Is an Automaker’s Road to Bankruptcy Paved with Customers’ Beliefs?

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Durable goods producers can face a pernicious feedback loop between their financial health and the demand for their products. Financial distress can reduce demand for a firm's products if it causes consumers to worry about the firm's ability to supply flows of goods and services—such as warranties, spare parts, and maintenance—that are typically bundled with the primary durable good. This drop in demand harms the firm's profitability, exacerbating its financial distress, which in turn further heightens the demand impact. In principle, this cycle can spiral until the firm falls into bankruptcy. The feedback mechanism might even sustain "bank-run-like" self-fulfilling expectations (e.g., Douglas W. Diamond and Philip H. Dybvig, 1983): if consumers suddenly believe a firm is distressed, even incorrectly, the resulting demand effect could push the firm into distress and even bankruptcy.

Concerns about such effects in auto manufacturing played a prominent role in policy discussions during the recent recession. Some feared that the already struggling General Motors and Chrysler would be further harmed due to consumers' worries about warranty viability. In March 2009, the U.S. Treasury announced the creation of the Warranty Commitment Program, which guaranteed warranties of new GM or Chrysler cars should either firm go bankrupt. This program was justified by its defenders as a device that could break the vicious circle between consumer expectations of firms' financial health and demand for their products, serving a function akin to bank deposit insurance. If the feedback mechanism was weak, however, such policies would be at best a wasteful distraction and at worst an unnecessary and possibly large transfer from taxpayers to automakers and their consumers. Measuring this feedback loop's strength is important for evaluating how it affects equilibrium outcomes in this and other durable goods markets as well as in evaluating interventions like the Warranty Commitment Program.

In this paper, we measure the impact of this feedback mechanism on outcomes in the auto market. One of the key inputs into this analysis comes from our related work (Ali Hortaçsu, Gregor Matvos, Chad Syverson, and Sriram Venkataraman, 2010) where we measure the direct effect of automakers' financial distress on consumer demand. We found that shifting an automaker's probability of default from zero to a near certain bankruptcy reduced the market prices of that producer's cars by roughly five percent (e.g., $1400 on a $28,000 car). Here, we measure the equilibrium impact of this, taking into account its feedback effect on an automaker's financial health and its influence on that firm's pricing and debt service choices. We do so by building a simple model where an automaker builds and sells cars to earn profits for its equity holders and service its debt payments. Consumers' demand depends on their expectations about whether the firm will continue operating (i.e., not default on its debt) and therefore be able to provide full flows of bundled goods and services that arrive after the initial purchase.

We find that multiple equilibria in prices (and therefore sales and operating profits) and bankruptcy probabilities can arise in the model, confirming the possibility of self-fulfilling expectations. We then combine our estimate of how much an automaker's financial distress affects demand for its cars with measures of the model's other parameters gleaned from data on actual automakers' operations and solve the model to see if multiple equilibria are likely in the current auto market. Finally, we do a counterfactual exercise to gauge how market outcomes would change if consumer demand were unaffected by an automaker's financial health.

I. Model

Our model automaker makes two decisions in every period. It sets the price of its product (we assume for simplicity the firm produces just one type of car) to maximize its operating profits. It also maximizes the present value of its equity by deciding, in the spirit of Hayne E.

Leland (1994), whether to pay its debt obligations and continue operating or to instead declare bankruptcy and effectively cease operations. The firm makes both its pricing and continuation decisions knowing that consumer demand for its cars depends on its likelihood of survival. (We assume whether a bankrupt automaker reorganizes or liquidates does not matter to consumers. The future flows of goods and services bundled with the car—warranties in particular—are diminished in either case.)

The timing of the model is as follows. In each period, the automaker first sets the price of its car. Risk-neutral consumers then make their purchase decisions. After sales are realized, the firm decides whether to pay its debt obligations or file for bankruptcy, and consumers' utility flows from their cars are realized. If the firm meets its debt obligations, these steps are repeated in the next period. If the firm declares bankruptcy, the game ends.

We first describe the consumer's purchase choice taking price and the automaker's probability of bankruptcy as given. For simplicity, a consumer's utility flow from a car occurs all in one period but depends on whether the automaker enters bankruptcy that period. Specifically, if the manufacturer does not default, consumer *j*'s indirect utility from a car is $u_j = \delta - \alpha p + \varepsilon_j$, where $\delta > 0$ is a mean utility level common across consumers, p is the car's price, $\alpha > 0$ parameterizes price sensitivity, and ε_j is the idiosyncratic taste of consumer *j*. If the automaker defaults, we assume the consumer loses a fraction $1 - \gamma$ of the mean utility flow δ, so $u_j = \gamma\delta - \alpha p + \varepsilon_j$. Let σ be the probability that the automaker chooses to stay in business. Normalizing the consumer's utility of not purchasing a car to zero, we thus have that the risk-neutral consumer buys a car if $\sigma\delta + (1 - \sigma)\gamma\delta - \alpha p + \varepsilon_j > 0$. We assume that ε_j is drawn iid from a Type 1 Extreme Value distribution, so the share of the consumers who buy the car takes the familiar logit form:

(1) $$s = \frac{exp(\sigma\delta + (1-\sigma)\gamma\delta - \alpha p)}{1 + exp(\sigma\delta + (1-\sigma)\gamma\delta - \alpha p)}.$$

We now turn to the automaker's problem. Each period it chooses price p_t to maximize operating profits $\pi_t = Ms(p_t - c)$, where M is the total market size and c is the per-unit production cost. Total profits involve two other components besides π_t. First, the firm incurs a stochastic fixed cost ξ_t that is an iid draw from distribution $F(\xi)$, which is normal with a zero mean and variance v_ξ. Second, the firm is financed with a consol bond that entitles debt holders to an infinite stream of per-period coupons b. Every period, the firm's equity decides whether to make the coupon payment if default has not yet occurred. If the coupon is paid, equity holders obtain the cash flows $\pi_t + \xi_t - b$. If it does not pay the coupon, the firm goes bankrupt, and equity obtains zero from that point onward.

We solve for the automaker's bankruptcy decision before moving on to the optimal pricing decision. It is straightforward to show that the firm's optimal policy is to select a cutoff stochastic profit shock ξ_t value such that if the firm obtains a shock below this level, it will default. Because all shocks are iid and market parameters are constant, the problem is stationary; the automaker uses the same cutoff rule and charges the same price and every period. Denote $\bar{\xi}$ as the endogenous value of the shock at which the automaker is indifferent between defaulting and continuing operations. The firm's probability of survival each period is thus $\sigma = 1 - F(\bar{\xi})$. This implies the expected equity (stock) value of the firm is $E_\xi S_t = \int_{\bar{\xi}}^{\infty} \left(\pi_t + \xi_t - b + \frac{E_\xi S_{t+1}}{1+r}\right) dF_\xi$. At the cutoff $\bar{\xi}$, this value must equal the equity value at default. This implies the boundary condition $\pi + \bar{\xi} - \mathrm{b} + \frac{E_\xi S}{1+r} = 0$ ($E_\xi S_t = E_\xi S$ and $\pi_t = \pi$ in all periods because of stationarity). Combining these equations and substituting in for operating profits π, we obtain an equation that implicitly defines the firm's optimal cutoff $\bar{\xi}$ given its price choice p:

$$(1+r)\left(-M\frac{\exp(\sigma\delta+(1-\sigma)\gamma\delta-\alpha p)}{1+\exp(\sigma\delta+(1-\sigma)\gamma\delta-\alpha p)}(p-c) - \bar{\xi} + b\right) = \int_{\bar{\xi}}^{\infty}(\xi - \bar{\xi})dF_\xi. \quad (2)$$

Note that the survival probability σ is a function of $\bar{\xi}$.

We next solve for the car price p that maximizes the expected equity value $E_{\xi}S_t$. Notice that while price can affect the firm's value through its influence on both current-period operating profits π_t and the bankruptcy boundary $\bar{\xi}$, the fact that the firm chooses the bankruptcy boundary optimally means we can invoke the envelope theorem and simply find the p that maximizes operating profits. The resulting first order condition yields an implicit equation for equilibrium p:

(3) $\alpha(p - c) = 1 + \exp(\sigma\delta + (1 - \sigma)\gamma\delta - \alpha p)$.

An equilibrium is a choice of price p and cutoff rule $\bar{\xi}$ that maximizes the firm's expected value given consumer purchases that maximize utility given p and $\bar{\xi}$. Equations 2 and 3 implicitly define the equilibrium $\bar{\xi}$ and p.

II. Theoretical Results

A. Unique Equilibrium When Consumers Don't Care about Survival

When consumer utility is not influenced by the firm's probability of survival—that is, when $\gamma = 1$—there is a unique equilibrium. The proof is in the online appendix, but the intuition for the result is straightforward: if demand is not sensitive to survival prospects, the feedback loop is broken. Demand drops for other reasons still negatively impact the firm's profitability and survival, but these survival effects do not in turn lead to further demand reductions.

B. Multiple Equilibria Are Possible When $\gamma < 1$

The model can produce multiple equilibria when the firm's survival probability affects demand. An example of this is shown in Figure 1, which plots the left- and right-hand-sides of Equation 2 (respectively labeled LHS and RHS) as the firm's probability of survival $\sigma = 1 - F(\bar{\xi})$

changes, for five different values of the automaker's debt service level *b*. Only the left-hand-side of Equation 2 is affected by *b*; larger values of *b* correspond to higher LHS curves on the figure. As can be seen, for intermediate *b*, multiple σ (equivalently, multiple bankruptcy thresholds $\bar{\xi}$) solve the equation.

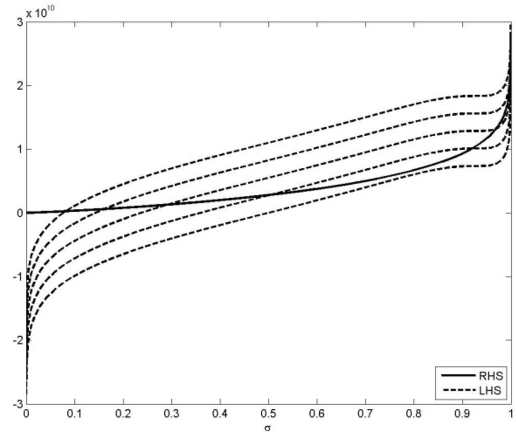

Figure 1. Existence of Multiple Equilibria.

Figure 1 also demonstrates how the model's parameters other than γ can affect the uniqueness or multiplicity of equilibria. At sufficiently low debt service levels (corresponding to lower left-hand-side curves in the figure), the automaker's financial condition is shielded from all but the most negative profit shocks. Consumers' expected utilities from purchase are high enough to hold demand at a level sufficient to support a high price and bankruptcy threshold, and this outcome is not sensitive to perturbations in consumers' expectations about firm survival. In this case the equilibrium is unique with high σ (low $\bar{\xi}$) and high *p*. Uniqueness can also obtain at sufficiently high debt service levels, as a similar process works in reverse. Default is so likely and consumers' expected utility so low that no perturbations would move the market away from an expectedly quick exit. Only at intermediate *b* are outcomes sensitive to perturbations in consumers' beliefs about the automaker's longevity. Here, a market with the same fundamentals could either stabilize or spiral down to low sales and firm bankruptcy.

We show in the online appendix how the other parameters of the model, α, c, and δ affect the uniqueness and multiplicity properties of the model.

III. Empirical Results

To see if multiple equilibria were likely in the actual auto market during the recent recession, we solve the model using our estimate for γ from Hortaçsu et al. (2010) and measures of the model's other parameters taken from market data in 2008. We do so for a firm that was in real danger of bankruptcy at the time and that would eventually become a beneficiary of the Warranty Commitment Program: GM.

A. Data, Model Solution, and Test for Multiple Equilibria

As mentioned above, we estimated that an automaker's likely impending bankruptcy would lead to an expected 5 percent drop in its car prices, so we use $\gamma = 0.95$. The other parameters of the model are taken from auto industry data in 2008. Data sources are detailed in the online appendix. We set the marginal cost c so that $(p - c)/p$ equals GM's observed accounting operating margin of about 3 percent. Given that the average price of a car that year was about \$28,000, $c = \$27{,}160$. Market size M equals the total number of new light vehicles sold in the U.S. that year (thus the model's outside good is effectively an amalgam of other automakers' cars). We compute GM's debt service coupon b by multiplying the debt level reported in its financial statements by interest rate $r = 0.1$, so $b = \$4.59$ billion.

Given these parameter values, we use Equations 1, 2, and 3 to solve for the values of the demand parameters δ and α and the variance of the profit shock v_ξ that fit the values of price p, market share s, and survival probability σ (equivalently, default threshold $\bar{\xi}$) that we observe for

GM in the data. (We use p = \$28,000 as above. We calculate a survival probability of $\sigma = 0.678$ using the average spread over 2008 on credit default swaps on GM debt, assuming risk neutrality.) We find $\delta = 41.7$, $\alpha = 0.0015$, and sqrt(v_ξ) = \$13.9 billion.

To see if the model exhibits multiple equilibria at these identified parameters, we check whether Equation 2 has multiple solutions in σ at these parameters. It does not; the equilibrium is unique, suggesting that while GM was in financial distress during the period, its survival was not subject solely to the whims of consumers.

B. Counterfactual Exercise Imposing $\gamma = 1$

Using the measured parameters and those we solved for above, we re-solve the model for the case where $\gamma = 1$, that is, where GM's expected longevity doesn't affect demand. This would be the case if the broader market were able to supply flows of the bundled goods and services that are perfect substitutes for those GM provides. It would also hold if policy interventions like the Warranty Commitment Program assuage such longevity concerns. We already know that the market equilibrium will be unique in this case. Comparing market outcomes in this equilibrium to those observed in the data is informative about how the ties between financial distress and demand impact the auto market.

We find that in the counterfactual world, GM raises its price by only 0.4 percent relative to when $\gamma = 0.95$, though this makes price-cost margins rise by 14 percent due to the small initial margin. Eliminating the longevity concern greatly expands GM's market share, from 0.21 to 0.31, raising profits by over 60 percent. It also raises GM's chance of survival, though default remains a considerable probability, with σ rising to 0.778. That both counterfactual operating profits and survival probabilities are notably higher for GM suggests the effect of financial distress on consumer demand greatly impacted that firm during the recent recession, even in absence of multiple equilibria. Another interesting comparison is in consumer surplus, computed as the inclusive value of the choice set (Kenneth A. Small and Harvey S. Rosen, 1981). Consumer surplus is 54 percent higher when $\gamma = 1$ than when $\gamma = 0.95$, despite the higher price. This reflects the direct utility effect of raising γ. Thus not only does an automaker benefit from policies that increase γ, its customers do too. But it is important to remember that raising γ has its own costs that need to be taken into account when making optimal policy choices. Further, in the absence of multiple equilibria, a government policy to raise γ by, say, guaranteeing warranties would essentially be a transfer from taxpayers to an automaker and its customers.

Considerable caution is warranted in interpreting these results. These calculations are derived from an extremely stylized model in which we have made several simplifications in structure and measurement. Rather than viewing these results as a dispositive evaluation of alternative market structures or policy, we see our exercise above as a useful template from which to build a more rigorous analysis.

IV. Conclusion

The feedback loop between automakers' financial health (and their survival probabilities) and the demand for their cars can in principle create multiple equilibria in the market. We demonstrate this possibility using a simple model of an automaker that makes pricing and debt service decisions recognizing that its demand depends on consumers' expectations about its survival probability. We calibrate our model to match stylized facts surrounding GM's bankruptcy during the recent recession, using parameters measured from observed market outcomes and our related research on how automakers' financial distress affects demand for their cars (Hortaçsu et al., 2010). The results from our calibration exercise suggest that while the impact of financial distress on demand may have substantially reduced GM's profit, it does not appear that bank-run-like multiple equilibria were a likely outcome in this market. These results should be interpreted with caution, however, due to the highly stylized nature of our model and the simplifications in structure and measurement that we made here. That said, we believe that our modeling framework can serve as a foundation on which to construct a more complete analysis. We leave this to future research.

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