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Reorganization or Liquidation: Bankruptcy Choice and Firm Dynamics

DEAN CORBAE
University of Wisconsin - Madison and NBER

and

PABLO D'ERASMO
Federal Reserve Bank of Philadelphia

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In this article, we ask how bankruptcy law affects the financial decisions of corporations and its implications for firm dynamics. According to current U.S. law, firms have two bankruptcy options: Chapter 7 liquidation and Chapter 11 reorganization. Using Compustat data, we first document capital structure and investment decisions of non-bankrupt, Chapter 11, and Chapter 7 firms. Using those data moments, we then estimate parameters of a general equilibrium firm dynamics model with endogenous entry and exit to include both bankruptcy options. Finally, we evaluate a bankruptcy policy change similar to one recommended by the American Bankruptcy Institute that amounts to a "fresh start" for bankrupt firms. We find that changes to the law can have sizable consequences for borrowing costs and capital structure which via selection affects productivity, as well as long run welfare.

Key words: Corporate bankruptcy, Capital structure, Firm dynamics, Capital misallocation.

JEL Codes: G30, G33, E22

1. INTRODUCTION

According to Aghion *et al.* (1992) (p. 524, hereafter AHM), Western bankruptcy procedures "are thought either to cause the liquidation of healthy firms (as in Chapter 7 of the U.S. Bankruptcy Code) or to be inefficient and biased toward reorganization under incumbent management (as in Chapter 11 in the United States)." AHM go on to propose a bankruptcy policy similar to a recent proposal by the American Bankruptcy Institute that amounts to a "fresh start" for the firm (existing debt is forgiven, and the new all-equity firm is allocated to former claim holders using absolute

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priority rule).[1,2] The Orderly Liquidation Authority of the Dodd–Frank Act and the "bail-in" policy in the Banking Recovery and Resolution Directive of the European Commission also entail bankruptcy procedures similar to the AHM proposal.[3] To evaluate the implications of bankruptcy procedures for firm value and capital structure, industry dynamics, and household welfare, we estimate a structural corporate finance model with both Chapter 7 and Chapter 11 bankruptcy options using Compustat data and then consider the positive and normative consequences of the AHM proposal.

Specifically, we ask along what dimensions it brings us closer to an "efficient" allocation where all financial frictions are absent. Specifically, we model Chapter 11 Reorganization in the current bankruptcy law as a bargaining game between creditors and equityholders over how much debt is repaid. Absolute priority rule does not apply because creditors take a haircut before equityholders lose all their value. In contrast, the AHM proposal imposes absolute priority rule so that creditors receive the entire value of the debt-free firm before any payments to prior equityholders. The higher value that creditors receive in reorganization under AHM lowers the entire menu of corporate borrowing costs which has implications for the firm size distribution. We model Chapter 7 Liquidation in the current bankruptcy law in the standard way; any remaining funds after firm capital is sold off are used to pay off creditors under limited liability. A form of "debt overhang" problem is more pronounced in Chapter 7 than Chapter 11 since no debt is forgiven.[4] The inefficiency arises since a firm might be liquidated even though the net-present value of a zero-debt firm is positive. The idea that a firm with existing risky debt may pass up valuable investment opportunities dates back to the seminal corporate finance contribution by Myers (1977).[5]

While the AHM proposal maintains a similar liquidation policy, since the reorganization proposal is different it induces firms at the margin to make different decisions. The debt overhang problem is reduced considerably under the AHM reform since the creditor chooses to liquidate the firm only when the net present value of a firm with no debt is negative. We show by means of counterfactual that the AHM proposal can generate equilibrium allocations which in many dimensions move closer to an "efficient" economy without financial frictions. The "efficient" economy is effectively a general equilibrium version of Hopenhayn's (1992) model with capital.

1. A Chapter 7 bankruptcy policy that gives consumers a "fresh start" has been in practice since 1978. For an analysis of the policy, see Livshits *et al.* (2007) and Chatterjee *et al.* (2007).

2. For the full report, see American Bankruptcy Institute (2014). There are elements of the AHM proposal that resemble Section 363(b) of the current Chapter 11 Bankruptcy Code different from the traditional Chapter 11 reorganization process. This section of the Code provides a sales mechanism (usually referred to as §363 sales) by which a debtor may speedily sell assets "free and clear" of all other claims "outside of the ordinary course of business." As Uziel (2011) states in the University of Pennsylvania Law Journal "From an efficiency standpoint, ... corporations in need of fast cash undoubtedly prefer the more expeditious §363 sale. In addition to the ease of bypassing the rather burdensome creditor voting rights, §363 sales are more appealing because assets are typically sold free of liabilities,..." The relation of §363 sales to the AHM proposal and their increasing use in Chapter 11 has been documented in LoPucki and Doherty (2007).

3. As stated in Berger *et al.* (2018), "When OLA is triggered, the FDIC temporarily takes over the BHC and fires its management, while banks and other holding company subsidiaries continue to operate. There is also a bail-in in which shareholders are wiped out and subordinated debtholders and possibly other uninsured creditors have part of their debt claims turned into equity capital, so that the BHC becomes well capitalized. The BHC is then returned to private hands with new management."

4. Here by "debt overhang" problem we simply mean that existing (one-period in our model environment) debt affects the present discounted value of the firm through current bankruptcy and capital structure decisions.

5. Specifically, Myers (1977) writes (p. 149) "The paper shows that a firm with risky debt outstanding, and which acts in its stockholders interest, will follow a different decision rule than one which can issue risk-free debt or which issues no debt at all. The firm financed with risky debt will, in some states of nature, pass up valuable investment opportunities which could make a positive net contribution to the market value of the firm."

In the long run, we find that the reform results in a considerable reduction of the bankruptcy rate (by 60%) and a shift toward reorganization (away from inefficient liquidation) with a slight increase in the exit rate. Prior to the reform, incentives to hold capital as collateral are stronger and induce firms to operate at an inefficient scale in order to lower their borrowing costs. Better credit terms after the reform result in a change in the firm size distribution (the average size of incumbents decreases and the average size of entrants increases), increasing measured total factor productivity (TFP) by 0.5%. The combination of these effects results in a reduction in aggregate adjustment and bankruptcy costs that induce an increase in aggregate consumption (+0.9%).[6]

Besides evaluating an important policy counterfactual, our paper makes two further contributions to the literature. First, using Compustat Industrial Annual data (1984–2014) from 1980 to 2014, we document capital structure and investment differences between non-bankrupt, Chapter 11, and Chapter 7 firms.[7] Our article complements and extends several studies that document heterogeneity among firms that choose Chapter 7 and Chapter 11 bankruptcy. One such paper is by Bris *et al.* (2006) who provide a comprehensive study of the costs of Chapter 7 versus Chapter 11 in a sample of 300 public and private firms in Arizona and New York from 1995 to 2001. As they point out, whether a corporation files for Chapter 7 or 11 is endogenous and self-selection can contaminate the estimation of bankruptcy costs. In our model, measured bankruptcy costs respond to selection and vary across policy counterfactuals.

Our second contribution is to extend the basic structural corporate finance models of Cooley and Quadrini (2001), Gomes (2001), and Hennessy and Whited (2007) to incorporate *both* bankruptcy choices that U.S. public firms face rather than simply one choice or the other.[8] Adding a non-trivial bankruptcy choice to an environment where cash flows can turn negative (due to fixed costs, as in Hopenhayn (1992)) has important implications beyond the selection issues raised above.[9] For instance, it implies that liquidation arises in equilibrium for a subset of firms in our model, while it does not in Cooley and Quadrini (2001) or Hennessy and Whited (2007). It even shows up methodologically since, with liquidation costs that depend on the amount of collateral, here we must expand the state space and cannot simply use net worth. Further, these papers only consider take-it-or-leave-it bargaining in renegotiation.[10] Our article also contributes to the literature on firm dynamics and misallocation due to financial frictions, such as Khan and Thomas (2013), which embeds a simplified version of the collateralized borrowing constraint of Kiyotaki and Moore (2013) into a quantitative model.[11] While the collateral constraint in those models implies there is no bankruptcy on-the-equilibrium path and all firms borrow at the risk free rate, misallocation occurs when the constraint binds for a productive firm. On-the-equilibrium-path bankruptcy in our model creates endogenous spreads that depend on recovery of a firm's collateral driving a wedge into borrowing costs which distorts

6. The idea that policies that affect the cost of exit can have important implications for entry, the firm size distribution, and welfare is not new. For instance, Hopenhayn and Rogerson (1993) (see Table 3) find that firing costs can have a significant impact on hiring, the firm size distribution, and welfare.

7. We complement Compustat with information from the UCLA-LoPucki Bankruptcy Research Database (1984–2014).

8. In the corporate finance literature, Broadie *et al.* (2007) study a Chapter 7 versus Chapter 11 decision problem but in a much simpler model with exogenous cash flows and initial bond finance of fixed investment. Several other corporate finance papers (Antil and Grenadier, 2019; Francois and Morellec, 2004; Galai *et al.*, 2007) extend their work.

9. See also Clementi and Palazzo (2016) who study the effects of aggregate fluctuations on endogenous entry and exit.

10. Eraslan (2008) studies Chapter 11 in a more general bargaining environment. Also related are Peri (2015) and Tamayo (2016).

11. Other papers extending the seminal work on firm dynamics and misallocation by Restuccia and Rogerson (2008) and Hsieh and Klenow (2009) include Buera *et al.* (2011) and Midrigan and Xu (2014). See Hopenhayn (2014) for a recent review of the literature.

investment resulting in misallocation.[12] Our article proceeds as follows. In Section 2, we document bankruptcy facts in the Compustat dataset. In Section 3, we propose a general equilibrium environment with firm dynamics where there are Chapter 7 and Chapter 11 bankruptcy choices. Section 4 defines an equilibrium and Section 5 estimates model parameters for that environment. Section 6 explores properties of our benchmark model and compares them where possible to untargeted data moments. For instance, we consider Chapter 7 versus Chapter 11 event analyses in the model and the data. Section 7 evaluates the positive and normative consequences of the policy counterfactual based on the "fresh start" proposal by AHM and compares it to an efficient, financially frictionless, economy. Section 8 concludes.

2. BANKRUPTCY FACTS FROM COMPUSTAT

Given the fact that the vast majority of empirical corporate finance papers use data from Compustat, we organize bankruptcy facts using Compustat Industrial Annual Data (1980–2014) data from 1980 to 2014. This is obviously a different sample than that in Bris *et al.* (2006). Some of our facts are similar to those in Bris *et al.* (2006) (*e.g.* the fraction of Chapter 11 bankruptcies relative to the total number of bankruptcies), while other facts differ (firms are more highly levered in their sample). We note, however, that there can be substantial differences in reported bankruptcy facts across datasets. For instance, bankruptcy statistics on *all* business filings from the U.S. Courts (www.uscourts.gov/Statistics/BankruptcyStatistics.aspx) suggest that the Bris *et al.* (2006) sample as well as ours overstates the proportion of Chapter 11 business bankruptcies.[13]

Besides simply comparing characteristics of firms in the state of bankruptcy as in Bris *et al.* (2006) or the U.S. Courts dataset, here we also compare characteristics of firms that are not bankrupt with those that are bankrupt. Table 1 displays a summary of some key differences between Chapter 7, Chapter 11, and non-bankrupt firm variables, which have analogues in our model (see Supplementary Appendix A.1 for a detailed description of the data). Since there can be substantial differences between the median and mean of these variables, the table provides both. Further, we test whether the means differ between Chapter 7, Chapter 11, and non-bankrupt. We follow the classification of Chapter 7 and Chapter 11 bankruptcy used by Duffie *et al.* (2007).[14]

Table 1 documents that exit rates (fraction of firms that exit out of all firms in a given year) are small (1.10%) in our sample and, 20% of exits are by Chapter 7 liquidation.[15] The fraction of all firms declaring bankruptcy is also small (0.96%) in our sample; 79% of bankruptcies are by Chapter 11 (as in Bris *et al.* (2006)).

Since firms in our model choose physical capital and net debt (total debt minus cash), we examine differences in size measured by total assets. Non-bankrupt firms are bigger than Chapter 11 firms, which in turn are bigger than Chapter 7 firms. In all cases, the differences in mean are statistically significant (at the 10% level).

Earnings before interest, taxes, depreciation, and amortization (EBITDA) measure a firm's profitability. Negative values generally indicate a firm has fundamental profitability issues, while

12. Other related papers with endogenous spreads that focus on firm liquidation or entrepreneur default include Arellano *et al.* (2012), D'Erasmo and Moscoso Boedo (2012), Glover and Short (2018), Khan *et al.* (2016).

13. Specifically, in the U.S. Courts dataset (which includes smaller firms), the fraction of Chapter 11 business bankruptcies out of total business bankruptcies was roughly 25% for the year ending in December 2013.

14. See Section A.1 of the Supplementary Appendix for the specific classification procedure.

15. Note that in a stationary environment (or period by period if working with a time series), the frequency of exit, the fraction of exit by Chapter 7, the frequency of (all) bankruptcy, and the fraction of Chapter 11 bankruptcy are not independent moments. In particular, it is possible to write one of these moments as a function of the other three. Here, we take the fraction of exit by Chapter 7 to be consistent with the other three and do not target that moment in our estimation.

TABLE 1
Balance sheet and corporate bankruptcies 1980–2014

Moment	
Frequency of exit (%)	1.10
Fraction of exit by Ch 7 (%)	19.83
Frequency of (all) bankruptcy (%)	0.96
Fraction of Chapter 11 bankruptcy (%)	79.15

	Non-bankrupt		Chapter 11		Chapter 7	
	Avg.	Median	Avg.	Median	Avg.	Median
Capital (millions 1983$)	984.16	37.02	402.12*,***	68.42	76.95**	18.03
Cash (millions 1983$)	130.55	10.41	50.38*,***	5.84	13.39**	2.85
Assets (millions 1983$)	1415.11	100.49	485.28*,***	99.11	108.30**	33.45
Op. income (EBITDA)/assets (%)	5.29	10.86	−8.32*	−0.52	−15.10**	−6.94
Net debt/assets (%)	9.00	11.19	30.71*,***	26.29	21.50**	20.11
Total debt/assets (%)	28.40	24.51	42.89*	37.48	43.30**	37.00
Frac. firms with negative net debt (%)	36.25	–	21.40*,***	–	32.26**	–
Secured debt/total debt (%)	43.66	40.61	49.07*	46.83	45.11	43.07
Interest coverage (EBITDA/interest)	14.10	4.95	−1.09*,***	−0.15	−9.99**	−1.07
Equity issuance/assets (%)	4.79	0.06	2.71*	0.01	3.06**	0.02
Fraction firms issuing equity (%)	22.12	–	12.88*	–	16.60**	–
Net investment/assets (%)	1.14	0.33	−2.78*	−2.98	−2.24**	−2.17
Dividend/assets (%)	3.53	2.06	1.71*,***	0.86	3.79**	2.56
Z-score	3.71	3.19	−1.16*	0.12	−1.46**	0.09
DD Prob. of default (%)	2.11	0.01	3.47*	1.22	3.73**	1.27

Notes: See Supplementary Appendix A.1 for a detailed definition of variables and the construction of bankruptcy and exit indicators. Medians (average) reported in the table correspond to the time series average of the cross-sectional median (mean) obtained for every year in our sample. Nominal variables are deflated using the CPI index (U.S. Bureau of Labor Statistics). Test for differences in means at 10% level of significance: * denotes Chapter 11 different from non-bankrupt, ** denotes Chapter 7 different from Non-bankrupt, *** denotes Chapter 11 different from Chapter 7. DD, distance to default, EBITDA, earnings before interest, tax, depreciation and authorization.

a positive value does not necessarily mean it is profitable since it generally ignores changes in working capital as well as the other terms described above. The median and mean ratio of EBITDA to assets is negative for both Chapter 11 and Chapter 7 firms, while it is positive for non-bankrupt firms. Differences in mean between non-bankrupt versus Chapter 11 and Chapter 7 are statistically significant, but not statistically significant between Chapter 11 versus Chapter 7. These statistics accord well with the idea that bankrupt firms have profitability problems.

We provide several measures of leverage. Net debt is measured as debt minus cash, where negative values imply that the firm is highly liquid. We find that both median and mean net debt or total debt to assets are highest for Chapter 11 and lowest for non-bankrupt firms. Statistical significance of differences in mean leverage exists across all types. The time average of the fraction of firms with negative net debt (*i.e.* liquid firms) is higher for non-bankrupt than bankrupt firms. There is a statistically significant difference in means between bankrupt and non-bankrupt, as well as between Chapter 11 and Chapter 7. The ratio of secured to total debt is highest for Chapter 11 and lowest for non-bankrupt firms. There is a statistically significant difference in means only between non-bankrupt and Chapter 11. Interest coverage is measured as the ratio of EBITDA to interest expenses. It is generally thought that a ratio less than one is not sustainable for long. Here we see that both mean and median interest coverage is positive and large for non-bankrupt firms, while it is in general negative for bankrupt firms. There are statistically significant differences in mean between the two bankruptcy choices and non-bankrupt firms.

Equity issuance is highest for non-bankrupt firms, and it is statistically significant relative to bankrupt firms but statistically insignificant between bankruptcy choices. The time average of the fraction of firms issuing equity in any given period is highest for non-bankrupt and lowest for Chapter 11, though the differences are only statistically significant between non-bankrupt and bankrupt.

Median and average net investment (gross investment minus depreciation) is positive for non-bankrupt firms and negative for bankrupt firms. The differences between non-bankrupt and bankrupt are statistically significant but not statistically significant between Chapter 11 and Chapter 7. Dividend payouts are highest for Chapter 7 firms and lowest for Chapter 11 firms. In terms of means, there is a statistically significant difference between Chapter 11 and other types of firms as well as Chapter 7 and non-bankrupt.

We also consider two well accepted measures of corporate default probabilities from the finance literature: z-scores and distance-to-default (DD). The Altman (1968) z-score is a linear combination of five common firm-level ratios: working capital to assets, retained earnings to assets, earnings before interest and taxes, market value of equity to book value of total liabilities, and sales to total assets. While simplistic, Altman's z-score is widely used by practitioners as a predictor of default within the next two years, with values greater than 2.9 deemed safe while values less than 1 are indicative of distress. Table 1 documents that both the median and average z-scores for non-bankrupt firms exceed 3, while z-scores for both Chapter 7 and Chapter 11 are generally below 1. All differences in mean between non-bankrupt and bankrupt are statistically significant. The DD measure is based upon an estimate of the asset value and volatility of a firm using an option pricing model, along with the observed book value of debt and market value of equity. To compute estimates of asset value and volatility, we use an iterative procedure as in Duffie *et al.* (2007) (see Supplementary Appendix A.1 for a full description of the construction of DD). Table 1 documents that the average DD is significantly higher for firms we classify as bankrupt than non-bankrupt.

In summary, non-bankrupt firms: (1) are bigger than bankrupt firms; (2) are profitable while bankrupt firms are not; (3) have lower leverage than bankrupt firms; (4) have lower interest expenses relative to their cash flow; (5) have higher equity issuance; (6) have positive net investment as opposed to negative net investment for bankrupt firms; and (7) have lower likelihoods of default as measured by practitioners "models" of default. Further, in terms of statistical significance, there is resounding support for differences between bankrupt and non-bankrupt firms but slightly less so between firms that choose Chapter 11 versus Chapter 7. This latter result could be due to the small sample size of bankrupt firms. We use these moments to estimate the parameters of our structural model, to which we now turn.

3. ENVIRONMENT

We consider a discrete time, general equilibrium model where heterogeneous firms produce a homogeneous good and issue short-term defaultable debt and costly equity to undertake investment and dividend choices. Since firms can choose Chapter 7 or Chapter 11 bankruptcy, competitive lenders must attempt to predict default decisions of the firms they are lending to when determining the price of debt. There is a representative household that maximizes lifetime utility and whose income comes from wages and dividends on the shares that the representative household holds in every firm. Since we wish to study the long run consequences of a permanent change to bankruptcy law, we focus our attention on a stationary equilibrium characterized by a measure of firms endogenously distributed across productivity, capital, and net debt.

3.1. *Firms and technology*

Competitive firms produce a homogeneous good that can be consumed by households or can be used as capital. Firm j maximizes the expected discounted value of dividends:

$$E_0 \sum_{t=0}^{\infty} (1+r)^{-t} d_{jt}, \tag{1}$$

where d_{jt} denotes dividends in period t and $(1+r)^{-1}$ is the discount rate of the firm.[16] Firms have access to a decreasing returns to scale production technology:

$$y_{jt} = z_{jt} \left(k_{jt}^{\alpha} n_{jt}^{1-\alpha} \right)^{\nu}, \quad \alpha \in (0,1), \nu \in (0,1), \tag{2}$$

where $z_{jt} \in Z \equiv \{z^1, \dots, z^n\}$ is an idiosyncratic productivity shock, i.i.d. across firms, that follows a first-order Markov process with transition matrix $G(z_{jt+1}|z_{jt})$; $n_{jt} \in \mathbb{R}_+$ is labour input; and $k_{jt} \in K \subset \mathbb{R}_+$ is capital input. There is a fixed cost of production c_f, measured in units of output. Firms must pay this fixed cost in order to produce. Active firms own their capital and decide the optimal level of gross investment

$$i_{jt}^{g} = k_{jt+1} - (1-\delta) k_{jt}, \tag{3}$$

where $i_{jt}^{n} = k_{jt+1} - k_{jt}$ is net investment. Firms pay capital adjustment costs:

$$\Psi(k_{jt+1}, k_{jt}) \equiv \frac{\psi}{2} \left(\frac{i_{jt}^{g}}{k_{jt}} \right)^2 k_{jt}. \tag{4}$$

In any given period, firm j's operating income (EBITDA) is given by:

$$\pi_{jt} = y_{jt} - w_t n_{jt} - c_f, \tag{5}$$

where w_t is the competitively determined real wage. Inputs can be financed from three sources: (1) one period non-contingent corporate discount bonds $b_{jt+1} \in B \subset \mathbb{R}$ at price q_{jt} (where $b_{jt+1} > 0$ is net debt and $b_{jt+1} < 0$ is net cash); (2) current cash flow and retained earnings; and (3) external equity injection $e_{jt} < 0$ at cost $\lambda(e_{jt})$.

Taxable income is $\Upsilon_{jt} = \pi_{jt} - \delta k_{jt} - \left(\frac{1}{q_{jt}} - 1 \right) \frac{b_{jt+1}}{(1+r)}$ (*i.e.* operating profits less economic depreciation less discounted interest expense). Since interest expenses are deductible, there is a tax-advantage to using debt. Corporate taxes are:

$$T_{jt}^{c} = \mathbf{1}_{\{\Upsilon_{jt} \geq 0\}} \tau_c \cdot \Upsilon_{jt}, \tag{6}$$

where $\mathbf{1}_{\{\cdot\}}$ is the indicator function that takes value one if the condition in brackets holds and zero otherwise.[17]

16. Since there are no aggregate shocks in this model, to conserve on notation here we define the objective using a constant discount rate, which is consistent in equilibrium.

17. As in Strebulaev and Whited (2012), we assume the firm takes the present value of the interest tax deduction in the period in which it issues debt. This allows us to avoid adding another state variable.

The after-tax net cash flow to equity holders is given by:

$$d_{jt} = \begin{cases} (1-\tau_d)e_{jt} & \text{if } e_{jt} \geq 0 \\ e_{jt} - \lambda(e_{jt}) & \text{if } e_{jt} < 0, \end{cases} \tag{7}$$

where:

$$e_{jt} = \pi_{jt} - T^c_{jt} - i^g_{jt} - b_{jt} + q_{jt}b_{jt+1} - \Psi(k_{jt+1}, k_{jt}). \tag{8}$$

In particular, a firm pays dividends if $e_{jt} \geq 0$, which incurs dividend taxes τ_d. If $e_{jt} < 0$, funds must be injected into a firm (seasoned equity) at $\lambda(e_{jt})$. Provided taxable income is positive, the tax benefit of a unit of debt is given by $(1-\tau_d) \cdot \tau_c \left(\frac{1}{q_{jt}} - 1\right)/(1+r) > 0$. With our assumptions on taxes and cost of issuing equity, firms will never find it optimal to simultaneously pay dividends and issue equity.

Firms can enter by paying a cost κ. After paying this cost, which is financed by equity at cost $\lambda_E(e_{jt})$ and/or debt issue to the measure of households, firms observe their initial level of productivity z_{j0} drawn from the stationary distribution $\overline{G}(z)$ derived from $G(z_{jt+1}|z_{jt})$ and choose an initial level of capital. We denote the mass of new entrants as M_t.

3.2. *Financial markets*

Firms finance operations either through debt or equity. Equity issuance costs are an increasing function $\lambda(e_{jt})$ of the amount of equity issued, and we normalize the number of shares per firm to 1. A share is a divisible claim on the dividends of the firm.

Competitive lenders have access to one-period, risk-free, discount bonds at after-tax price q^B_t. Lenders finance risky corporate debt which matures each period where their price q_{jt} depends on how much firm j borrows b_{jt+1} as well as other characteristics such as firm capital holdings k_{jt+1} (since this affects liquidation value) and current productivity z_{jt}.[18] Debt is non-contingent in the sense that it does not depend on future productivity z_{jt+1}. If debt prices (interest rates) are decreasing (increasing) in the amount of debt issued due to bankruptcy risk (as we will show happens in equilibrium), the tax benefits of issuing more debt are offset by the interest costs of issuing more debt as in Myers' (1984) standard tradeoff theory.

Firms can default on their debt, triggering a bankruptcy procedure. To resemble U.S. law, we allow for two default options:

1. **Chapter 7 liquidation**: Firm j liquidates its assets at firesale discount $s_7 < 1$, which it uses to pay debts; incurs a size dependent bankruptcy cost $c_7(z_{jt})$ [19]; and exits. Shareholders obtain (pre-tax) $\max\{s_7k_{jt} - b_{jt} - c_7(z_{jt}), 0\}$. Lenders obtain $\min\{b_{jt}, \max\{s_7k_{jt} - c_7(z_{jt}), 0\}\}$.
2. **Chapter 11 reorganization**: Firm j and lenders renegotiate the defaulted debt, bargain over the repayment fraction ϕ_{jt} (where the firm's size dependent bargaining weight is given by $\theta(z_{jt})$); the firm pays size dependent bankruptcy cost $c_{11}(z_{jt})$, reduces its debt to $\phi_{jt}b_{jt}$ (where $\phi_{jt} \in [0,1]$), and faces equity finance costs $\lambda_{11}(e_{jt})$, debt finance costs $\lambda^b_{11} \leq 1$, and a discount in its capital

18. For tractibility, we focus on one-period (annual in our calibration) debt. According to Greenwood *et al.* (2010), 19.9% of the flow of nonfinancial corporate debt issues were "long term" (defined as having a maturity of 1 year or more) in 2000 using data from the Flow of Funds. The same authors state that the share of long-term debt in the stock of corporate debt is 61.5%. In our dataset of Compustat firms, we found that on average long-term debt (debt with maturity of more than 1 year) represents 66.35% of total debt.

19. Since endogenous size is correlated with exogenous firm specific productivity, this allows measured bankruptcy costs to vary with endogenous firm size across counterfactuals.

sales $s_{11} < 1$ (*i.e.* $\mathbf{1}_{\{i^g_{jt}<0\}} s_{11} i^g_{jt}$); it is not allowed to pay dividends and continues operating (*i.e.* does not exit).[20]

When making a loan to a firm, lenders take into account that in the case of default they can recover up to a fraction of the original loan. As described above, the recovery rate of a loan depends on the bankruptcy procedure chosen by the firm. In the case of a Chapter 7 liquidation, when making a loan of size b_{jt} in period t, in period $t+1$ lenders can expect to recover $\min\{b_{jt+1}, \max\{s_7 k_{jt+1} - c_7(z_{jt+1}), 0\}\}$, where s_7 is the scrap price of the firm's capital (which serves as collateral).[21] Stromberg (2000) finds that asset fire sales and resales to management can lead to low salvage values and striking inefficiencies in the Chapter 7 procedure. If the firm chooses to reorganize (*i.e.* Chapter 11), the recovery rate in period $t+1$ will be ϕ_{jt+1}. That is, lenders will recover a fraction of debt that they agree upon during the reorganization process. We assume the negotiation over recovery rate solves a Nash bargaining problem, where the firm's weight is $\theta(z_{jt+1})$ and the lender's weight is $1-\theta(z_{jt+1})$. Once reorganized, the firm undertakes new capital structure choices. By backwards induction then, the subsequent capital structure choice is considered in Chapter 11 since it directly affects the value of the firm in Chapter 11.

Of course, a firm can choose to exit without defaulting at any point in time. In this case, the firm liquidates its assets (at value $s_x \in (s_7, 1]$) and pays its debt in full.

3.3. *Households*

In any period t, households choose a stream of consumption C_t, shares $\{S_{jt+1}\}_j$ of incumbent and entrant firms, and risk-free bonds B_{t+1} to maximize the expected present discounted value of utility given by:

$$\max E_0 \left[\sum_{t=0}^{\infty} \beta^t U(C_t) \right] \tag{9}$$

subject to:

$$C_t + \int p_{jt} S_{jt+1} dj + q^B_t B_{t+1} = w_t(1-\tau_i) + \int \left(p_{jt} + d_{jt}\right) S_{jt} dj + B_t + T^h_t, \tag{10}$$

where p_{jt} is the after-dividend stock price of firm j, q^B_t is the after-tax price of the risk-free discount bond, and T^h_t are lump sum taxes/transfers for households. The marginal income tax τ_i applied to wage and interest earnings is rebated back to households in T^h_t. It should be understood that the stock price of a firm that exits is taken to be zero and that, since preferences do not include leisure, households supply their unit of labour inelastically.

3.4. *Government*

Corporate debt choice in our model balances the tax benefit of debt against possible bankruptcy costs as in the trade-off theory of capital structure cited in Myers (1984). To do so, we include

20. Bankruptcy laws do not allow firms to divert funds by distributing dividends. See Bharath *et al.* (2010), who provide evidence that new financing under Chapter 11 comes with much more stringent restrictions from creditors. The data presented in Table 1 show a positive value for dividend to assets that is considerably smaller (and statistically different) than dividend payments for firms outside bankruptcy.

21. Hennesy and Whited (2005) make a similar assumption.

corporate taxes as one of the financial frictions. Specifically, firms face proportional tax τ_c on their income and equity holders face proportional tax τ_d on dividend payments. Households face proportional income taxes τ_i on wage and interest earnings, as well as final distributions of exiting firms. The government levies proportional and lump sum taxes on corporations and households that must balance every period including those that cover losses associated with corporate bankruptcy.

3.5. *Timing*

At the beginning of period t:

1. Productivity z_{jt} is realized. The state space for incumbent firm j is given by $\{z_{jt}, k_{jt}, b_{jt}\}$.
2. Bankruptcy decision for incumbent firms:

- If the firm chooses to declare bankruptcy, it chooses whether to exit by Chapter 7 liquidation incurring costs $(c_7(z_{jt}), s_7)$ or to continue via Chapter 11 reorganization bargaining with creditors over the recovery rate ϕ_{jt} incurring costs $(c_{11}(z_{jt}), s_{11})$ after which it emerges making investment and capital structure choices.[22]
- If the firm chooses not to declare bankruptcy, it repays in full and chooses whether to continue (making investment and capital structure choices) or to exit (avoiding $(c_7(z_{jt}), s_7)$).

3. Entry decision: If a potential entrant chooses to start a firm, it incurs entry cost κ and before learning its beginning of next period productivity shock drawn from $\overline{G}(z)$, it chooses its initial level of capital k_{jt+1} by issuing equity at cost $\lambda_E(e_{jt})$ and/or debt b_{jt+1}.
4. Households choose shares and bonds, which given earnings and taxes determines their consumption.

4. EQUILIBRIUM

We consider only stationary equilibria of the model. In what follows, we use the notation that $a_t = a$ and $a_{t+1} = a'$. Rather than refer to a given firm by its name j, it will be named by its place in the cross-sectional distribution of firms $\Gamma(z,k,b)$. To save on notation, we avoid making the dependence of decision rules on prices explicit.

4.1. *Recursive representation of the firm's problem*

An incumbent firm starts the period with productivity z, capital k, and debt b. The value of the firm $V(z,k,b)$ is defined as follows:

$$V(z,k,b) = \max\{V_N(z,k,b), V_X(z,k,b), V_7(z,k,b), V_{11}(z,k,b)\}, \tag{11}$$

where V_N (V_X, V_7, V_{11}) denotes the value function of an incumbent who chooses neither to exit nor declare bankruptcy (to exit, to declare Chapter 7, to declare Chapter 11), respectively.

If the firm chooses not to declare bankruptcy and not to exit, then:

$$V_N(z,k,b) = \max_{n\geq 0, k'\geq 0, b'} \left\{ d + (1+r)^{-1} E_{z'|z}[V(z',k',b')] \right\} \tag{12}$$

22. Note that because of our timing assumptions, taxation issues about applying net operating losses in Chapter 7 are absent.

s.t.

$$e = \pi - T^c(k,z,k',b') - i^g - b + q(b',k',z)b' - \Psi(k',k)$$

$$d = \begin{cases} (1-\tau_d)e \text{ if } e \geq 0 \\ e - \lambda(e) \text{ if } e < 0 \end{cases}.$$

We denote the optimal labour, capital, debt, and dividend decision rules by $n = h_N^n(z,k,b)$, $k' = h_N^k(z,k,b)$, $b' = h_N^b(z,k,b)$, and $d = h_N^d(z,k,b)$, respectively.

If the firm chooses to exit but not to declare bankruptcy in the event $s_x k \geq b$, the final distribution is given by[23]

$$V_X(z,k,b) = (1-\tau_d)(s_x k - b). \tag{13}$$

We denote the exit decision rule associated with this choice $x(z,k,b)$ which takes the value 1 in this state and 0 otherwise.

If the firm chooses to declare Chapter 7 bankruptcy (*i.e.* liquidation), then:

$$V_7(z,k,b) = (1-\tau_d)\max\{s_7 k - b - c_7(z), 0\}. \tag{14}$$

We denote the Chapter 7 bankruptcy decision rule associated with this choice $\Delta_7(z,k,b)$ which takes the value 1 in this state and 0 otherwise.

Finally, if the firm chooses to declare Chapter 11 bankruptcy (*i.e.* reorganization), we can define payoffs, for any recovery rate φ as:

$$V^R(z,k,b;\varphi) = \max_{n \geq 0, k' \geq 0, b', d \leq 0} \left\{ d + (1+r)^{-1} E_{z'|z}[V(z',k',b')] \right\} \tag{15}$$

s.t.

$$e = \pi - T^c(k,z,k',b') - \mathbf{1}_{\{i^g \geq 0\}} i^g - \mathbf{1}_{\{i^g < 0\}} s_{11} i^g - \varphi b + q(k',b',z)\lambda_{11}^b b' - \Psi(k',k) - c_{11}(z),$$
$$d = e - \lambda_{11}(e).$$

We allow the external finance costs λ_{11}^b and $\lambda_{11}(e)$ to differ for a firm under reorganization. Consistent with bankruptcy law, firms in reorganization are constrained not to distribute dividends (which accounts for $d \leq 0$).

As (15) makes clear, the value of Chapter 11 bankruptcy depends on the recovery rate φ. The equilibrium recovery rate $\phi(z,k,b)$ is determined by Nash bargaining. Upon reaching a bargaining agreement in state (z,k,b), the value of defaulted debt is reduced to a fraction $\varphi = \phi(z,k,b)$ of the unpaid debt b. The reorganized firm then chooses the optimal level of investment, can issue debt or equity (which may cost a different amount during renegotiation), and continues operating. Since either the borrower or lender in the renegotiation phase of Chapter 11 has a right to declare Chapter 7 bankruptcy, we assume that the threat points are equal to the payoffs associated with Chapter 7 liquidation.[24] In that case, the surplus for the firm is:

$$W^R(z,k,b;\varphi) = V^R(z,k,b;\varphi) - (1-\tau_d)\max\{s_7 k - b - c_7(z), 0\}. \tag{16}$$

23. If $s_x k < b$, then exit without declaring bankruptcy is strictly dominated by limited liability afforded by Chapter 7.

24. As stated on p. 663 in Eraslan (2008), "If no progress (in Chapter 11) is made toward agreement, then the court can decide to convert the case to Chapter 7." See also "Conversion or Dismissal" at www.uscourts.gov/FederalCourts/Bankruptcy/BankruptcyBasics/Chapter11.aspx.

Since the value of an agreement for the lender is φb (*i.e.* the recovery on defaulted debt), the surplus for the lender is:

$$W^L(z,k,b;\varphi)=\varphi b-\min\{b,\max\{s_7k-c_7(z),0\}\}. \tag{17}$$

The recovery rate is then the solution to the following Nash bargaining problem[25]:

$$\phi(z,k,b)\equiv\arg\max_{\varphi\in[0,1]}[W^R(z,k,b;\varphi)]^{\theta(z)}[W^L(z,k,b;\varphi)]^{1-\theta(z)} \tag{18}$$

s.t.

$$W^R(z,k,b;\varphi)\geq 0,$$
$$W^L(z,k,b;\varphi)\geq 0.$$

Then, the equilibrium value of reorganization is given by

$$V_{11}(z,k,b)=V^R(z,k,b;\varphi=\phi(z,k,b)) \tag{19}$$

where $\phi(z,k,b)$ satisfies (18). We denote the Chapter 11 bankruptcy decision rule associated with this choice $\Delta_{11}(z,k,b)$ which takes the value 1 in this state and 0 otherwise. We denote the optimal labour, capital, debt, and dividend decision rules by $n=h^n_{11}(z,k,b)$, $k'=h^k_{11}(z,k,b)$, $b'=h^b_{11}(z,k,b)$, and $d=h^d_{11}(z,k,b)$, respectively.

4.2. *Entrant's problem*

After paying a fixed cost κ, a new firm chooses its beginning-of-next period capital k' with an initial value of equity raised by issuing new shares (owned by households) and debt b'. At the beginning-of-next period, it draws its productivity shock z' from $\overline{G}$.

The value of a potential entrant is given by:

$$V_E=\max_{k'\geq 0,b'}\left\{d_E+(1+r)^{-1}\sum_{z'}V(z',k',b')\overline{G}(z')\right\}, \tag{20}$$

where:

$$d_E=-k'_E+q_E(k'_E,b'_E)b'_E-\kappa-\lambda_E(-k'_E+q_E(k'_E,b'_E)b'_E-\kappa). \tag{21}$$

We denote the entrant's optimal capital and borrowing decision rules by k'_E and b'_E.

25. Due to the general equilibrium nature of our problem, it is difficult to sign the effect of changes of firm bargaining power (θ) on the fraction it repays lenders ϕ. Notice further that if $\theta(z)=1$, then the lender's surplus in (17) will be zero. In that case, an equilibrium with positive debt where $s_7k-c_7(z)<0$ implies $\phi=0$ (*i.e.* if a firm with little capital has all the bargaining power, it does not repay debt in reorganization). However, if $s_7k-c_7(z)\geq 0$, then even with $\theta(z)=1$, creditors will receive some repayment (*i.e.* $\phi>0$); a violation of absolute priority rule. Thus, if high capital firms with debt enter reorganization (something which happens in the data and under our parameterization), then even if creditors have no bargaining power it is possible that there will be some payment in Chapter 11.

4.3. *Lender's problem*

The profit on a loan of size b' has two important components. First, the probability of default $\Lambda(b',k',z)$ is given by:

$$\Lambda(b',k',z)=\sum_{\{z'\in D_7(k',b')\}\cup\{z'\in D_{11}(k',b')\}} G(z'|z), \tag{22}$$

where $D_7(k,b)$ and $D_{11}(k,b)$ denote the Chapter 7 and Chapter 11 default sets, respectively defined as:

$$\begin{aligned} D_7(k,b) &= \{z\in Z:\ \Delta_7(z,k,b)=1\}, \text{ and} \\ D_{11}(k,b) &= \{z\in Z:\ \Delta_{11}(z,k,b)=1\}. \end{aligned}$$

The second important component of a lender's profit is the expected recovery rate. If the firm chooses to file for Chapter 7 bankruptcy, the lender recovers $\min\{b',\max\{sk'-c_7,0\}\}$. If the firm chooses to reorganize under Chapter 11, the lender will recover $\phi(z',k',b')b'$, which is the solution to the bargaining game (18) between the firm and the lender. Thus, we can write the lender's profit function as follows:

$$\begin{aligned} \Omega(b',k',z) = & -q(b',k',z)b'+q^B[1-\Lambda(b',k',z)]b' \\ & +q^B\sum_{z'\in D_7(k',b')} \min\{b',\max\{s_7k'-c_7(z),0\}\}G(z'|z) \\ & +q^B\sum_{z'\in D_{11}(k',b')} \phi(z',k',b')b'G(z'|z). \end{aligned} \tag{23}$$

4.4. *Household's problem*

The first-order conditions for the household's problem (9) and (10) are given by:

$$\begin{aligned} B_{t+1} &: q_t^B U'(C_t)=\beta E_t\left[U'(C_{t+1})\right] \\ S_{jt+1},\forall j &: p_{jt}U'(C_t)=\beta E_t\left[U'(C_{t+1})\left(p_{jt+1}+d_{jt+1}\right)\right]. \end{aligned}$$

In a steady state, this implies:

$$q_t^B = \beta \tag{24}$$

$$p_{jt} = \beta E_t\left[p_{jt+1}+d_{jt+1}\right]. \tag{25}$$

To characterize stock prices, consider the case of an incumbent firm and let $p(z,k,b)=V(z,k,b)-d(z,k,b)$ (*i.e.* the ex-dividend stock price is given by firm value). Then, it is straightforward to show that (25) is equivalent to (11) or:

$$\begin{aligned} p(z,k,b) &= \beta E_{z'|z}\left[p(z',k',b')+d(z',k',b')\right] \\ &\iff V(z,k,b)-d(z,k,b)=(1+r)^{-1}E_{z'|z}\left[V(z',k',b')\right]. \end{aligned} \tag{26}$$

In the case of purchasing a stock of an entrant, $S_E=S'=S$, in which case p_jS_{jt+1} and p_jS_{jt} cancel and the initial equity injection given by d_E in (21) is accounted for in the household's budget set (10).

An implication of (24) and firm optimization is that in steady state:

$$(1+r)^{-1}=\beta. \tag{27}$$

4.5. *Cross-sectional distribution*

Let $\overline{K} \subset K$, $\overline{B} \subset B$ and $\overline{Z} \subset Z$. The law of motion for the cross-sectional distribution of firms is given by:

$$\Gamma'(\overline{K},\overline{B},\overline{Z};M,w) = \int_{\overline{K},\overline{B}} \sum_{\overline{Z}} \left\{ \int_{K,B} \sum_{Z} (1-x(z,k,b)-\Delta_7(z,k,b)) \Big[\mathbf{1}_{\{k'=h_N^k(z,k,b),b'=h_N^b(z,k,b)\}} \right.$$
$$\left. + \mathbf{1}_{\{k'=h_{11}^k(z,k,b),b'=h_{11}^b(z,k,b)\}} \Big] G(z'|z)\Gamma(dk,db,z) \right\} dk'db'$$
$$+ M \sum_{\overline{Z}} \mathbf{1}_{\{k_E',b_E'\}} \overline{G}(z), \tag{28}$$

where M is the mass of new entrants.

4.6. *Definition of equilibrium*

A stationary Markov equilibrium is a list $\{V^*, w^*, r^*, q^{B*}, q^*, \phi^*, p^*, D_7^*, D_{11}^*, \Lambda^*, \Gamma^*, M^*, C^*, B'^*, S'^*, T^*\}$ such that:

1. Given w, r, q, and ϕ, the value function V^* is consistent with the firm's optimization problem in (12)–(19).
2. Given V, w, r, and q, the recovery rate $\phi^*(k,b,z)$ solves the bargaining problem (18).
3. The probability of default Λ^* in (22) and the sets D_i^* for $i=7,11$ are consistent with firm decision rules.
4. The equilibrium loan price schedule is such that lenders earn zero profits in expected value on each contract. That is, at $q^*(b',k',z)$, $\Omega^*(b',k',z)=0$ in (23).
5. The cost of creating a firm is such that $V_E^*=0$ in (20).
6. $\Gamma^*(z,k,b)$ and M^* in (28) is a stationary measure of firms consistent with firm decision rules and the law of motion for the stochastic variables.
7. Given w, q^B, p, and taxes/transfers T^h, households solve (9) and (10), and (q^{B*}, p^*, r^*) are consistent with (24), (25), and (27).
8. Labour, bond, and stock markets clear at w^*, q^{B*}, and p^* or

$$\int_{K,B} \sum_{Z} (1-x(z,k,b)-\Delta_7(z,k,b)) \Big[h_N^n(z,k,b) + h_{11}^n(z,k,b) \Big] \Gamma(dk,db,z) = 1$$
$$\int_{K,B} \sum_{Z} (1-x(z,k,b)-\Delta_7(z,k,b)) \Big[h_N^b(z,k,b) + h_{11}^b(z,k,b) \Big] \Gamma(dk,db,z) = B'^*$$
$$S'^* = 1.$$

9. Taxes/transfers satisfy government budget balance.[26]

26. The entire set of taxes are defined in Section A.2 of the Supplementary Appendix.

5. ESTIMATION

To estimate our model, we make several functional form assumptions.[27] First, we assume that firm productivity follows an AR(1) process:

$$\log(z_t) = \rho_z \log(z_{t-1}) + \epsilon,$$

with $|\rho_z| < 1$ and $\epsilon \sim N(0, \sigma_\epsilon)$. We use Tauchen's procedure to discretize this process into an 11-state Markov process $\{z_1, \ldots, z_{11}\}$.

We assume a flexible functional form for the bankruptcy cost and bargaining weight functions. More specifically, we set $c_7(z) = \max\{0, c_7^0 + c_7^1(\max\{0, z-\mu_z\} - \max\{0, \mu_z - z\})^2\}$, $c_{11}(z) = \max\{0, c_{11}^0 + c_{11}^1(\max\{0, z-\mu_z\} - \max\{0, \mu_z - z\})^2\}$, and $\theta(z) = \max\{0, \min\{\theta^0 + \theta^1(\max\{0, z - \mu_z\} - \max\{0, \mu_z - z\})^2, 1\}\}$. Since, as we will show, firm size depends on productivity z, this specification results in measured bankruptcy costs which vary with the firm size distribution through selection (and hence with policy changes). Conditional on issuing a positive amount of equity, we parameterize equity issuance costs as a linear function, $\lambda(e) = \lambda^1 |e|$.

Our model has 24 parameters, which appear in Table 2. We divide the parameters into two groups. The first group (those above the line in Table 2) are set outside the model using standard values in the literature or independent targets. The second group (those below the line in Table 2) are estimated via Simulated Method of Moments (SMM). A model period is taken to be one year.

For the first group of parameters, once we set the pre-tax risk-free rate together with the income tax τ_i, equilibrium conditions determine β, r, and q^B. More specifically, $\beta = q^B = (1+r)^{-1}$ and $r = r^{TB}(1-\tau_i)$ where r^{TB} is the pre-tax risk free rate. We calibrate the pre-tax risk-free rate to the real one 1-year maturity adjusted T-Bill Rate (Board of Governors of the Federal Reserve System). The production function parameters come from Atkeson and Kehoe (2005). Taxes are set following Hennessy and Whited (2005). To estimate the parameters of the z process, we follow Cooper and Haltiwanger (2006). In particular, taking logs of operating income (evaluated at optimal labour) and quasi-differencing yields:

$$\pi_{it} = \rho_z \pi_{it-1} + \eta k_{it} - \rho_z \eta k_{it-1} + \epsilon_{it}, \tag{29}$$

where $\eta = \frac{\alpha\nu}{1-(1-\alpha)\nu}$. We estimate this equation for firms outside bankruptcy using a panel fixed effect estimator with a complete set of dummies to capture year fixed-effects. The results provide us with an estimate of ρ_z and σ_ϵ.[28] The value of assets in Chapter 11 and Chapter 7 (s_{11} and s_7) are taken from Bris *et al.* (2006) who present information on the value of assets after bankruptcy conditional on whether the firm was liquidated or reorganized.

The second group of parameters are estimated via SMM by minimizing the distance between model moments and data moments (weighted by the optimal weighting matrix) selected to provide identification of our overidentified model parameters. Specifically, the parameters are chosen to minimize:

$$Q(\Theta) = [\mu^d - \mu^s(\Theta)]' W^* [\mu^d - \mu^s(\Theta)], \tag{30}$$

with respect to parameters Θ, where μ^d are the moments from the data, $\mu^s(\Theta)$ are the moments from the simulated model at parameters Θ, and W^* is a positive definite weighting matrix.[29] The

27. A summary of the model-implied definitions for key variables we observe in the data is given in Table A.4 in Supplementary Appendix A.2.

28. Our annual estimates are in line with those presented in the literature for quarterly data. See for example Cooper and Haltiwanger (2006) and Khan and Thomas (2013).

29. In a first pass, we set W^* to the identity matrix (adjusting the moments by their data means to avoid putting more weight on moments that are large in absolute value). We then estimate the optimal weighting matrix using the inverse of the

TABLE 2
Parameter values

Parameter		Value	s.e.	Targets
Discount rate	r	0.015	–	After Tax T-Bill rate
Corporate tax rate	τ_c	0.300	–	Corporate Taxes U.S. (see Hennessy and Whited (2005))
Dividend tax rate	τ_d	0.120	–	Dividend Tax U.S. (see Hennessy and Whited (2005))
Income tax rate	τ_i	0.250	–	Income Tax U.S. (see Hennessy and Whited (2005))
Depreciation rate	δ	0.150	–	Capital Dep. Rate Compustat
Capital share	α	0.330	–	Standard parameter
Return to scale	ν	0.850	–	Standard parameter
Autocorrelation z	ρ_z	0.657	–	Autocorrel Op. Inc. (eq. (29))
Std. Dev. shock	σ_ϵ	0.199	–	Autocorrel Op. Inc. (eq. (29))
Price capital after liquidation	s_7	0.400	–	Asset Value Ch. 7 (see Bris *et al.* (2006))
Price capital in Chapter 11	s_{11}	0.869	–	Asset Value Ch. 11 (see Bris *et al.* (2006))
Fixed cost production	c_f	0.051	0.001	Exit Rate
Chapter 7 cost	c_7^0	0.001	0.000	Recovery Rate Ch 7
Chapter 7 cost	c_7^1	0.001	0.000	Expenses over Assets Ch 7
Chapter 11 cost	c_{11}^0	0.128	0.038	Fraction of Bankrupty Ch. 11
Chapter 11 cost	c_{11}^1	0.015	0.003	Expenses over Assets Ch 11
Firm's bargaining power	θ^0	0.968	0.012	Interest Rate Spread All Firms
Firm's bargaining power	θ^1	0.005	0.000	Recovery Rate Ch. 11
Equity issuance cost	λ^1	0.010	0.041	Equity Issuance Non-Bankrupt
Equity issuance cost Chapter 11	λ_{11}^1	0.440	0.163	Equity Issuance Ch. 11
Debt cost in Chapter 11	λ_{11}^b	0.880	0.122	Debt to Assets Ch. 11
Adjustment cost	ψ	0.297	0.025	Net Investment Non-Bankrupt
Price of capital exit	s_x	0.724	0.067	Bankruptcy Rate
Entry cost	κ	0.174	–	Debt to Assets Non-Bankrupt
				Net Investment Ch. 11

Notes: The entry cost κ is chosen so it is consistent with the equilibrium where the wage rate equals 1.

covariance matrix of $\sqrt{N}(\hat{\Theta}-\Theta)$ is given by:

$$\left(1+\frac{1}{J}\right)[\partial\mu^s(\Theta)/\partial\Theta]'W^*[\partial\mu^s(\Theta)/\partial\Theta]^{-1}, \tag{31}$$

where the term $\left(1+\frac{1}{J}\right)$ is the adjustment for simulation error. Table 2 presents the parameter values and their standard errors.

Before presenting the estimation outcome, we discuss the selection of these moments. Since every moment that results from the model is a function of all parameters, there is no one-to-one link between parameters and moments. However, we can point to moments that are more informative to pin down a given parameter or set of parameters than others. The value of the fixed operating cost c_f is important for matching the exit rate. The cost of filing for Chapter 7 bankruptcy (c_7^0 and c_7^1) are important for matching the average expenses over assets for firms in Chapter 7 and the recovery rate in Chapter 7. The cost of filing for Chapter 11 bankruptcy (c_{11}^0 and c_{11}^1) are important for matching the average expenses over assets for firms in Chapter 11 as well as the fraction of Chapter 11 bankruptcy. The parameters of the bargaining power of the firm once in reorganization θ^0 and θ^1 are important for matching the observed recovery rate in Chapter 11. Moments that help identify these parameters are the average recovery rate and the interest

variance-covariance matrix of the simulated moments. Finally, with the optimal weighting matrix at hand, we minimize (30) to estimate the parameters of the model and compute (31) to obtain their standard errors. See Strebulaev and Whited (2012) and references there for a comprehensive description of SMM estimation.

rate spread over the risk free rate. Since Chapter 11 accounts for almost all the bankruptcy risk in our sample, it contributes the significant portion of risk behind the overall spread. The equity issuance cost parameters λ_1 and λ_1^{11} are set to match the median equity issuance by non-bankrupt and Chapter 11 firms, respectively. The differential borrowing cost of Chapter 11 firms λ_{11}^b is selected to match the debt-to-asset ratio of firms in Chapter 11. The net investment rate provides information on the adjustment cost parameter ψ. The scrap value of capital s_x is related to the bankruptcy rate. The entry cost κ is set so it is consistent with an equilibrium where the wage rate is normalized to 1.[30] Our model is overidentified since we include the debt-to-asset ratio of non-bankrupt firms as well as net investment of Chapter 11 firms.

Most of our targets are estimated using our sample of Compustat firms presented in Section 2 (see Table 1). We do not have access to information on recovery rates for bankrupt firms. For this reason, we rely on estimates from Bris *et al.* (2006). Their paper documents substantial differences in recovery rates. In particular, Table 13 documents the mean recovery rate (as a percentage of the initial claim) as 5.4% for Chapter 7, while it is 69.4% for Chapter 11.[31] We also rely on Bris *et al.* (2006) for estimates of bankruptcy costs. They estimated that expenses over assets are 8.10% and 16.90% for Chapter 7 bankruptcies and Chapter 11 bankruptcies, respectively. Since there is no direct measure of interest rates in our Compustat sample, we use the median spread from Arellano *et al.* (2016), which is 1.30 in their sample of Compustat firms linked to Moody's data. To construct the spread for a given firm, they obtain the credit rating for each firm from Compustat and then proxy the firms spread using Moody's spread for that credit rating.[32]

Given these parameter values, the moments we find in our overidentified model are given in Table 3. Above the line, we show moments that were targets. Below the line we present some additional moments.

6. RESULTS

6.1. *Model properties*

We begin by describing decision rules concerning exit and bankruptcy choice. Figure 1 presents the bankruptcy and exit decision rules across capital, debt, and productivity. The top panel presents decision rules for a firm with low ($z=z_L$) productivity. Similarly, the middle and bottom panels present decision rules for a firm with middle ($z=z_M$) and high ($z=z_H$) productivity, respectively.

As evident in Figure 1, firms with high productivity do not exit no matter what their mix of capital and debt. Some firms with high productivity and high debt do however choose Chapter 11. At the other end of the spectrum, for firms with low productivity, those with (i) negative net debt (cash) and low capital choose to exit without declaring bankruptcy, (ii) high debt and low

30. This normalization is done only in the benchmark economy. In our counterfactual experiments, the value of κ remains fixed and the wage rate w adjusts to satisfy the equilibrium conditions.

31. The median recovery rate is 5.8% and 79.2% for Chapter 7 and Chapter 11, respectively. Their estimates in Bris *et al.* (2006) are similar to those by Acharya *et al.* (2007), who document (Table 8) that the mean recovery rate for Chapter 7 is 16.03% and for Chapter 11 is 63.65%.

32. The spread is defined as $(1/q)-(1/q^B)$. We also compare the model spreads with statistics reported by Gilchrist *et al.* (2013). Moments reported in their paper are computed by trimming the upper tail of the distribution of credit spreads at 10%. After imposing a similar restriction in our model sample, while we find that the average spread in the model is 0.26% compared to 2.4% reported in the sample of manufacturing firms, we find that the model generates an untargeted standard deviation equal to 1.55% very much in lin with the 1.6% standard deviation reported in Gilchrist *et al.* (2013). We note that after estimating our model parameters we can calculate model interest spreads for non-bankrupt and reorganized firms, which we find to be 1.11% and 18.40%, respectively.

TABLE 3
Comparison of data and model moments

Targeted moments (%)	Data	Benchmark Model
Exit rate	1.10	1.12
Frequency of all bankruptcy	0.96	1.46
Fraction of bankruptcy reorganization	79.15	72.20
Recovery rate by liquidation	5.40	5.29
Recovery rate reorganization	69.40	58.75
Med. equity issuance non-bankrupt	0.06	0.09
Med. equity issuance reorganization	0.01	0.08
Debt to assets non-bankrupt	28.40	24.07
Debt to assets reorganization	42.89	43.07
Net investment/assets non-bankrupt	1.14	0.82
Net investment/assets reorganization	−2.78	−2.99
Expenses over assets Chapter 7 - Liq.	8.10	6.59
Expenses over assets Chapter 11 - Reorg.	16.90	7.50
Spread all firms	1.30	1.30
Non-targeted moments (%)		
Fraction of exit by liquidation	19.83	36.41
Frac. firms issuing equity non-bankrupt	22.12	36.36
Frac. firms issuing equity reorganization	12.88	5.94
Dividend to asset non-bankrupt	3.53	2.93
Net debt/assets non-bankrupt	9.00	16.91
Net debt/assets reorganization	30.71	43.07

capital choose Chapter 7, and (iii) medium to high levels of capital choose to continue operating and, depending on their level of debt-to-capital ratio, choose to reorganize or not.

We next describe bond prices offered to firms conditional on how much they borrow (b'), what collateral they will have next period when they have to repay (k'), and their current productivity (z). Figure 2 graphs equilibrium price menus offered to firms with low, median, and high productivity, respectively. For a given level of capital (which serves as collateral), the higher a firm's debt the less lenders recover, and, for a given level of debt, the higher a firm's capital the more lenders recover. Thus, firms with high debt to assets face higher real interest rates on their borrowings. We also note that, since firms with lower productivity are more likely to go bankrupt in Figure 1 for a given level of borrowing and collateral (b', k'), bond prices (interest rates) are increasing (decreasing) in firm-level productivity. Finally, note that equilibrium interest rates observed in the economy depend not only on these menus but also the equilibrium cross-sectional distribution of firms. Table 4 makes clear, for instance, that the equilibrium average spread that non-bankrupt, non-exiting firms face is lower (1.1%) than those faced by firms that are reorganizing (18.4%).

The equilibrium cumulative distribution function of firms conditional on their productivity is illustrated in Figure 3. It is evident that firms with low productivity are amassed on lower capital and debt levels, while those with high productivity are amassed on higher capital and debt levels. Importantly, Figure 3 establishes the link between exogenous productivity z and endogenous firm size (one measure of which is capital k).

The productivity dependent Figures 1, 2, and 3 are closely linked. Low productivity firms are more likely to choose Chapter 7 in Figure 1 where the recovery rates are lowest. Thus, they face the highest interest rates in Figure 2. Facing high interest rates, they borrow and invest less, leading them to amass on the lower end of the cumulative distributions for capital and net debt in Figure 3. On the other hand, high productivity firms are least likely to choose bankruptcy in Figure 1. Thus, they face the lowest interest rates in Figure 2 and hence borrow and invest more.

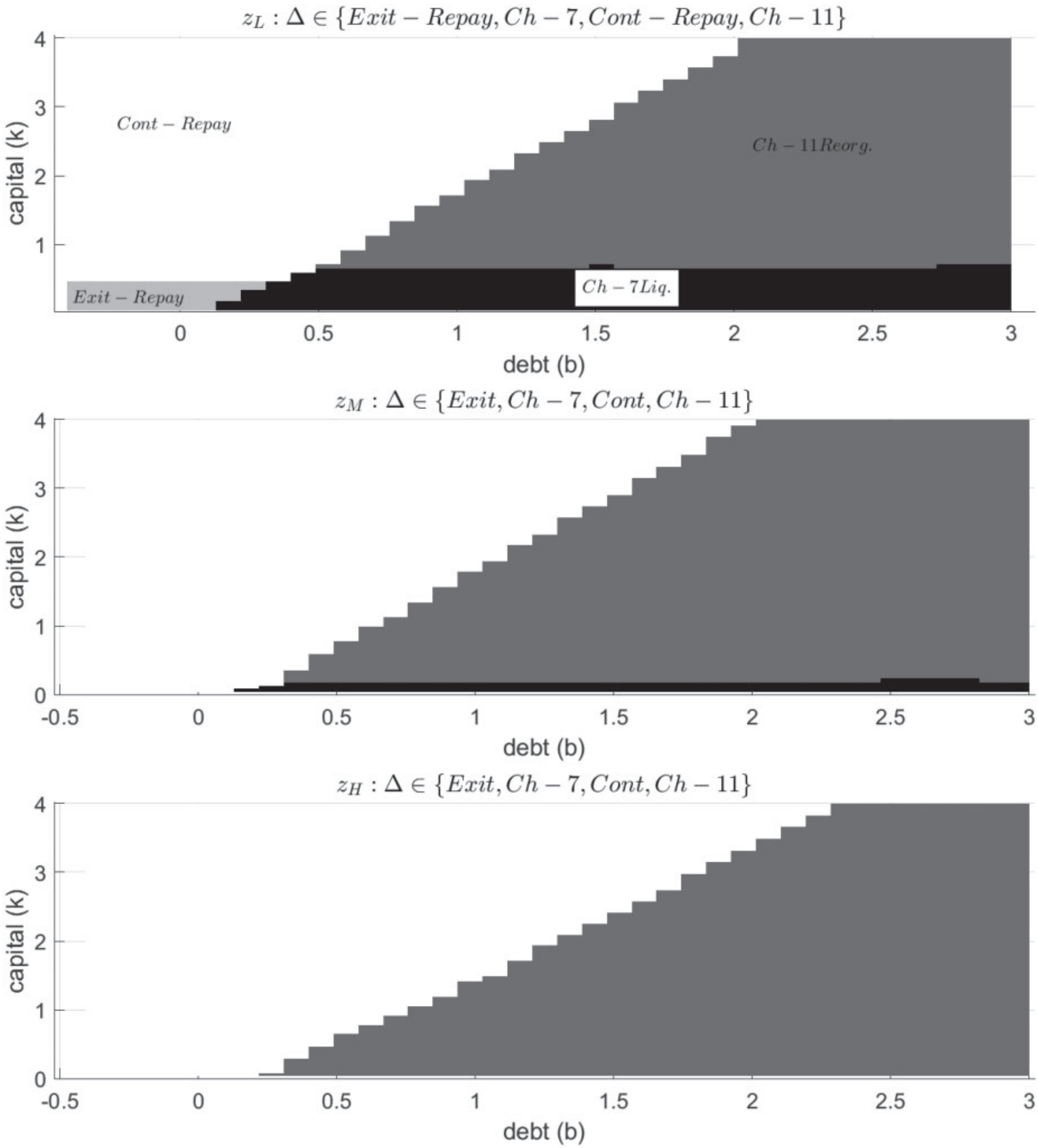

FIGURE 1

Bankruptcy and exit decision rules

This leads them to amass on the upper end of the cumulative distributions for capital and net debt in Figure 3.

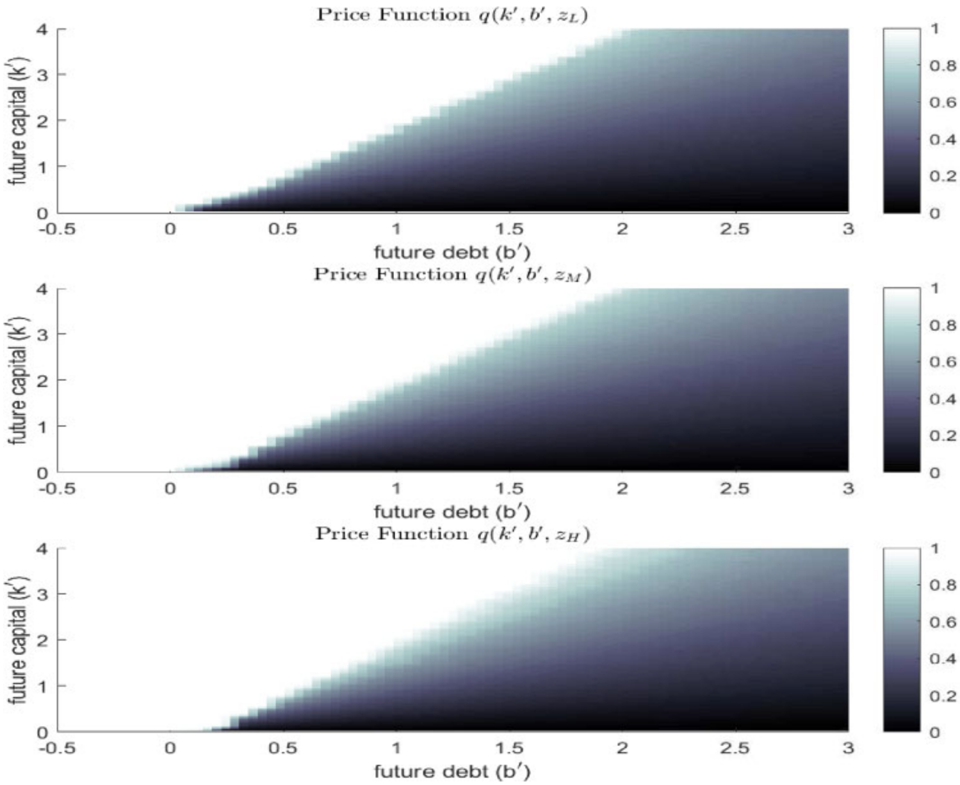

FIGURE 2
Debt price schedules

6.2. *Cross-sectional properties*

We turn to non-targeted cross-sectional distributions in the model and the data in Figure 4. We start with a measure of the size distribution of firms. Specifically, panel (*i*) presents the cross-sectional distribution of capital (normalized by average assets). It shows that while our model generates a considerable amount of capital dispersion, the dispersion in the data is considerably larger than in the model. The Gini coefficient for the model is 0.27 while the value for the data is 0.91. The distribution in the data shows fatter tails with a much larger fraction of firms at the bottom and a small set of very large firms at the top. There are 70.01% of firms below the (normalized) mean capital in the model while there are 89.30% in the data. Factors such as, for example, industry differences which are not incorporated in our parsimonious model may account for the wider dispersion.

Panel (*ii*) shows that the model cross-sectional distribution of debt-to-assets is largely consistent with the data. In particular, the average is 28.5% and 26.6% and the standard deviation is 22.2% and 23.9% in the data and the model, respectively.

Finally, the gross investment rate distribution in panel (*iii*) makes evident that the model generates a spike around the value of gross investment consistent with replacing depreciated capital (*i.e.* $i^g = \delta k$). This is due to adjustment costs and financial frictions in the model. In line with the model, the data present a significant mass of firms at similar levels of gross investment rates. While many firms in the data are in the inaction region (*i.e.* investment rates of $\pm 2\%$) since we work with firm level data the share of firms in this region is significantly lower than that reported in studies that focus on establishment level data.

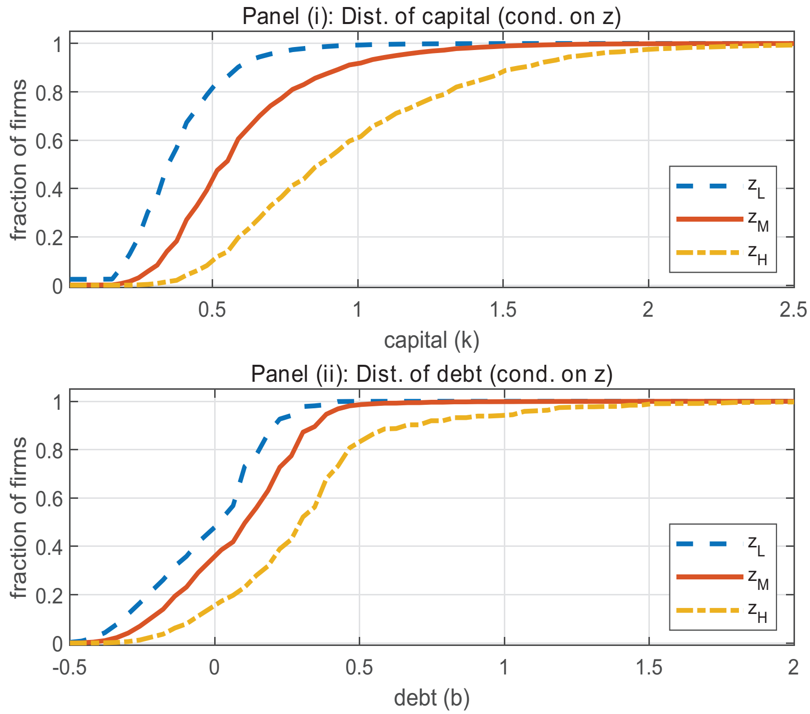

FIGURE 3

Distribution of firms (conditional on z)

6.3. *Event analyses*

Next, we study dynamics around bankruptcy events both in the model and the data. This allows us to describe the dynamics of the model and provides a natural "test" of the model since we do not estimate parameters to match the dynamics.

6.3.1. Reorganization. We start by depicting the evolution around a bankruptcy that results in reorganization. Figure 5 shows a set of charts based on the simulated data of the model on the left and the actual data on the right. The plots show 11-year event windows (from $t=-5$ to $t=5$) centred on the year of bankruptcy ($t=0$). Solid lines represent the average of the variable in each panel and dotted lines to a $+/-$ 1 standard deviation band across all firms that went through reorganization.[33]

Starting with model dynamics on the left hand side of Figure 5, we note that the increase in the sales-to-asset ratio (panel (v)) prior to bankruptcy is driven by a high productivity state inducing a run-up in the debt-to-asset ratio (panel (i)) to finance net investment (panel (vii)) as the marginal product of capital increases. Interest rates (Panel (iii)) remain close to the risk-free level ($t=-5,-4,-3$) despite the growth in debt since most debt is fully collateralized and the bankruptcy probability is close to zero when productivity is high. The bankruptcy event is triggered

33. See Supplementary Appendix A.1 for a description of variables and how events are constructed. In the data, events are constructed using firms that go through only one reorganization during the duration of the event analysis. Compustat does not have available a measure of debt interest rate at the firm level. For that reason, as a proxy, we use the ratio of interest payments to total debt.

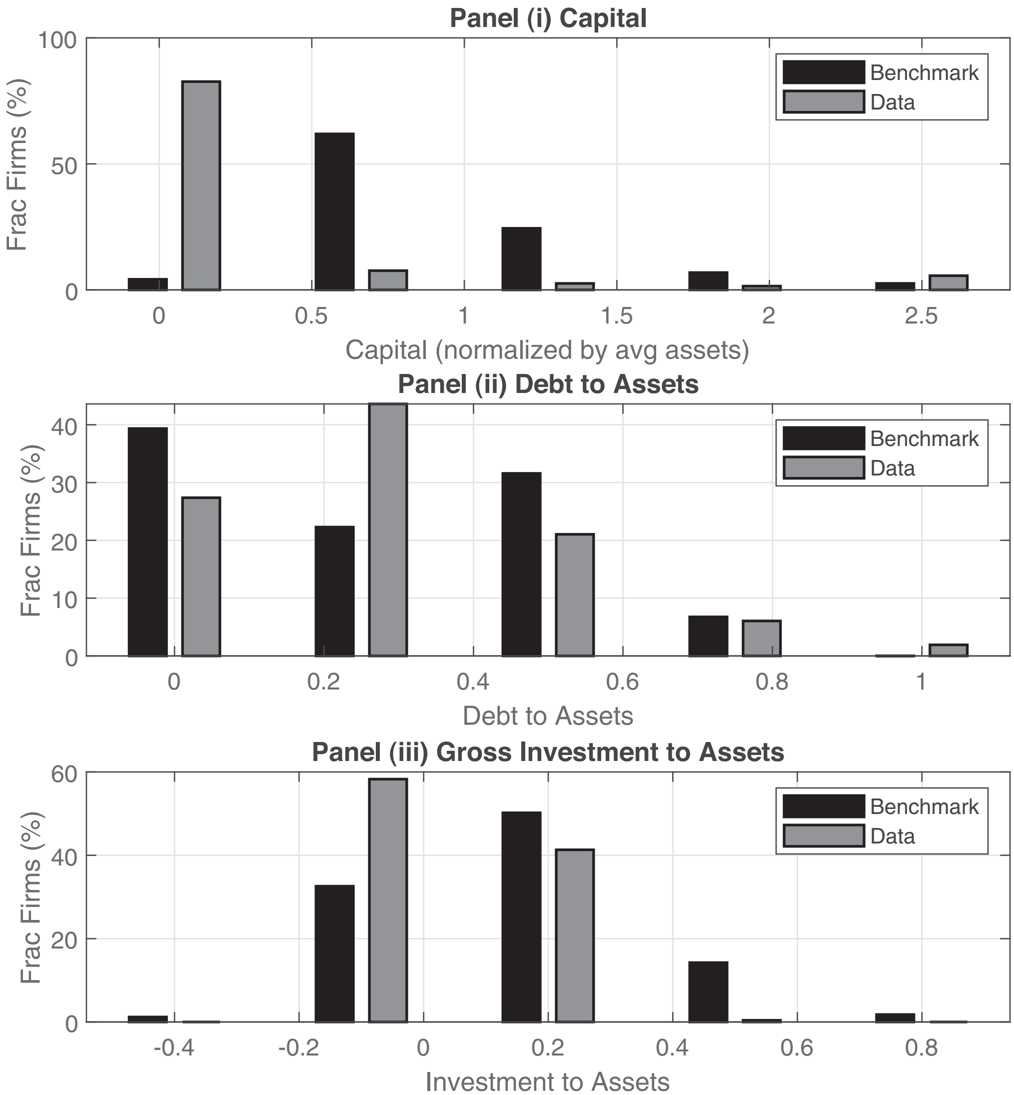

FIGURE 4

Cross-sectional distributions: baseline versus data

Notes: Capital in model and data normalized by average assets.

by a drop in productivity (as predicted by the bankruptcy decision rule in Figure 1) showing up as a drop in the sales/asset ratio. Interest rates do not increase as much as the bankruptcy probability since the expected recovery rate for lenders is positive. Post-bankruptcy, firms reduce their leverage ratio, the sales-to-asset ratio also decreases, and the investment rate remains below the levels observed prior to bankruptcy.

The right hand side of Figure 5 shows that the model is qualitatively consistent with the dynamics of the debt-to-asset ratio, interest rates, and the investment rate observed in the data (the debt-to-asset ratio increases prior to bankruptcy and declines abruptly during the bankruptcy, the interest rate increases close to bankruptcy, and the investment rate declines sharply when the firm enters bankruptcy). While the data is consistent with rising sales/assets prior to the event

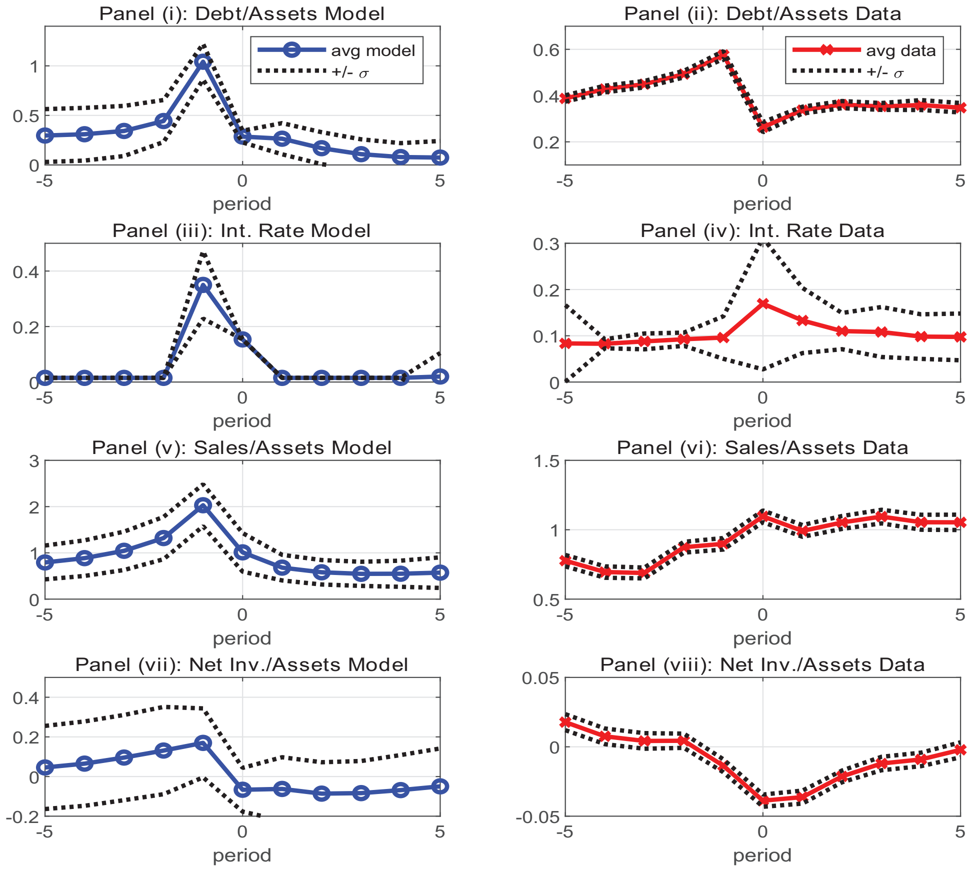

FIGURE 5

Reorganization event dynamics: model and data

Notes: Solid lines represent the average of the variable in each panel and dotted lines to a $+/-$ 1 standard deviation (across all firms that exit via liquidation).

as in the model, the flattening in sales after the event is slightly lower in the model than in the data.

6.3.2. **Liquidation.** Here, we describe the dynamics of a bankruptcy event ending in liquidation both in the model and the data. Figure 6 shows 5-year event windows that end the year of liquidation (at $t=0$). In the model (*i.e.* the left hand side of the figure), a liquidation event is the result of a slow decline in productivity as is evident from the decline in sales to assets (panel (*v*)). Investment declines (panel (*vii*)) to the point where the firm is actually reducing its level of capital. The leverage ratio remains constant for most of the event (Panel (*i*)), implying that the level of debt is also diminishing. Interest rates in the model jump the year prior to the bankruptcy, together with a significant increase in debt-to-asset ratio that derives mostly from the fact that during this period the firm decreases its level of capital (the investment rate is close to -1). Since the firm is liquidated with a debt level that is above the residual value of capital, limited liability binds and the recovery rate is close to 0.

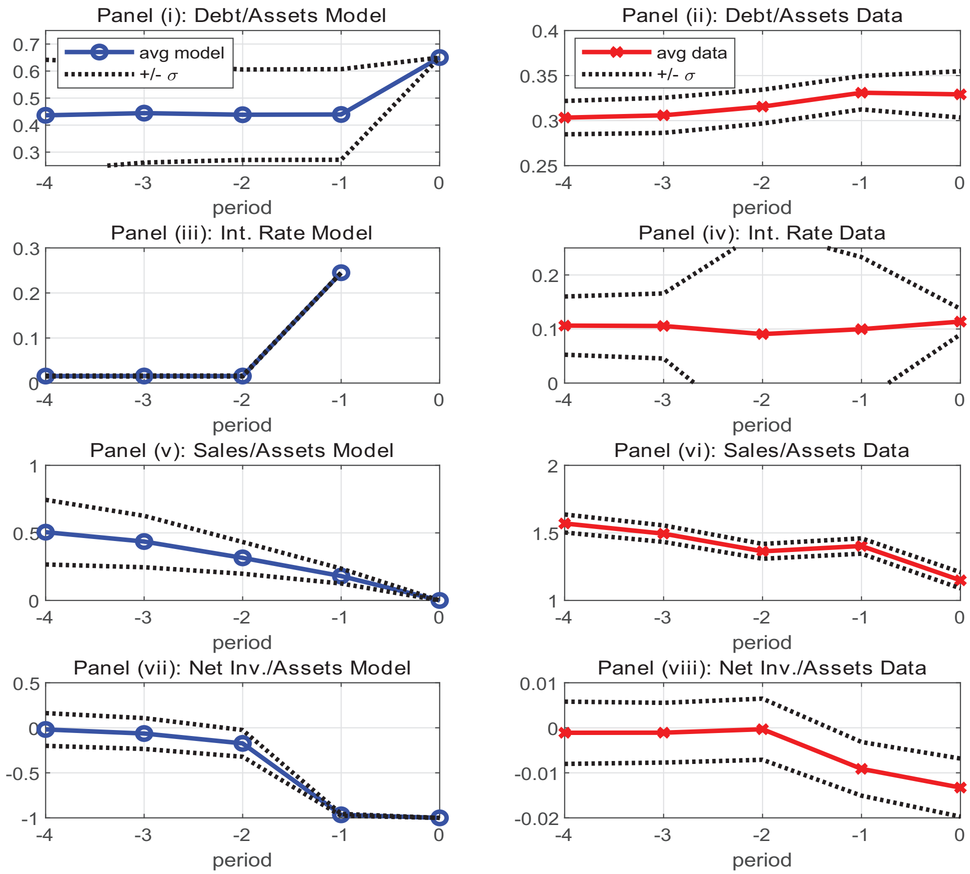

FIGURE 6

Liquidation event dynamics: model and data

Notes: Solid lines represent the average of the variable in each panel and dotted lines to a $\pm$ 1 standard deviation (across all firms that exit via liquidation).

When comparing the dynamics of the model and the data (the right had side of the figure), we observe that the model is qualitatively consistent with the evolution of the leverage ratio, sales-to-assets, and net investment. However, the model overpredicts the increase in the interest rate the year prior to liquidation. We note however that there is wide dispersion in interest rates in the data (since it is a small sample) and that the measure of interest rates we use (interest payments to debt due to the lack of an actual interest rate in the Compustat data) may not adequately reflect the true measure.

7. POLICY COUNTERFACTUAL: A FRESH START FOR FIRMS

In our counterfactual experiment, we analyse a variant of the bankruptcy procedure proposed by Aghion *et al.* (1992) (hereafter AHM), which itself is related to Bebchuk (1988). In particular, their proposal consists of three simple steps: (1) when a firm goes bankrupt, the firm's existing debts are cancelled; (2) bids are solicited for the "new," all equity firm and rights to the equity in this new firm are allocated among the former claim holders (applying absolute priority rule, first to bond holders, then to former equity holders);[34] and (3) the new shareholders—that is, the former debt holders—decide whether to continue the all equity firm or exit. After these steps, the firm exits from bankruptcy.

A similar proposal has been suggested by the American Bankruptcy Institute and has been implemented following the 2008 financial crisis for financial firms in Dodd Frank and the Banking Recovery and Resolution Directive of the European Commission.

In this section, we contrast by means of counterfactual the existing bankruptcy policy (our benchmark) to the AHM proposal as well as an "efficient," financially frictionless, economy. For clarity the main differences between the cases are given by:

1. Benchmark

- Chapter 11 Reorganization. Creditors and equityholders bargain (with equityholder bargaining weight $\theta(z)$ over how much of the debt is repaid φ along with capital structure (debt b' and equity e) and production (capital k' and labour n) choices. The explicit costs of Chapter 11 bankruptcy are $c_{11}(z)$ and disinvestment incurs salvage value s_{11}. Note that since not all debt is forgiven in Chapter 11, a form of debt overhang problem distorts the new debt issuance and investment decisions in Chapter 11 state φb. Absolute priority rule does not apply because creditors lose $(1-\varphi)b$ before equityholders lose all their value.
- Chapter 7 Liquidation. Any remaining funds after firm capital is sold off at salvage value s_7 and bankruptcy costs $c_7(z)$, creditors are paid off under limited liability. Note that the debt overhang problem is even more pronounced in Chapter 7 since no debt is forgiven. The debt overhang problem generates an inefficiency since a firm might be liquidated even though the net-present value of a zero-debt firm is positive. Absolute priority rule applies because by the time creditors lose any value, equityholders have lost all their value.

2. AHM Reform

- AHM Reorganization. Unlike Chapter 11, there is no bargaining over recovery rates. Instead the "fresh start" firm (*i.e.* one with no debt) is valued by the market (*i.e.* the value function V_{AHM}) and transferred (exclusive of bankruptcy costs $c_{\text{AHM}}(z)$) to the creditors. Capital structure and production input decisions are made at the AHM Reorganization state $b=0$ thus avoiding the partial debt overhang friction associated with Chapter 11. Another difference with Chapter 11 reorganization is that absolute priority rule applies. The original equity holders will receive a positive payment only after original creditors are paid in full.
- AHM Liquidation. As in Chapter 7 Liquidation, absolute priority rule applies. However, as opposed to Chapter 7 liquidation, the debt overhang problem is reduced considerably in AHM liquidation since the creditor chooses to liquidate the firm only when the net present value of a firm with no debt is negative.
- Unlike the current bankruptcy law where equityholders choose which bankruptcy option to initiate (Chapter 7 or Chapter 11), under the AHM reform equityholders choose whether to go bankrupt but creditors choose which option to exercise (AHM reorganization or AHM liquidation).

34. The solicitation of bids means the firm is competitively priced in our full information framework and satisfies the pricing equation in (26) with stock price easily computed given the value function of the firm. Since all households are identical, this can be implemented with an English auction.

3. Efficient (financially frictionless) economy

- The corporate debt tax shield τ_c is set to zero and equity issuance costs λ are zero. Firms cannot go bankrupt but can choose to exit at zero cost. Since there are no financial frictions the liability side of the balance sheet of the firm is irrelevant (*i.e.* Modigliani-Miller applies). This is effectively a general equilibrium version of Hopenhayn's (1992) model embedding Hayashi's (1982) investment decision.

Turning to the firm's decision problem in the AHM economy, at the beginning of the period, the firm decides whether to declare bankruptcy or not. As before, if it decides not to default, the firm repays its debt and decides whether to continue or exit as in (12) and (13). However, unlike (14) or (19), if the firm decides to declare bankruptcy, the AHM procedure described above is triggered. Specifically, given limited liability the value for equityholders is given by:

$$V_{\text{AHM}}(z,k,b)=\max\{0,(1-\tau_d)(W_{\text{AHM}}(z,k,0)-b)\}, \tag{32}$$

where $W_{\text{AHM}}(z,k,0)$ is the value of the "new" firm after its original debts have been cancelled and the lender decides whether to continue with the firm (*i.e.* reorganize it) or liquidate it. This value is given by

$$W_{\text{AHM}}(z,k,0)=\max\{W(z,k,0)-c_{\text{AHM}}(z),\max\{0,s_{\text{AHM}}k-c_{\text{AHM}}(z)\}\}, \tag{33}$$

where $c_{\text{AHM}}(z)$ and s_{AHM} are the bankruptcy cost and salvage values under the new proposal and

$$W(z,k,0) = \max_{n\geq 0,k'\geq 0,b',d\leq 0}\left\{d+(1+r)^{-1}E_{z'|z}[V(z',k',b')]\right\} \tag{34}$$

s.t.

$$\begin{aligned} e &= \pi-T^c(k,z,k',b')-i^g+q(k',b',z)b'-\Psi(k',k),\\ d &= e-\lambda(e). \end{aligned}$$

Let $\Delta_{\text{AHM}}(z,k,b)=1$ denote the decision rule to choose the AHM default option and the optimal labour, capital, debt, and dividend decision rules by $n=h^n_{\text{AHM}}(z,k,b)$, $k'=h^k_{\text{AHM}}(z,k,b)$, $b'=h^b_{\text{AHM}}(z,k,b)$, and $d=h^d_{\text{AHM}}(z,k,b)$, respectively.

The difference in firm value under the counterfactual bankruptcy policy has important implications for the pricing of debt. The analogue of (23) is given by the bankruptcy set

$$D_{\text{AHM}}(k,b) = \left\{z\in Z:\Delta_{\text{AHM}}(z,k,b)=1\right\}$$

and lender profit function given by

$$\begin{aligned}\Omega_{\text{AHM}}(b',k',z) = &-q(b',k',z)b'+q^B[1-x(z,k',b')]b'\\ &+q^B\sum_{z'\in D_{\text{AHM}}(k',b')}\min\{b',W_{\text{AHM}}(z',k',0)\}G(z'|z).\end{aligned} \tag{35}$$

In equilibrium, the lender's expected profits must be zero.

The key difference between the proposed bankruptcy reform and that of the current law is that absolute priority rule is applied in all cases in the AHM proposal while it is only applied in Chapter 7 currently. This can have a big impact on recovery rates and the pricing of debt. In particular, in return for debt forgiveness the creditors receive an all-equity firm without having to go through a bargaining process; altering both the relative positions of creditors and shareholders in the recovery process as well as costs associated with bankruptcy. Changing bargaining positions alters recovery rates in (35) and hence interest rate menus that firms face, which will have important implications for capital structure and firm dynamics. Changes in the endogenous selection of the default option alters deadweight bankruptcy costs ultimately borne by households.[35]

Table 4 compares the steady state of our benchmark economy with that of the AHM economy and a frictionless "efficient" economy. Since absolute priority rule in the AHM proposal prioritizes creditors and eliminates the bargaining process, we also include in Table 4 a counterfactual which sets the shareholders' bargaining power to zero in order to provide an intermediate decomposition of the AHM proposal. This intermediate case is important since our structural estimate of the bargaining weight from the data $\theta_0 = 0.968$ is quite different from that implied by the policy counterfactual $\theta_0 = 0$.

The reform results in a considerable reduction of the long run bankruptcy rate (from 1.46% to 0.56%). The reform virtually eliminates all inefficient Chapter 7 bankruptcies from the benchmark level of 28% of all bankruptcies. The overall exit rate rises slightly with the AHM reform, bringing it exactly to the efficient level. Our decomposition shows that the reduction in bankruptcy is importantly influenced by the pro-lender policy (*i.e.* setting $\theta_0 = 0$) which results in the bankruptcy rate falling even further to 0.46%. The decomposition also highlights that managers self-select into liquidation as opposed to entering into reorganization. This intermediate case completely reduces inefficiencies that arise from breaking absolute priority rule (since it eliminates Chapter 11 reorganization on-the-equilibrium path) but exacerbates problems with inefficient liquidations.

An important implication of the endogenous changes in bankruptcy rates is for measurement of aggregate deadweight losses (a version of the "Lucas critique"). In our main experiment, we set the parameters of the cost function $c_{\text{AHM}}(z) = c_7(z)$ (since the bargaining protocol is absent) but it is important to note that measured bankruptcy costs are a function of the equilibrium distribution of firms which pins down the set of firms that self-select into reorganization or liquidation. It is possible to see the pure cost effect of changes in the distribution of firms by looking at the average cost over assets for firms that liquidate in the baseline and the AHM reform (since these firms face an identical cost function). The average cost of bankruptcy is affected not only by the parameterized bankruptcy cost function but also by the change in the distribution of firms and their bankruptcy decisions.[36] The average cost over assets goes from 6.59% to 5.97% and this is mostly explained by a decline in the average productivity of the firm that selects into liquidation.

To understand the differences between the benchmark and AHM reform economies, we begin by comparing the interest rate menus in both cases. The reform allows firms access to better credit terms and reduces the need for the firm to hold as much capital (collateral against loans).

35. In Supplementary Appendix A.2, we provide the modified taxes and bankruptcy costs that are part of an AHM equilibrium.

36. In Supplementary Appendix A.4, we also perform an experiment where $c_{\text{AHM}}(z) = c_{11}(z)$. We show that the main predictions of the AHM reform are not affected by this choice because at that cost, almost no firms choose bankruptcy so despite a rise in average costs from 7.5% in the benchmark to 20.31% in the reform, aggregate costs are again smaller than in the benchmark. The rise in the average cost is explained mostly by a decline in the average level of capital of reorganized firms in the AHM reform (which appears in the denominator).

TABLE 4
Counterfactual new bankruptcy procedure

Moments (%)	Bench. model	Lender all Barg. power	AHM bankruptcy	Efficient
	$\theta_0=0.968$	$\theta_0=0.00$	Reform	Economy
Exit rate	1.12	1.18	1.14	1.14
Frequency of all bankruptcy	1.46	0.46	0.56	–
Fraction of bankruptcy reorganization	72.20	0.00001	99.99	–
Recovery rate by liquidation	5.29	5.33	28.15	–
Recovery rate reorganization	58.75	76.88	86.69	–
Equity issuance/assets non-bankrupt	0.09	0.03	0.00	2.07
Equity issuance/assets reorganization	0.08	0.25	0.25	–
Debt to assets non-bankrupt	24.07	29.19	38.82	–
Debt to assets reorganization	43.07	60.92	90.83	–
Net investment/assets non-bankrupt	0.82	0.50	1.17	0.77
Net investment/assets reorganization	−2.99	−48.03	−27.69	–
Expenses over assets Liqui.	6.59	6.35	5.97	–
Expenses over assets Reorg.	7.50	5.57	0.15	–
Std. Dev recovery rate Reorg.	4.27	1.49	7.50	–
Fraction of exit by liquidation	36.41	38.55	0.00	–
Frac. firms issuing equity non-bankrupt	36.36	35.68	20.65	38.75
Frac. firms issuing equity reorganization	5.94	100.00	56.60	–
Dividend to asset non-bankrupt	2.93	3.15	2.96	5.69
Dividend to asset Reorganization	0.00	0.00	0.00	–
Net debt/assets non-bankrupt	16.91	23.60	35.99	–
Net debt/assets reorganization	43.07	60.92	90.83	–
Spread all firms	1.30	0.24	0.07	–
Spread non-bankrupt	1.12	0.24	0.07	–
Spread reorganization	18.40	14.59	0.00	–
Avg size (k)/Prod. z non-bankrupt	0.636/1.012	0.650/1.018	0.633/1.021	0.603/1.019
Avg size (k)/Prod. z Ch 11 - Reorg.	1.789/1.538	2.304/0.532	0.434/0.617	–
Avg size (k)/Prod. z Ch 7 - Liq.	0.010/0.672	0.010/0.671	0.010/0.584	–
Avg size (k)/Debt b Entrant	0.625/0.425	0.737/0.546	0.685/0.619	0.511/0.000

Notes: $s_{\text{AHM}}=s_7$ and $c_{\text{AHM}}=c_7(z)$. Table A.6 in Supplementary Appendix A.4 provides results under alternative cost parameterizations.

Figure 7 presents the price schedule for both cases (Panel (*i*) our benchmark and Panel (*ii*) the counterfactual AHM economy, both evaluated at median productivity $z=z_M$).[37] Figure 7 makes clear that, at any given level of (b',k'), prices are higher in the reform economy than in our benchmark. For example, a firm in the baseline choosing to issue a future debt level $b'=0.5$ can access risk free debt by selecting $k'\geq 0.849$ but it needs only $k'\geq 0.662$ under the reform. This comes from the fact that in a more "lender" friendly economy, the expected recovery rate goes up from 58.7% to 86.7% and the recovery rate for firms that are liquidated also increases. One can also show that the entire menu of debt prices facing new entrants shifts down as well, which induces more entry in the AHM reform than the benchmark economy (as can be seen in Table 5).

An alternative way to see the price effect of the reform, is to compare "debt Laffer curves" $q(k',b',z)b'$ for the benchmark versus the AHM reform (versus the frictionless economy where a firm can issue any amount of debt at the risk-free rate).[38]

As Figure 8 makes clear for the median productivity case ($z=z_M$) and three levels of capital (the median level from the benchmark economy and two standard deviations on each side), under

37. We do not include the equilibrium "price" for the efficient economy (*i.e.* 0.9852 associated with the risk-free rate) in this graph.

38. The downward (off-the-equilibrium path) portion of the "debt Laffer curve" arises from the indirect negative effect of increasing debt on debt prices offsetting the positive direct effect of taking out more debt.

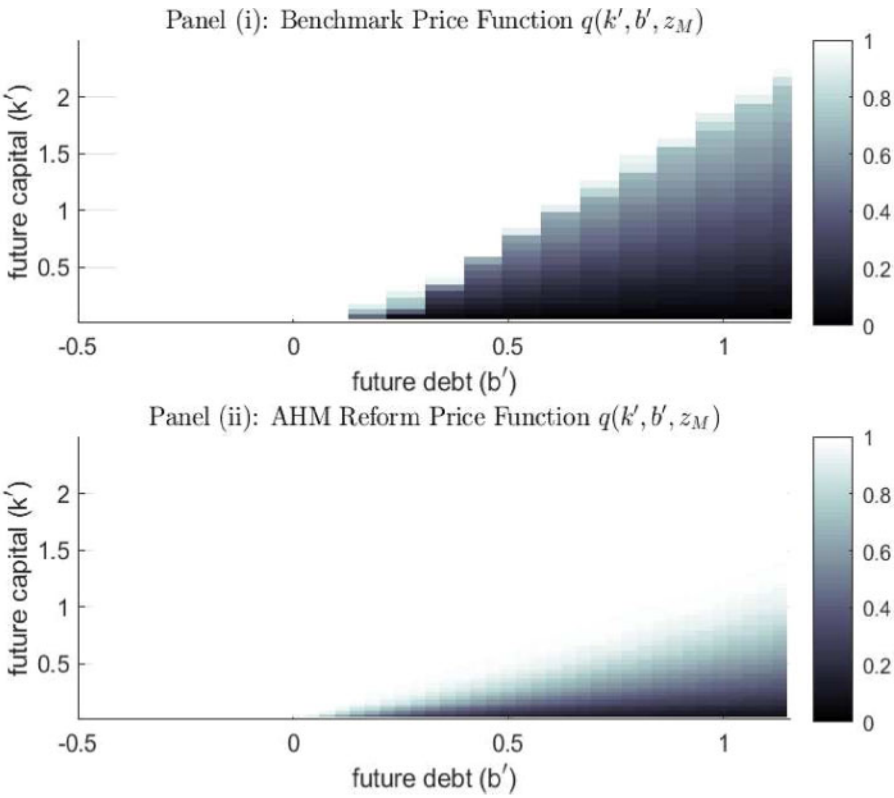

FIGURE 7

Comparison equilibrium price function

Notes: Light colours correspond to high bond prices and dark colours correspond to low bond prices. Bond prices $q(k',b',z)\in[0,(1+r)^{-1}]$.

the reform the debt price schedule shifts and a firm needs less capital collateral in order to raise cheap funds (like those in the efficient case) for investment. The figure makes clear a firm receives much more financing for a given level of debt in the reform as opposed to the benchmark.

The resultant shift in the interest rate menu has two effects: (i) firms are willing to borrow even at lower productivity levels in order to invest (so the numerator in the debt-to-asset ratio goes up); and (ii) they need to hold less collateral in order to sustain a given level of investment (so the denominator in the debt-to-asset ratio goes down). These two effects lead to a substantial increase in the debt-to-asset ratio for non-bankrupt firms (from 24% to 39%) and from 43% to 91% for those firms entering the new bankruptcy policy in Table 4. Figure 9 illustrates this rightward shift in the cross-section of debt-to-asset ratios of firms.

Despite an increase in borrowing (which would tend to increase spreads), the sizeable downward shift in interest rate menus dominates resulting in the *average* spread paid by non-bankrupt firms declining from 1.12% to 0.07% and from 18.4% to 0% for reorganized firms. The biggest beneficiary of the change are bankrupt firms; in the benchmark 100% borrowed at a positive spread while after the reform all borrow at the risk-free rate. While 11.5% of non-bankrupt firms borrowed at a positive spread in the benchmark, 21.4% borrow at a positive (albeit lower) spread in the AHM reform economy. The fact that less non-bankrupt firms choose to borrow at a spread in the benchmark is consistent with the steeper slope of the price menus in the benchmark than in the AHM reform evident in Figure 7.

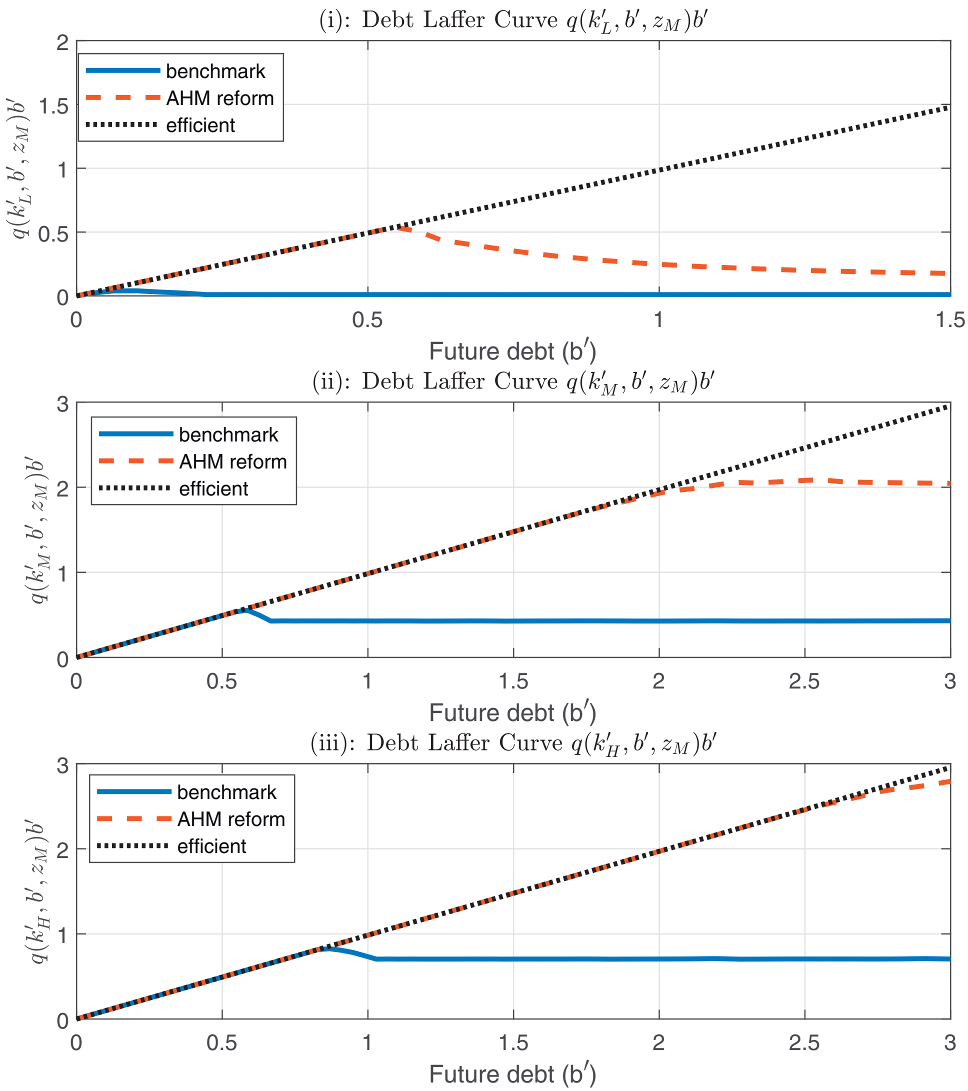

FIGURE 8

Baseline, reform, and efficient: debt Laffer curve

Notes: $k'_L = 0.027$, $k'_M = 1.05$, and $k'_H = 1.72$.

The fact that less capital is necessary to secure a low borrowing rate drives changes in investment and firm size (as measured by capital). Table 4 documents net investment rates at the non-bankrupt firm level rise from 0.82% to 1.17%, but this ratio is again driven by the lower denominator. Net investment rates for those firms that are reorganized falls substantially from −3% to −28%. Table 5 documents the aggregate effect is a slight decline in investment of 0.64%. These flows lead to a decline in average size (measured in terms of capital) of non-bankrupt firms from 0.636 to 0.633 and 1.789 to 0.434 for reorganized firms. The latter result arises since firms that enter reorganization under the AHM reform are on average less productive than in the benchmark and hence choose not to invest at such a low marginal product of capital.

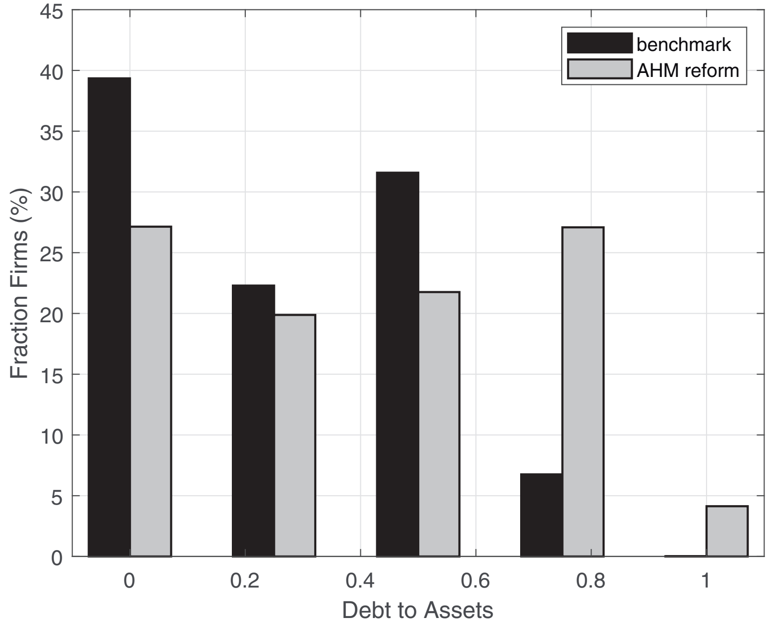

FIGURE 9

Distribution of debt to assets

We also explore the implications of the reform for firms of different sizes. Table A.7 in the Supplementary Appendix presents summary statistics conditional on firm size when size is measured by total assets. We focus on the bottom 25% and the top 25% of the firm size distribution. The baseline model is consistent with the untargeted data that exit rates decline with firm size (an exit rate of 3.9% for the bottom quartile as opposed to 0 for the top quartile) as well as a fraction of firms that select into Chapter 11 bankruptcy which is increasing in firm size (from 0 for the bottom quartile and 100% for the top quartile). After the reform, there is a significant increase in the exit rate for the bottom quartile (from 3.9% in the benchmark to 4.27% after the reform) bringing the exit rate closer to the efficient level (4.42%) for the bottom quartile. Also in Table A.7 for firms in the bottom 25%, we uncover a reduction in the bankruptcy rate and, among the firms that go bankrupt, a large shift from liquidation to reorganization. The reduction in the bankruptcy rate and the shift from liquidation to reorganization (with the corresponding increase in the realized recovery rate for the lender) results in a large drop in spreads (from 0.60% to 0.12%). The reduction in bankruptcy rates is also present at the top quartile of the distribution. In this group, prior to the reform, all bankrupt firms were reorganized. After the reform, since bankruptcy also implies a change in ownership, large and productive firms operate in a region where default risk is absent.

The positive effects in Table 4 have implications for household welfare (long run aggregate consumption) presented in Table 5. Table 5 shows that while there is only a slight increase in aggregate output from the reform, large drops in adjustment costs, equity issuance costs, and bankruptcy costs lead to a nearly 0.9% increase in long run aggregate consumption.[39] The small rise in aggregate output under the AHM reform is because, as discussed above, firms do not need

39. Of course how one treats these costs matters for aggregate consumption. We treat them as deadweight losses rather than transfers, and hence the increase in aggregate consumption should be considered an upper bound.

TABLE 5
Bankruptcy Reform: Welfare and Aggregates

		Deviation from Benchmark (%)	
	Bench. Model	Bankruptcy Reform	Efficient Economy
Aggregate Consumption C	1.126	0.87	1.91
Aggregate Output Y	1.755	0.05	5.00
Fixed Cost CF	0.203	1.49	17.71
Investment I	0.363	−0.51	12.53
Adjustment Costs Ψ	0.025	−5.98	−8.43
Equity Issuance Λ	0.003	−90.36	–
Bankruptcy Costs BC^c	0.006	−99.82	–
Bankruptcy Costs BC^s	0.000	−100.00	–
Exit Value X	0.005	67.97	111.33
Entry Costs E	0.035	9.29	3.12
Equilibrium wage	1.000	0.05	4.97
Capital to output ratio K/Y	1.461	−1.23	4.74
Measured TFP $(=Y/K^{1/3})$	1.282	0.45	1.73
Avg. Productivity $\bar{z}$	1.017	0.19	0.23
Avg. (output weighted) Prod. $\hat{z}$	1.246	−0.01	−0.18
$Cov(z,\omega)$	0.229	−0.90	−2.00
Mass Entrants	0.044	1.75	20.24
Total Mass Firms	3.991	1.49	17.87
Capital K	2.564	−1.19	10.09
$Var(mpk)$	0.300	−1.67	−1.65
Avg. Capital	0.648	−2.37	−6.91
Avg. (output-weighted) Capital	0.887	−3.02	−6.67
$Cov(k,\omega)$	0.240	−4.78	−6.02

Note: Benchmark Model in levels, bankruptcy reform column presents the percent deviation from the benchmark model. $\bar{z}$ is average firm productivity, $\widehat{z}$ is the (output weighted) average firm-level productivity, and ω is the output share of each firm. The efficient case corresponds to an economy where all debt and equity finance frictions are removed.

to hold as much capital for collateral in order to obtain cheap funding. Investment drops −0.51% relative to the benchmark and aggregate capital drops −1.19% relative to the benchmark.[40] While Table 5 documents a rise in investment for the efficient case relative to the benchmark, this qualitative difference from the AHM reform result is driven primarily by the absence of the financial friction associated with the corporate tax shield.[41]

Given that aggregate capital drops and labour is supplied inelastically, the source of the slight rise in output in Table 5 comes from changes in measured productivity. While the stochastic process for productivity is unchanged, changes in measured productivity reflects selection and the firm size distribution. The reform changes the distribution of firms bringing it closer to that of an efficient economy. Because of the lower borrowing costs to finance entry, the mass of entrants rises 1.75% and the total mass of firms rises 1.49% relative to the benchmark in Table 5. The total mass of firms depends directly on the fraction of entrants that survive over time. Higher entry swamps the small increase in exit rate which accounts for the rise in the total mass of firms.

Table 5 shows that measured aggregate TFP rises by 0.45%, about one third of the way to the value associated with the efficient economy. Another important standard measure of allocative

40. While we did not target the capital-to-output ratio, we note that K/Y in the benchmark model equals 1.46 which is close to the average private non-residential capital-to-output ratio (Net Stock of Private Non-Residential Fixed Assets to GDP from the Bureau of Economic Analysis) which equals 1.21 on average during our sample period (1980-2014).

41. In Table A.8 in the Supplementary Appendix, we show that when $\tau_c > 0$ in the frictionless case, investment also drops, making it qualitatively consistent with the AHM reform along that dimension.

efficiency (from the work of Hsieh and Klenow, 2009), the variance of marginal product of capital ($Var(mpk)$), declines almost identically in both the reform (-1.67%) and the efficient case (-1.65%); a sign of a better allocation of resources. The reform also results in a lower variance of investment (which declines by more than 5% from 22.0% to 20.7%) and a 28% reduction in the inaction region from 1.4% to 1.0%.

To further understand productivity differences, we also provide a decomposition of weighted average firm-level productivity proposed originally by Olley and Pakes (1996):

$$\widehat{z} \equiv \int_{K\times B} \sum_{z} z_j \omega_j dj = [\bar{z} + cov(z,\omega)],$$

where $\widehat{z}$ is the average of firm-level productivity weighted by output share, ω_j is the output share of each firm j, and $\bar{z}$ is the unweighted mean productivity (i.e., $\int_{K\times B}\sum_z z\Gamma(dk,db,z)$). That is, output weighted productivity can be decomposed into two terms: the unweighted average of firm-level productivity and a covariance term between output shares and productivity which captures the degree of allocative efficiency.

Table 5 shows the values for this decomposition. We observe that the change in measured TFP can be explained mostly by an increase in average productivity. Output weighted productivity remains almost constant in the reform economy and declines in the efficient economy. The covariance between output and productivity decreases in both the reform and the efficient case. Two effects are at play. First, as financial frictions are relaxed, low productivity firms that exited or were liquidated in the benchmark find it optimal to remain active (this can be seen for example in Table 4 since firms that are reorganized in the reform have lower productivity than firms that were liquidated in the benchmark). Second, firms need less capital to be used as collateral and this reduction is more significant for large firms (note that the covariance between capital and output ($Cov(k,\omega)$) declines in both the reform and the efficient economy) inducing a reduction in the covariance between output shares and productivity. In sum, since financial costs are lower in both the AHM reform and efficient economies, low productivity firms survive with positive net-present-value projects and represent a larger share of total output than in the benchmark.

While the aggregate results are relatively modest, they are in line with recent papers that have analysed the role of financial frictions on aggregate productivity, consumption, and welfare. For example, Midrigan and Xu (2014) find that changes in borrowing limits predict fairly small efficiency losses from capital misallocation (close to 0.4%) and negligible changes in consumption.

Misallocation arising from a financial wedge associated with on-the-equilibrium path bankruptcy as in our model can generate quite different predictions from a wedge associated with collateral constraints which ensure bankruptcy only arises off-the-equilibrium path as in the models of Khan and Thomas (2013) or Midrigan and Xu (2014). Collateral constraints in such latter models take the form of $b_{t+1} \leq \zeta k_t$ with all borrowing (either constrained or unconstrained) at the risk free rate. A relaxation of financial frictions in that environment modelled as an exogenous rise in the parameter ζ leads to an increase in borrowing (at the risk free rate) and capital holdings by constrained firms, bringing them closer to their efficient marginal product of capital. The only reason why aggregate capital would not rise in response to the relaxation of frictions can arise if there is an endogenous rise in real interest rates, which is usually dwarfed by the relaxation of the constraint.[42] This stands in contrast to our result where aggregate capital

42. For example, Figure 6 in Khan and Thomas (2013) documents the long run drop in aggregate capital associated with a permanent tightening of the collateral constraint (*i.e.* drop in ζ).

falls as a consequence of a relaxation of the financial friction in the AHM proposal leading to a decrease in collateralizable capital necessary to lower endogenous borrowing costs.

8. CONCLUSION

We extend a standard model of firm dynamics to incorporate Chapter 7 and Chapter 11 bankruptcy choices. We find that, if reforms proposed by legal and economic scholars are followed, there can be significant changes in borrowing costs, capital structure, and investment decisions as well as the firm size distribution. The general equilibrium consequences of such reforms can lead to a rise in consumer welfare and more efficient allocation of resources as measured by lower variance of marginal product of capital across firms.

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Supplementary Data

Supplementary data are available at Review of Economic Studies online. And the replication packages are available at https://doi.org/10.5281/zenodo.4287356.

Data Availability Statement

The replication package can be found in Zenodo (DOI 10.5281/zenodo.4287356) under "Replication package for: Reorganization or Liquidation: Bankruptcy Choice and Firm Dynamics." Zenodo. https://doi.org/10.5281/zenodo.4287356

The data underlying this article comes from three sources:

1. Compustat - Capital IQ, North America, Fundamentals Annual (Compustat Industrial Annual Data, 1984–2014). Data are subject to distribution restrictions as it is proprietary data. We access this data trough Wharton Research Data Service (WRDS). To request an account and access the data please visit: https://wrds-www.wharton.upenn.edu/register/. Detail instructions on how to access and download the data can be found in the replication package.
2. The UCLA-LoPucki Bankruptcy Research Database (BRD) (UCLA-LoPucki Bankruptcy Research Database, 1984–2014) Data are subject to distribution restrictions as it is proprietary data. To request an account and access the data please visit https://lopucki.law.ucla.edu/buy_cases_table.htm Detailed instructions on how to access the data can be found in the replication package.
3. Federal Reserve Bank of St Louis Economic Data (FRED). We retrieve the data from FRED, Federal Reserve Bank of St Luis: https://fred.stlouisfed.org/. We use the following variables

(a) Consumer Price Index (U.S. Bureau of Labor Statistics) from the U.S. Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers: All Items in U.S. City Average [CPIAUCSL] which can be access at https://fred.stlouisfed.org/series/CPIAUCSL
(b) 1-Year Constant Maturity Treasury Bill Rate (Board of Governors of the Federal Reserve System (US)) from the Board of Governors of the Federal Reserve System (US), retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/DGS1

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