{\omega}$. First consider the case where a firm is indifferent between repayment and liquidation, then the following must hold

$$\bar{\omega}_D(z', k, n, Rb; z) = \max\left\{ \frac{Rb + \bar{x}(z') - (1-\delta)k}{f(k, n)}, 0 \right\}. \tag{19}$$

For ω less than this cutoff, the firm will always default on its outstanding debt. Next, for $\omega < \bar{\omega}_D(z', k, n, Rb; z)$ the firm will be indifferent between restructuring and liquidation if the following equation holds

$$\theta = \left[1 - \left(1 - \underline{\theta}\right)\omega\right] - \frac{-\bar{x}\left(z'\right)}{f\left(k, n\right)}. \tag{20}$$

This equation is decreasing in ω. Using this allows us to define cutoffs $\bar{\theta}_B\left(z', k, n; z\right) \geq \bar{\theta}_L\left(z', k, n, Rb; z\right)$ such that a defaulting firm will always prefer restructuring if $\theta > \bar{\theta}_B\left(z', k, n; z\right)$ and a defaulting firm will always be liquidated whenever $\theta < \bar{\theta}_L\left(z', k, n, Rb; z\right)$ where the cutoffs are defined by the following equations

$$\bar{\theta}_L\left(z', k, n, Rb; z\right) = \max\left\{\left[1 - \left(1 - \underline{\theta}\right)\bar{\omega}_D\left(z', k, n, Rb; z\right)\right] - \frac{-\bar{x}\left(z'\right)}{f\left(k, n\right)}, 0\right\}, \tag{21}$$

$$\bar{\theta}_B\left(z', k, n; z\right) = \max\left\{1 - \frac{-\bar{x}\left(z'\right)}{f\left(k, n\right)}, 0\right\}. \tag{22}$$

For values of $\theta \in \left[\bar{\theta}_L\left(z', k, n, Rb; z\right), \bar{\theta}_B\left(z', k, n; z\right)\right]$ whether a defaulting firm will restructure or liquidate depends on the realisation of ω. Specifically, there will be a cutoff $\bar{\omega}_L\left(z', k, n; z\right)$ such that if $\omega \geq \bar{\omega}_L\left(z', k, n; z\right)$ a defaulting firm will restructure while if $\omega < \bar{\omega}_L\left(z', k, n; z\right)$ a defaulting firm will be liquidated. The cutoff is defined by the following equation

$$\bar{\omega}_L\left(z', k, n; z\right) = \max\left\{\frac{\bar{x}\left(z'\right) + \left(1 - \theta\right)f\left(k, n\right)}{\left(1 - \underline{\theta}\right)f\left(k, n\right)}, 0\right\}. \tag{23}$$

In cases where the firm has some bargaining power during restructuring ($\phi > 0$) the firm may choose to restructure when $\omega > \bar{\omega}_D\left(z', k, n, Rb; z\right)$. For this to occur, the recovery rate from restructuring must be sufficiently high, that is $\theta > \bar{\theta}_L\left(z', k, n, Rb; z\right)$. The firm will prefer restructuring over repayment of its debt whenever $\omega < \bar{\omega}_B\left(\theta, z', k, n; z\right)$ where the cutoff is defined by the following equation

$$\bar{\omega}_B(\theta, z', k, n, Rb; z) = \max\Bigg\{ \bar{\omega}_D(z', k, n, Rb; z) + \phi\left(\frac{\left(\theta - \bar{\theta}_L(z', k, n, Rb; z)\right) f(k, n) + \bar{x}(z')}{\left[1 - \phi(1 - \underline{\theta})\right] f(k, n)}\right), 0 \Bigg\}. \tag{24}$$

I refer to this case as strategic default as the firm has sufficient funds to be able to repay its loan but chooses to restructure its debt as they receive a higher net-worth by doing so. This is the only cutoff which depends on ϕ, specifically, $\bar{\omega}_B(\theta, z', k, n, Rb; z)$ is increasing in ϕ and thus for a given (z', k, n, Rb, z) firms have a greater incentive to restructure in a creditor-friendly (high ϕ) regime than in debtor-friendly (low ϕ) regime.

3.2 Bank's Problem

The expected profit of a bank for a given debt contract $(k, n, Rb, b; z)$ is written as

$$\begin{aligned} \Pi_B(k, n, Rb, b; z) = & E_{z'|z}\left[Rb \int_{\mathcal{S}_R(z', k, n, Rb; z)} d\left[G(\omega) \times H(\theta)\right]\right] \\ & + E_{z'|z}\left[\int_{\mathcal{S}_B(z', k, n, Rb; z)} T_B(\theta, \omega, z', k, n; z)\, d\left[G(\omega) \times H(\theta)\right]\right] \\ & + E_{z'|z}\left[\int_{\mathcal{S}_L(z', k, n, Rb; z)} T_L(\omega, k, n; z)\, d\left[G(\omega) \times H(\theta)\right]\right] \\ & - (1 + r)\, b. \end{aligned} \tag{25}$$

For a given contract $(k, n, Rb, b; z)$ the profit of the bank is strictly decreasing in the firm's bargaining power ϕ. There are two reasons for this. First as discussed in the previous section, a firm with high bargaining power is more likely to default on its debt and enter the restructuring process and the bank's profit from restructured debt is strictly less than if the debt was repaid. Second, as the bank has less bargaining power, it will receive a lower payment when the debt is restructured.

3.3 Firm's problem

Following the realisation of its revenue and its default decision, a firm that is not liquidated has cash-in-hand $\tilde{x}$ and knows the persistent component of its productivity for the next period z'. The firm can now choose to produce in the next period or it can issue a final dividend and exit. The equity issuance problem is written as follows

$$\tilde{V}(\tilde{x}, z') = \max_{e} \left\{ -(e + \psi(e)) + \frac{1}{1+r} V(\tilde{x} + e, z'), \tilde{x} - \psi(-\tilde{x}) \right\}. \tag{26}$$

The value function $\tilde{V}(\cdot, \cdot)$ is not everywhere differentiable. Specifically, there will be a point of non-differentiability at the point where the firm is indifferent between default and repayment as well as at points of indifference between exit (without default) and production. Nevertheless, by applying Theorem 1 from Clausen and Strub (2016) it follows that at the optimal solution to the equity issuance problem the following first order condition is satisfied[3]

$$\frac{1}{1+r} \frac{\partial V(\tilde{x} + e, z')}{\partial e} = 1 + \frac{\partial \psi(e)}{\partial e}. \tag{27}$$

A firm with $\partial V / \partial e > 1 + r$ will issue equity until they are no longer borrowing constrained. A firm with $\partial V / \partial e = 1 + r$ is no longer borrowing constrained and will be indifferent between issuing dividends and accumulating additional assets. To ensure that firms do not accumulate too many bonds and the asset market clears, I assume that in this situation shareholders demand that firms

[3] To apply Theorem 1 from Clausen and Strub (2016) and obtain the first order condition presented in this section, it is necessary to construct a 'differentiable lower support function', this is made possible by the differentiability of the function $\psi(e)$. If this function was not differentiable, as in Gomes (2001), then this would not be possible and we would not be able to use Clausen and Strub's theorem here.

issue dividends rather than accumulate assets. This ensures that there is a maximum net-worth for a firm conditional on z.[4]

The firm's problem can be written recursively as

$$V(x,z) = \max_{\{k,n,b,R\}} \Bigg\{ E_{z'|z} \left[\int_{\mathcal{S}_R(z',k,n,Rb;z)} \tilde{V}\left(\tilde{x}_R(\omega,k,n,Rb;z), z'\right) d\left[G(\omega)\times H(\theta)\right] \right] + E_{z'|z} \left[\int_{\mathcal{S}_B(z',k,n,Rb;z)} \tilde{V}\left(\tilde{x}_B(\theta,\omega,z',k,n;z), z'\right) d\left[G(\omega)\times H(\theta)\right] \right] \Bigg\}, \tag{28}$$

subject to

$$\tilde{V}(\tilde{x},z) = \max\left\{ \max_e \left\{ -(e+\psi(e)) + \frac{1}{1+r} V(\tilde{x}+e,z) \right\}, \tilde{x} - \psi(-\tilde{x}) \right\}, \tag{29}$$

$$b + x = k + \frac{1}{1+r}\left(wn + c_f\right), \tag{30}$$

$$\Pi_B(k,n,Rb,b;z) = 0. \tag{31}$$

The firm maximises expected utility by choosing a contract $\{k,n,b,R\}$. The expectation in equation (28) is over future technology z' and the transition of net wealth x depends on the realisation of ω, z' and the firm's choice of whether it repays or restructures its loan. Equation (29) combines the firm's equity issuance and exit decision, equation (30) specifies the firm's budget constraint and equation (31) specifies that due to perfect competition, banks makes zero profit in expectation.

3.4 Firm Entry

Every period there is a constant mass $M > 0$ of prospective firms. Each firm draws an initial productivity level z_0 from a distribution $G_E(\cdot)$. Firms observe

[4] A common assumption made here is that firms discount the future at a rate smaller than $1/1+r$. I avoid making this assumption here so that there exist unconstrained firms in equilibrium. I will exploit the existence of these firms in my calibration strategy.

their initial productivity level and then decide whether to enter the market or not. In order to enter, a firm must pay a fixed entry cost $c_e > 0$. Entrants fund the cost of entry through an initial equity issuance and enter the economy with zero net-worth $x = 0$. The value of a prospective entrant which receives an initial productivity level z_0 is

$$V_E(0, z) = \max_e \left\{ -(e + \psi(e)) + \frac{1}{1+r} V(e, z) \right\}. \tag{32}$$

Firms will only enter if their initial productivity level is sufficiently high and there is a cutoff value $\bar{z}$ such that firms enter when $z_0 > \bar{z}$ with the cutoff defined by the following free-entry condition

$$V_E(0, \bar{z}) = c_e. \tag{33}$$

Firms that enter the market decide on their production inputs and financing for the following period. Entrants do not produce until the period following their entry.

3.5 Recursive Competitive Equilibrium

A recursive competitive equilibrium consists of (i) value functions V, $\tilde{V}$, and V_E, (ii) policy functions $n(x, z, \Gamma)$, $k(x, z, \Gamma)$, $b(x, z, \Gamma)$, $R(x, z, \Gamma)$, $e(\tilde{x}, z', \Gamma)$ and $\bar{z}(\Gamma)$ (iii) a wage function $w(\Gamma)$ and distribution of firms Γ such that

1. The value functions $V(x, z)$, $\tilde{V}(\tilde{x}, z')$ and policy functions $n(x, z, \Gamma)$, $k(x, z, \Gamma)$, $b(x, z, \Gamma)$, $R(x, z, \Gamma)$, $e(\tilde{x}, z', \Gamma)$ solve the incumbent firm's problem
2. The value function $V_E(0, z)$ and the policy functions solve the prospective firm's problem free entry condition hold for entrants and firms enter the market only if $z \geq \bar{z}$ where$V_E(0, \bar{z}) = c_e$
3. Given the wage function $w(\Gamma)$ and the interest, the labour, equity and bond markets clear

4. The distribution of firms is consistent with firm decision rules and evolves according to the following law of motion

$$\begin{aligned}\Gamma_{t+1}\left(x',z'\right)=&\int_{\mathcal{S}_R}\left(1-\tilde{\chi}\left(\omega,x;z\right)\right)\mathbb{1}_{\{x',z'|x,z\}}\Gamma_t\left(x,z\right)d\left[G\left(\omega\right)\times H\left(\theta\right)\right]\\&+\int_{\mathcal{S}_B}\left(1-\tilde{\chi}\left(\theta,\omega,z',x;z\right)\right)\mathbb{1}_{\{x',z'|x,z\}}\Gamma_t\left(x,z\right)d\left[G\left(\omega\right)\times H\left(\theta\right)\right]\\&+M\int_{z>\bar{z}}\mathbb{1}_{\{x',z'|x=0,z\}}dG\left(z\right),\end{aligned}\tag{34}$$

where $\mathbb{1}_{\{x',z'|x,z\}}$ is the indicator function given the firm's policy function. $\tilde{\chi}_R\left(\omega,x;z\right)$ and $\tilde{\chi}_R\left(\omega,x;z\right)$ are the exit rules for firms following repayment and restructuring of debt respectively. These equations are given by

$$\begin{aligned}\tilde{\chi}_R\left(\omega,x;z\right)=&\mathbb{1}\Big\{\tilde{V}\left(\tilde{x}_R\left(\omega,k\left(x,z\right),n\left(x,z\right),R\left(x,z\right)b\left(x,z\right);z\right),z\right)<\\&\tilde{x}_R\left(\omega,k\left(x,z\right),n\left(x,z\right),R\left(x,z\right)b\left(x,z\right);z\right)\Big\},\end{aligned}\tag{35}$$

$$\begin{aligned}\tilde{\chi}_B\left(\theta,\omega,z',x;z\right)=&\mathbb{1}\Big\{\tilde{V}\left(\tilde{x}_B\left(\theta,\omega,z',k\left(x,z\right),n\left(x,z\right);z\right),z\right)<\\&\tilde{V}\left(\tilde{x}_B\left(\theta,\omega,z',k\left(x,z\right),n\left(x,z\right);z\right),z\right)<\\&\tilde{x}_B\left(\theta,\omega,z',k\left(x,z\right),n\left(x,z\right);z\right)\Big\}.\end{aligned}\tag{36}$$

The definition of a recursive equilibrium here allows me to analyse the dynamic impact of shocks to the model. I will also consider the numerical solution to a stationary equilibrium which occurs at the point where $\Gamma_{t+1}\left(x',z'\right)=\Gamma_t\left(x,z\right)$. For a stationary distribution to exist, we require that firms have a sufficiently large probability of exiting. This will occur so long as there exists some combination of (ω,z) for all x at which point firms choose to exit.

3.6 Impact of the Insolvency Regime

Before turning to the calibration of the model, I first discuss some of the channels through which the insolvency regime can impact the real economy and specifically, labour productivity. The insolvency regime is determined by the firm's bargaining power in restructuring ϕ. In this section, I focus on the impact of ϕ on the capital-to-labour ratio, which is a key component, along with aggregate TFP, of labour productivity. The mechanism through which the capital-to-labour ratio is made clear in the following equation for the capital-to-labour ratio which I obtained from the first-order conditions of the firm's problem

$$\frac{k}{n} = \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{w}{r+\delta+(1-\delta)\,\Lambda_k\left(k,n,Rb;z\right)}\right), \tag{37}$$

where $\Lambda_k\left(k,n,Rb;z\right)$ is a distortion to the capital-to-labour ratio given by the following equation

$$\begin{aligned}\Lambda_k\left(k,n,Rb;z\right) = {} & (1-\underline{\theta})\,E_{z'|z}\left[\int_{\bar{\theta}_L(z',k,n,Rb;z)}^{1} G\left(\bar{\omega}_B\left(\theta,z',k,n,Rb;z\right)\right) dH\theta\right] \\ & + (1-\underline{\theta})\,E_{z'|z}\left[H\left(\bar{\theta}_L\left(z',k,n,Rb;z\right)\right) G\left(\bar{\omega}_D\left(z',k,n,Rb;z\right)\right)\right],\end{aligned} \tag{38}$$

which is simply the expected default probability multiplied by $(1-\underline{\theta})$. Thus equation (37) provides a direct mechanism through which an increase in the default probability leads to a decrease in the capital-to-labour ratio and hence a fall in labour productivity.[5]

As illustrated by Figure 6, an increase in ϕ will mean the firm has a greater incentive to restructure loans that it could otherwise repay. However, banks will anticipate the lower repayment probability and will adjust loan terms accordingly, which would result in higher interest rates being charged to the firm. As is common to models based on the costly state verification model of

[5] It should be noted that this result relies on the timing assumption that firms choose capital and labour simultaneously as in Cooley and Quadrini (2001).

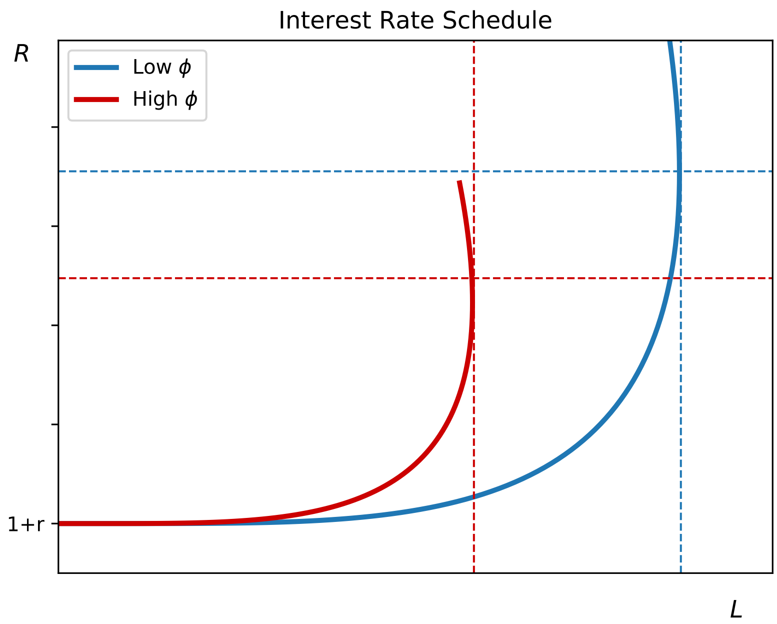


Figure 7: Impact of ϕ on firm leverage

debt, the interest rate schedule offered to the firms is backward-bending and there is an upper limit to firm leverage where $L = \frac{b}{x+b}$ is firm leverage. An illustration of this is set out in Figure 7 where a higher ϕ results in higher interest rate and a lower debt capacity.

Furthermore, firms that are more highly leveraged will require higher output in order to repay the loan and hence the default probability is increasing in leverage. This allows Figure 8 to be rewritten in terms of Λ_k and L as illustrated by Figure 8. In cases where the bank response to high ϕ is sufficiently strong, a higher ϕ results in lower debt capacity and lower maximum default probability.

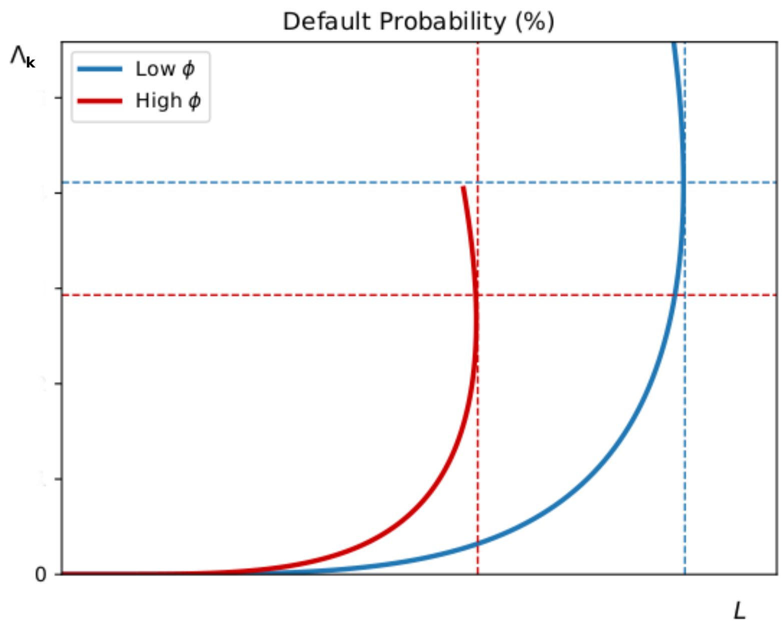


Figure 8: Impact of regime on default probability

4 Calibration

I solve the model numerically using a baseline calibration of the model to UK data since the financial crisis. One period in the model is a year. The distribution of entrants is assumed to be the stationary distribution implied by the AR(1) process for z. I approximate the process for z using the method described in Tauchen (1986). The distribution for $\theta \in [0, 1]$ is assumed to be a standard uniform distribution. The distribution of the revenue shocks ω are log-normal with $\mu_\omega = -\frac{1}{2}\sigma_\omega^2$ so that $E[\omega] = 1$.

The model parameters are split into two categories, those calibrated using the model through indirect inference and those that are calibrated outside of the model or taken from standard values found in the literature. The first set of parameters are set out in Table 1 and are not inferred using the model. The second set of parameters are jointly calibrated using moments from the model. Table 2 sets out the benchmark values and provides a summary of the moments targeted.

Parameter		Value	Source
Interest rate	r	0.04	annual interest rate
Depreciation rate	δ	0.1	standard parameter
Discount factor	β	1/1.04	inverse of $1+r$
Labour production elasticity	α	0.65	standard parameter
Decreasing returns parameter	v	0.85	standard parameter
Mass of potential entrants	M	0.405	set so that $N = 0.72$
Labour utility parameter	γ	1.55	set so that $w = 1$
Frisch elasticity	η	0.75	Chetty et al. (2011)
Persistence of z productivity	ρ_z	0.597	estimated from UK firm data

Table 1: Calibrated parameters

The risk-free interest rate r is set to 4% which is a commonly used value in annual models. The discount factor β is set to be the inverse of $1 + r$ so that firms discount the future at the same rate as households. The depreciation rate of capital δ is set to 0.1. The Frisch elasticity η is set to 0.75 which is a value suggested by Chetty et al. (2011) for representative agent macro models. The utility function parameter γ is chosen so that the household's labour supply equation is consistent with the wage w which is normalised to 1. This, coupled with the mass of potential entrants M pins down the employment level in the model and M is calibrated to ensure that steady state employment equals 0.72 which is approximately the employment rate of the UK.

The parameters of the production function are similar to those used in the literature, with the labour production elasticity α set to 0.65 which is approximately the labour share of income in the UK and the decreasing returns to scale parameter v set to 0.85 which is used in other similar models such as in Corbae and D'Erasmo (2017).

The parameters for the persistence of the firm technology shock ρ_z is estimated independently from the other parameters using Compustat data for UK firms. To estimate the parameters we follow a method similar to that described in Blundell and Bond (2000) and Cooper and Haltiwanger (2006), in particular,

Parameter		Value	Target
Firm Bargaining Power	ϕ	0.149	Ratio of administrations to liquidations
Fixed cost of production	c_f	0.279	Entry rate of UK firms
Cost of entry	c_e	0.866	One year survival rate of UK firms
s.d of technology process	σ_z	0.183	Debt-to-asset ratio
s.d. of revenue shocks	σ_ω	0.487	Liquidation rate of UK firms
Liquidation recovery rate	$\underline{\theta}$	0.210	Default recovery rate
Equity issuance cost	ψ	1.48	Equity-to-asset ratio

Table 2: Model-estimated parameters

I estimate the following equation

$$\ln y_{it} = \rho_z \ln y_{it-1} + a_1 \ln n_{it} + a_2 \ln n_{it-1} + a_3 \ln k_{it} + a_4 \ln k_{it-1} + A_t + \tilde{\eta}_{it}, \quad (39)$$

where y_{it} is the firm's revenue, k_{it} is capital, n_{it} is employment and the parameters are estimated using a dynamic panel data model.

The regression estimated in equation (39) could be used to estimate the variance of productivity shocks, however, in the model, this would correspond to a combination of σ_z and σ_ω. Instead, I calibrate the standard deviation of the technology parameter σ_z to the average debt-to-asset ratio of the Compustat firms. The standard deviation of the revenue shock σ_ω is calibrated to the proportion of firms in the UK declaring bankruptcy. Data from the UK Insolvency Service suggests that 0.66% of the total number of firms in the UK declare bankruptcy every year. The fixed cost of production c_f is calibrated to the average startup rate of UK firms between 2008 and 2015, while the cost of entry (c_e) is calibrated to the one year survival rate of UK firms. The data for both of these targets is obtained from the Eurostat Structural business statistics database.

Armour et al. (2012) study the impact of a 2003 change in UK Bankruptcy law. They find that post-2003, in the UK the debtor recovers through Administrations 20.2% of their claim on average. I choose the liquidation recovery rate $\underline{\theta}$ to match this recovery rate. In the UK insolvency regime, firms that default and attempt to restructure enter administration rather than another

Targeted Moments (%)	Model	Data
Firm entry rate	10.7	12.3
Debt-to-asset ratio	55.4	47.9
Equity-to-asset ratio	19.2	18.0
Proportion of defaulting firms	0.651	0.660
Ratio of restructures to liquidations	10.6	10.8
Debt recovery-rate in default	22.4	20.2
One year survival rate	90.4	90.5
Untargeted Moment (%)	Model	Data
Average spread on borrowing	3.13	2.05

Table 3: Calibrated Moments

form of insolvency. I use data from the UK Insolvency Service on the average proportion of total insolvencies that are administrations between 2008 and 2017 to calibrate the firm's bargaining power ϕ which in the model governs the likelihood that a firm restructures rather than enters bankruptcy. The equity cost parameter ψ is chosen to match the equity-to-asset ratio of the UK firms sampled in Compustat.

Table 3 sets out the moments used to calibrate the model and the model fit. The model fits the data reasonably well although it struggles somewhat to capture the entry rate of firms and the debt-to-asset ratio. The model also does a reasonable job at fitting the average spread on borrowing, which was an untargeted moment. The data for the UK spread on borrowing comes from the Bank of England.

5 Results

5.1 Steady State

In this section I explore the steady state properties of the benchmark model and compare it to the steady state of a model that features a more debtor-friendly insolvency regime. The debtor-friendly regime uses the same parameters as the benchmark model, with the exception of the firm's bargaining power during debt restructure (ϕ) which is increased. The increase in ϕ is calibrated to the ratio of firm restructurings to liquidations in the US economy. The data comes from the American Bankruptcy Institute and is calculated as the ratio of Chapter 11 bankruptcies to the total number of Chapter 11 and Chapter 7 bankruptcies. This ratio is 17.6% which is larger than the target of the benchmark model of 10.8% which was calibrated to UK data. The resulting parameter increase in the debtor-friendly is set to 0.273 which results in a ratio of restructurings to liquidations of 17.9% which is close to the targeted moment. As the mass of entrants is fixed at the same quantity for the two models, the wage adjusts to ensure the labour market clears.

I refer to the benchmark model, with $\phi_L = 0.149$, as the creditor-friendly model and compare it to the debtor-friendly model which features $\phi_H = 0.273$. Apart from the change in ϕ, all other parameters remain the same as in the benchmark model. Table 4 compares the aggregate values of the steady states for the two regimes. While the change in the aggregate values is minimal, the ϕ_H economy has lower output, lower aggregate capital and a lower equilibrium wage. This is because the increase in firm bargaining power leads to firms getting charged higher interest rates. This is shown in table 5 which compares the moments of the two models. The ϕ_L economy features a slightly higher spread on firm borrowing due to the higher debt-to-asset ratio in equilibrium. While banks may gain a larger share of restructuring in the ϕ_L economy, there are more defaulting firms and fewer firms that choose to restructure, which results in a lower average recovery rate of loans in default.

As discussed earlier, equation 38 specifies a distortion on the capital-to-labour ratio which increases with the firm's probability of default. This is due to the fire-sale cost of selling depreciated capital if the firm defaults which makes holding capital less efficient for firms with a higher default probability. The ϕ_H economy features a lower default probability which lowers the value of Λ_k and this is the key driver of the increase in the capital-to-labour ratio from the ϕ_L economy to the ϕ_H economy as measured by the output to employment ratio as found in table 4. Both regimes feature lower than optimal capital

	Creditor-friendly (ϕ_L)	Debtor-friendly (ϕ_H)
Bargaining Power (ϕ)	0.148	0.273
Wage (w)	1.0	0.995
Employment (N)	0.720	0.717
Aggregate Capital (K)	2.65	2.65
Output (Y)	3.84	3.83
Y/N	5.34	5.36
K/N	3.62	3.68

Table 4: Steady State Aggregates of Insolvency Regimes

Moments (%)	Creditor-friendly (ϕ_L)	Debtor-friendly (ϕ_H)
Firm entry rate	10.7	10.5
Debt-to-asset ratio	55.4	54.3
Equity-to-asset ratio	19.2	18.7
Proportion of defaulting firms	0.651	0.535
Ratio of restructures to liquidations	10.6	17.9
Debt recovery-rate in default	22.4	24.3
One year survival rate	90.4	90.5
Average spread on borrowing	3.13	3.09

Table 5: Moments of Insolvency Regimes

investment. This is due to the financial frictions distorting the relative price of capital and labour.

The unconditional distributions of firm net worth and persistent productivity z are shown in Figure 9 and Figure 10 respectively. The ϕ_H economy features more selection into the economy and thus the distribution of firm net worth x and productivity z shift to the right.

The increase in firm bargaining power, if everything else were constant would result in the bank charging higher interest spreads. However, in the ϕ_H economy, firms are unable to borrow as much and are less highly leveraged, hence why the spread on borrowing actually decreases. Both of these factors make production more costly in the ϕ_H economy and thus less productive firms exit sooner and there is more selection in firm entry. Figure 11 shows the productivity distribution of entrants in the steady state. As the mass of potential firms M is held constant between the two economies, the greater selection in the ϕ_H economy results in fewer entrants, a smaller mass of firms in the stationary distribution and a higher survival rate of newly entering firms. The fall in the equilibrium wage again dampens the variation of the distributions across regimes.

5.2 Dynamic Response

In this section I present the dynamic response of the model to an unexpected aggregate shock to the distribution of firms. The shock is a negative shock to the mean of the revenue shock distribution such that $\mathbb{E}[\omega]$ falls by 0.1 standard deviations. The shock lasts for only one period and will impact the revenue and hence the net wealth of firms in the economy. Firms with sufficiently low net wealth will exit the economy, reducing the mass of incumbent firms below the steady state value. As the mass of entrants is constrained by the value of M, the wage will adjust to ensure the labour market clears. I assume that firms fully anticipate the path of wages, which after the initial probability zero shock follow a deterministic path. As the wage changes, the firm's policy

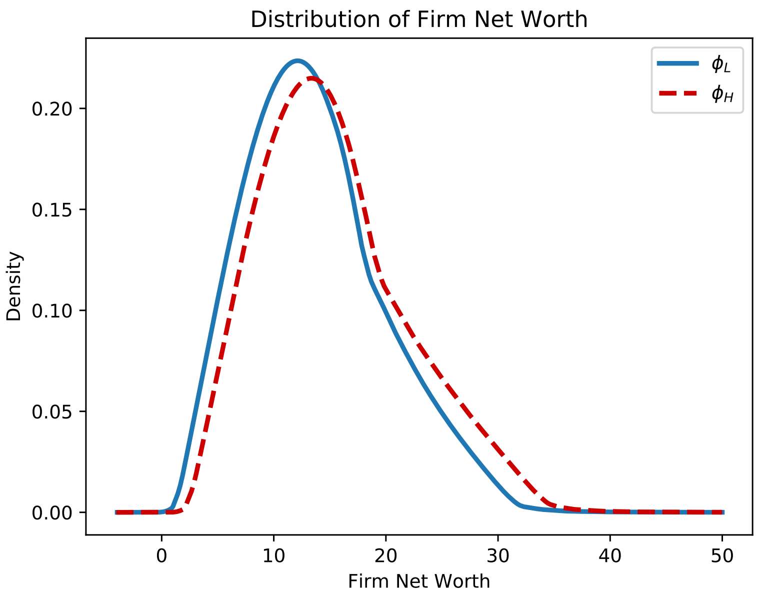


Figure 9: Distribution of Firm Net Worth (x) in the Steady State

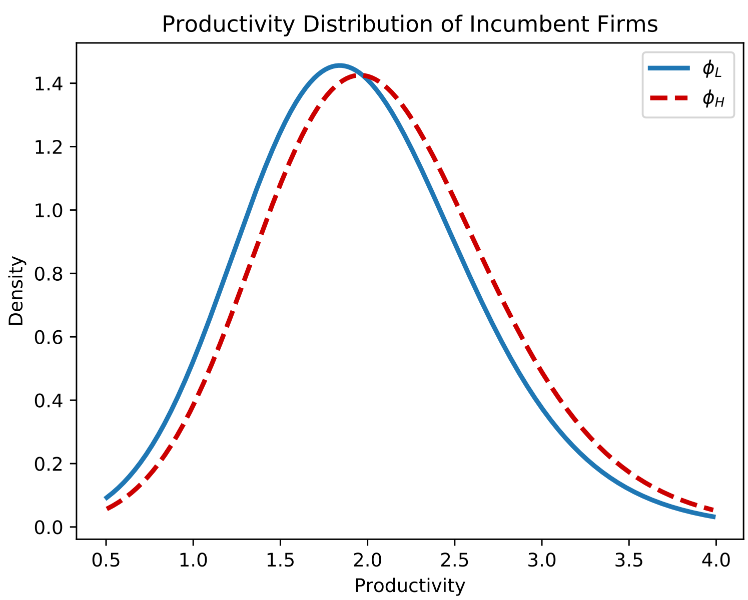


Figure 10: Distribution of Persistent Firm Productivity (z) in the Steady State

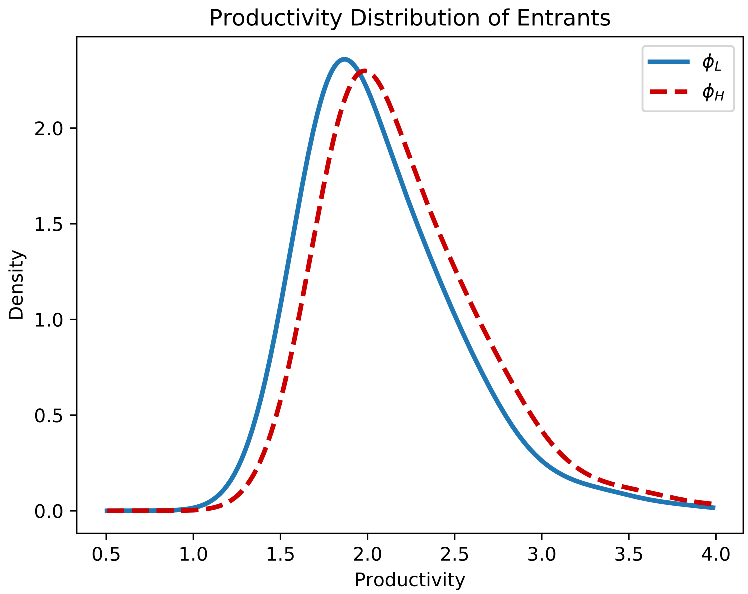


Figure 11: Distribution of Persistent Firm Productivity (z) of Entrants

functions also change. From a technical point of view, this requires the firm's problem to be solved in order to find the wage that clears the market.

Figure 12 sets out the response of the two regimes to the negative shock to z. Employment falls less in the creditor-friendly (ϕ_L) than the debtor-friendly (ϕ_H) regime, employment falling 3 percent on impact in the ϕ_L case compared to 5.4 percent with ϕ_H. Labour productivity, measured as the ratio of output to employment, falls in both models, but falls most in the creditor-friendly regime (ϕ_L). In this experiment, the ϕ_H economy features leads to a 75 percent larger peak drop in employment and a 20 percent smaller fall in labour productivity following the negative productivity shock.

Labour productivity falls as firms are more borrowing constrained when their bargaining power is low and this in turn leads to firms lowering their capital holdings, with the capital-to-labour ratio falling more in the creditor-friendly regime. The response of output to the shock is similar in both regimes, suggesting that the employment and productivity responses roughly offset. The firm's bargaining power during restructuring may be costly in the steady-state,

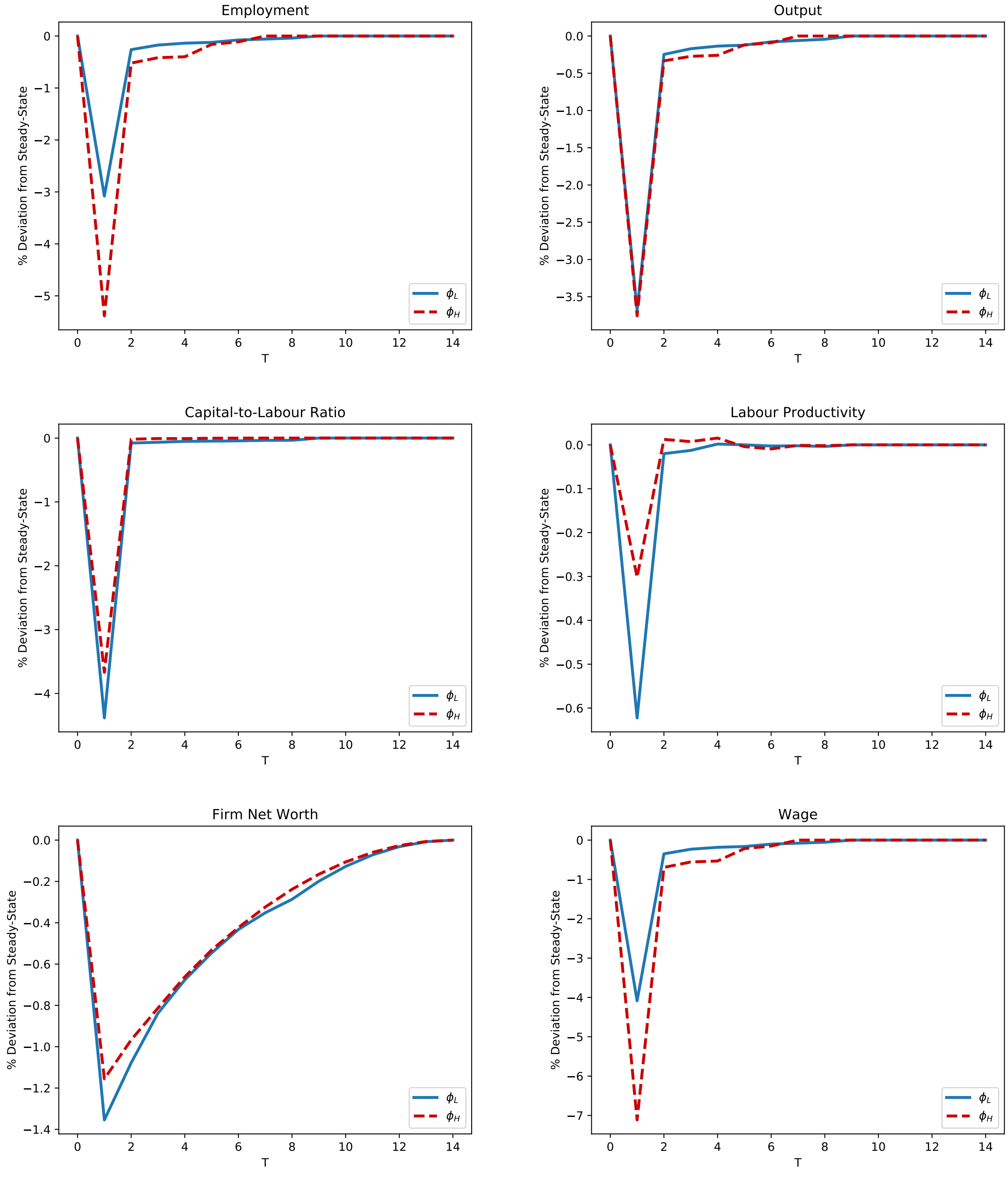


Figure 12: Dynamic Response to a negative shock to Firm productivity z

but provides a degree of insurance when the firm, or the economy, is hit by a negative shock. Firms that default as a result of the shock are more likely to restructure their debt when their bargaining power is high and firms that restructure their debt will begin the next period with higher net worth and thus are less borrowing constrained than if their bargaining power was low.

To gain some further insight into the mechanism driving this result, consider the impact of the shock if the wage is held fixed. The negative shock to ω acts as a negative shock to firm end-of-period net worth and pushes some firms into default. In the debtor-friendly regime, any defaulting firm that restructures will enter the period following the shock with a higher net worth than if their bargaining power was lower. As the shock is temporary, in the following period, banks will offer identical contracts to firms, conditional on net-worth, as before the shock, thus the higher aggregate net-worth of firms in the debtor-friendly regime would result in firms being less debt-constrained than in the creditor-friendly regime. It follows from equation (37) that the aggregate capital-to-labour ratio and hence aggregate labour productivity will be relatively higher in the debtor-friendly regime.

While the wage falls further in the debtor-friendly insolvency regime, this occurs for the same reasons as the fall in employment as w and N move together as can be shown from equation (15) and thus is a rather trivial result. As firms hit by the negative productivity shock more firms exit and employment falls. As employment falls, the household labour supply condition results in a falling wage. In the creditor-friendly bankruptcy regime, borrowing constrained firms substitute from capital to labour and the resulting fall in employment is less, hence the equilibrium wage falls less. The debtor-friendly regime does not fully capture the US experience, labour productivity still falls in the model while it rose slightly following the crisis. Fully capturing the response of the US economy was not the purpose of this exercise and I chose to calibrate the model to UK data only. However, the current formulation of the model would struggle to reverse the direction of the labour productivity response. This is because the capital-to-labour ratio will fall as the firm's default risk increases and a negative shock will increase the firm's probability of default. Nevertheless, the model presented here highlights how the difference in insolvency regimes between the UK and the US can partly explain the fall in labour productivity the UK witnessed since the financial crisis.

6 Conclusion

This paper presents a heterogeneous firm model of the UK's creditor-friendly insolvency regime and investigates a hypothetical change in the insolvency regime to a US-style debtor-friendly regime. The insolvency regime is modeled as a costly-state verification model where firms have the option to restructure their debt. Default costs create a wedge on the capital-to-labour wedge, effectively raising the price of holding capital for high-risk firms. As a consequence of this, firms that are more borrowing constrained have a lower capital-to-labour ratio and thus lower labour productivity. In the steady-state, lower firm bargaining power results in both higher output and a higher level of firm indebtedness. This higher firm indebtedness in turn lower labour productivity through higher equilibrium default costs. The dynamic response of the benchmark model to a negative shock matches the response of the UK to the financial crisis. In particular, following a negative shock to firm productivity firms in the creditor-friendly regime substitute from capital to labour. This dampens the fall in employment while causing labour productivity to fall. Firms in a debtor-friendly insolvency regime, while more costly in the steady-state allows firms to remain less borrowing constrained following a large aggregate shock and thus these firms hold relatively more capital relative to their counterparts in a creditor-friendly regime. In addition to the static benefits of the UK regime the results highlight the trade off in the dynamic response to shocks. The counterfactual debtor-friendly insolvency regime led to a 75 percent larger peak drop in employment following the negative productivity shock but a 20 percent smaller fall in labour productivity.

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