The Temporary Shutdown Decision: Lessons from the Great Recession

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The temporary shutdown condition provides guidance on dealing with a serious transitory downturn in demand. The traditional condition says managers should stop production when revenues fall below avoidable costs. This condition is flawed because it ignores how lost human capital and reputational damage harm future profits. As a consequence, firms may optimally operate with losses far larger than stipulated by the traditional condition. We provide the first broad empirical analysis of the temporary shutdown decision, focusing on the Great Recession. We show that large operating losses were common and temporary shutdowns were exceedingly rare, even among very small public firms.

Keywords: Shutdown condition, temporary shutdown decision, human capital, firm reputation, corporate liquidity

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So an industry may, and often does, keep tolerably active during a whole year or even more, in which very little is earned beyond prime costs, and the fixed plant has 'to work for nothing.' But when the price falls so low that it does not pay for the out of pocket expenses during the year for wages and raw materials, for coal and for lighting, etc., then the production is likely to come to a sharp stop."

- Principles of Economics (Alfred Marshall, 1920, Book V, Chapter IX)

1. INTRODUCTION

The temporary shutdown condition is important for managerial decision making because it provides guidance on operations when firms suffer a serious downturn in demand. The traditional (neoclassical) shutdown condition is that firms should temporarily stop production when revenues do not cover avoidable costs. This condition dates back to Alfred Marshall's *Principles of Economics* and continues to appear in numerous textbooks covering managerial economics, industrial organization, and the theory of the firm.[1] If this condition is correct, the temporary shutdown option provides valuable insurance for the firm because it puts a relatively high lower bound on operating losses. If the traditional condition is not correct, however, firms may be forced to operate in spite of extremely high losses during downturns, jeopardizing their survival.

Surprisingly, the broad literature on managerial strategy has given little consideration to the temporary shutdown decision. This lack of attention is notable given how extensively the literature has studied related issues, such as retrenchment strategies, corporate downsizing, and *permanent* exits.[2] While it may be obvious that the neoclassical temporary shutdown condition is flawed, it is important to understand why it is flawed and consider whether an alternative framework can provide better insight on the temporary shutdown decision. Perhaps most importantly, the lack of empirical evidence on the temporary shutdown decision means that the extent to which the traditional condition fails is unknown. In particular, if temporary shutdowns are rarely undertaken, this has important implications for managing firms during severe downturns such as the Great Recession.

There are several reasons why the neoclassical temporary shutdown condition likely provides poor guidance to managers of modern firms. For example, numerous studies emphasize the importance of

[1] For example, see Samuelson (1st edition, 1948, p. 507; 18th edition, with William D. Nordhaus, 2005, p. 150), Varian (1992, p. 216-217) and Mas-Colell, Whinston and Green (1995, pp. 144-146).

[2] For example, see DeWitt (1993), Pearce and Robbins (1994), Guthrie and Datta (2008), and Elfenbein and Knott (2015).

intangible resources as critical for achieving a competitive advantage (e.g., Barney, 1991 and 1996; Castanias and Helfat, 1991), and many empirical studies support this view (e.g., Hall, 1992; Michalisin et al., 1997; Wiggins and Ruefli, 2002; Crook et al., 2008; Kamasak, 2017). Key intangible resources are almost certainly damaged if a firm temporarily shuts down.

We discuss two motivating examples. Consider first firm-specific human capital, a critical concept introduced by Becker (1962) more than fifty years ago. Firm-specific human capital has long been viewed as one of the most important resources for sustained competitive advantage (e.g., Hitt et al., 2001; Hatch and Dyer, 2004; Coff and Kryscynki, 2011). If a firm temporarily shuts down and releases workers it surely sacrifices a portion of its stock of human capital. Temporarily releasing workers will lower *future* profits for at least three reasons: i) the firm will have to re-incur search costs and training expenses when it resumes operations, ii) the firm will unlikely be able to replace, in the near term, all of the on-the-job learning by workers who departed the firm and iii) fired workers may reveal proprietary information to competitors (Colombo et al., 2014). The traditional neoclassical temporary shutdown condition ignores these lost future profits because it implicitly assumes that labor markets are spot markets, with no labor hoarding and workers acquiring no firm-specific human capital. In fact, while current wages are almost always an avoidable expense in many countries (e.g., the U.S.), there are often large firm-specific human capital investments attached to labor, and these investments can dramatically change the appropriate shutdown condition.

A second example is corporate reputation, another key intangible strategic resource (e.g., Barney, 1991; Hall, 1992; Roberts and Dowling, 2002; Flanagan and O'Shaughnessy, 2005; Kristandl and Bontis, 2007). Dierickx and Cool (1989) argue that a reputation for quality can be created only by many years of regular production with careful quality control, something not consistent with temporary shutdowns. A firm that temporarily shuts down will damage its reputation as a reliable seller, which will likely cause a loss in future sales and profits because some existing customers will be forced to discover new options. More broadly, modern firms have numerous "relational" assets with external stakeholders and strategic partners that may be damaged by a temporary shutdown (e.g., Srivastava et al., 2001).

Once damages to these key strategic resources are acknowledged, the traditional temporary shutdown condition likely provides poor guidance on when firms should temporarily halt production. In particular, accounting for lost future profits from lost human capital and damage to other intangible resources

(from a shutdown) will drive the true temporary shutdown price well below the traditional shutdown price. More importantly for this paper, it means that firms will likely continue operating when revenues are substantially below avoidable costs because reductions in future profits arising from a shutdown would be even greater than the losses from operating during the downturn.

We know of no evaluation of the temporary shutdown decision within the strategy or managerial decision-making literatures. Within the economics literature, the only modern update to the neoclassical condition is Dixit (1989) and Dixit and Pindyck (1994) who show formally that when there are irreversible investments that may be sacrificed during a firm shutdown (e.g., human capital), together with uncertainty about the persistence of a decline in price, there is an option value of waiting for new information that potentially pushes the true temporary shutdown price far below the traditional shutdown price. The work of Dixit and Pindyck has not, however, generated empirical work on temporary shutdowns, nor has it altered the way the temporary shutdown condition is presented in textbook treatments.

We believe one key reason for the lack of attention to the temporary shutdown condition in the management literature, and the general failure to update the condition in textbook treatments, is that there is virtually no empirical evidence on the temporary shutdown decision. We make a first attempt to fill this gap in the literature by studying the temporary shutdown decision during the Great Recession. Other studies have explored how the Great Recession impacted firm decision making and the study closest to ours is Polat and Nisar (2013). For a sample of six Eastern European countries, they examine how the Great Recession affected firm employment, firm performance and organizational structure. They did not, however, explore either temporary shutdowns or permanent exits. Interestingly, they conclude that firms learned from previous recessions to avoid firing permanent staff, consistent with these workers being very costly to replace. Such a conclusion is consistent with a view that although wages are an avoidable expense, firms often treat a large component of wage payments as quasi-fixed (e.g., Oi, 1961), in which case the traditional temporary shutdown condition is badly flawed.

The Great Recession is perfect for evaluating the temporary shutdown decision. First, it was by far the sharpest recession since the Great Depression (see the overview in Polat and Nisar, 2013), with many firms experiencing pronounced declines in demand and profitability. Thus, if temporary shutdowns are a viable managerial strategy, this is the time period they should occur. Second, the Great Recession lasted all

of 2008 and much of 2009; therefore, if temporary shutdowns did occur, many of these firms will presumably be inactive for multiple quarters, making their shutdowns readily detectable with quarterly data, the highest frequency data that is available for a broad sample of firms.

To explore the temporary shutdown decision, we report three sets of findings. First, we explore the frequency and magnitude of operating losses during the Great Recession. The traditional shutdown condition indicates that operating income (e.g., revenues less avoidable costs) should be bounded below at zero. However, once the omissions noted above are acknowledged, operating income can fall far below zero before it is optimal for a firm to temporarily shut down. Thus, information on the size of negative operating incomes sheds light on the extent to which temporarily shutting down may damage intangible assets and lower future profits. Second, we explore whether temporary shutdowns are a commonly used strategy during a dire economic event. To our knowledge, no research to date has provided a broad-based empirical examination of the frequency of negative operating income and temporary shutdowns. Finally, we report information on the high number of permanent exits during the Great Recession, which provides some context for our main findings: unlike temporary shutdowns, we expect a high incidence of permanent shutdowns during the Great Recession.

We conduct our main investigation with panel data containing quarterly observations for 2600 publicly traded firms in existence during the Great Recession. It is important to point out that this data base contains a great many very small firms (e.g., less than $10 million in sales), who typically operate a single plant. In our main sample, comparatively few firms report negative operating income in 2006, and when losses are reported, they are typically small. In the Great Recession, however, the fraction of firms reporting operating losses explodes; for example, 25.4% of the manufacturing firms we sample have negative operating income in the first quarter of 2009. Furthermore, the magnitude of these operating losses (relative to assets) is often very large. These results point to serious problems in the traditional temporary shutdown condition.

Our second main finding is that temporary shutdowns are extremely rare, even in the Great Recession. We explore all firms where quarterly sales decline by more than 70%, checking their annual reports and other sources to determine if a temporary shutdown did in fact occur. In only one case (a gold mining company) were we able to confirm that there was a temporary shutdown. For all of the other firms with

dramatic sales declines, there was no evidence of a temporary shutdown. Rather, the sales decline was usually caused either by pronounced seasonality (e.g., operations impacted by weather), extreme cyclicality, or loss of a key customer. The fact that operating losses in the Great Recession were frequent and large, while temporary shutdowns were essentially nonexistent, shows that the traditional temporary shutdown condition is badly flawed. More importantly, this evidence suggests that temporary shutdowns are rarely a viable strategy for dealing with sharp and unexpected downturns in demand.

Our third set of findings is that there were a very high number of permanent shutdowns (i.e., exits) during the Great Recession, which is what we expect, given the frequency and magnitude of operating losses. Moreover, we estimate logistic regressions and find that firms with negative operating income have a much higher likelihood of permanently exiting during the Great Recession. In addition, the regressions show that conditional on having negative operating income, a large buffer stock of liquidity (i.e., cash holdings) substantially reduces the likelihood of permanently exiting.

Our findings strongly suggest that the temporary shutdown condition provides poor guidance to managers. Furthermore, the finding that temporary shutdowns were almost never a viable option during the Great Recession is important for managers, as it matters a great deal for contingency planning. One critical aspect of contingency planning is liquidity management. As noted above, the traditional temporary shutdown condition can put a floor on losses, providing a form of protection during adverse economic conditions. But if a temporary shutdown is rarely a viable option, firms may need other forms of downside protection (e.g., large stocks of precautionary liquidity), a conclusion supported by our evidence linking cash reserves with survival during the Great Recession.

Our paper fits into the broad literature on strategic entry and exit, among the most important decisions made by top management. Given that a temporary shutdown can be viewed as a temporary exit, our work is obviously more relevant for the strategic exit portion of the broader literature (e.g., Decker and Mellewigt, 2007). Elfenbein and Knott (2015) document that the strategy literature contains far more articles on market entry compared to market exit (by a factor of nearly nine-to-one); they also provide an excellent review of the literature on factors affecting the timing of exits. We emphasize that the exit literature has

focused almost entirely on *permanent* exists, which are fundamentally different than temporary shutdowns.[3] The only study we know of with some empirical evidence on temporary shutdowns is Moel and Tufano (2002), who note that permanent closings of gold mines are much more frequent than temporary closings.

The next section of the paper reviews some of the evidence pertaining to omissions in the traditional temporary shutdown condition. We then review the shutdown condition developed by Dixit and Pindyck (1994) and also provide a simple illustration showing that human capital and firm reputation can cause the lower bound on operating losses to be far lower than stipulated by the traditional temporary shutdown condition. Subsequent sections provide evidence on the frequency and magnitude of negative operating income, the lack of temporary shutdowns during the Great Recession, and permanent exits during the Great Recession. We also provide a discussion of the various implications of our findings for the management of the firm.

2. OMISSIONS FROM THE TRADITIONAL TEMPORARY SHUTDOWN CONDITON

The traditional temporary shutdown condition is flawed if there are strategic resources that are sacrificed or damaged during a shutdown. Not all strategic resources need be damaged during a shutdown; we focus below on the two intangible investments we believe are the best examples of key resources that will be damaged during a temporary shutdown.[4] A classic example is firm-specific human capital, which is widely viewed as a primary source of sustainable competitive advantage (see Coff and Raffiee, 2015, for an overview). For example, Hitt et al. (2001, p. 14) note that "firms create value through their selection, development, and use of human capital", and Hatch and Dyer (2004, p. 1156), in their study of the semiconductor industry, conclude that firms most capable of developing and utilizing human capital are the most successful at reducing the future costs of production.

In Goldin's (2000) overview of labor markets in the 20th century, she notes that (2000, p. 551) workers accumulate far more firm-specific skills today than in the past and that because of the "specificity of skill

[3] See Dunne, Roberts and Samuelson (1988) for a classic study on facts involving permanent firm closings. Studies also consider permanent plant closures (e.g., Bernard and Jensen, 2007), but almost never temporary plant closings. Temporary shutdowns are also fundamentally different from "retrenchment" or "reconfiguration" strategies, which typically involve a change in the size or scope of the firm to improve long-run performance (e.g., Pearce and Robbins, 1994; Chakrabarti, 2015).

[4] Hall (1993) provides a long list of intangibles including reputation and human capital; in addition, he lists intellectual property rights (such as patents and trademarks), trade secrets, contracts and licenses, data bases, etc. The most obvious intangible resources on this list that would be damaged by a temporary shutdown are reputation and human capital.

and higher level of skill, both workers and firms have a greater interest in a long-term relationship." There is a substantial amount of empirical evidence on the quantitative importance of firm investment in human capital, particularly on-the-job training.[5] The accounting costs of hiring and training appear to be large. For example, Hamersmesh and Pfann (1996, p. 1268) review the literature and state that for the average worker, the cost of hiring and training is around one year of wages and that these costs rise rapidly with the skill of the worker. Colombo et al. (2014) emphasize that firm investments in hiring and screening workers are likely to be particularly large for high-tech firms, which make up a very large fraction of publicly traded firms. Evidence from two large employer surveys shows that on-the-job training occupies a large fraction of a new worker's first three months on the job while other studies show that substantial on-the-job training continues well beyond the first three months of employment (Barron, Berger, and Black, 1997, Table 3.3).

There is also a complementary body of evidence on productivity and real wages for newly trained workers. Bishop (1997, Table 1) reports dramatic productivity gains for all categories of workers for their first two years of employment, together with only small increases in real wages. Likewise, Barron, Berger, and Black (1997, Table 6.7) report that the impact of training on productivity is roughly ten times greater than the impact on the growth of real wages. These facts suggest that firms both bear most of the costs and receive most of the returns from formal and informal on-the-job training, as expected if investment is firm-specific human capital. Finally, as would be expected with major firm investments in workers, Fay and Medoff (1985) and Aizcorbe (1992) report evidence of substantial hoarding of blue-collar workers in manufacturing during downturns, and Bernanke and Parkinson (1991) find labor hoarding to be a leading explanation for short-run increasing returns to labor.

Besides human capital, there are other intangible strategic resources that may be lost or damaged during a temporary shutdown. The most obvious is firm reputation. Flanagan and O'Shaughnessy (2005, p. 445) note that a firm's reputation is often a key strategic resource and several studies find that reputation affects corporate performance (e.g., Hall, 1992; Roberts and Dowling, 2002; Newbert, 2007). There are multiple ways a temporary shutdown can negatively impact a firm's reputation and future profits. If an input

[5] In addition to lost investment in training, costs to firing workers include the disruption to the team of workers (Hamermesh, 1993) and transmission of proprietary knowledge to competitors (Colombo et al., 2014).

supplier engages in a temporary shutdown, downstream customers may be damaged from curtailment of the input, forcing them to find alternative suppliers, which reduces future demand. More broadly, temporary shutdowns can result in a loss of customer "goodwill", which has long been recognized as an important intangible investment for many firms (e.g., Chauvin and Hirschey, 1994).[6] Besides issues stemming from loss of reputation, customers may also reduce their future demand because the shutdown causes them to engage in search that leads them to substitute products. The upshot is that a temporary shutdown likely leads to a loss of future sales, causing *future profits* to be substantially lower for some time. While not as obvious, there may also be higher *future costs* from temporarily shutting down because of damaged reputation with suppliers. This is particularly true if suppliers must make specific investments (e.g., worker training) to provide inputs to the firm in question and these investments are jeopardized when the supplier loses customers because of a temporary shutdown. These effects on future profitability can sharply alter the temporary shutdown condition, as we discuss in the next section.

3. ALTERNATIVES TO THE TRADITIONAL SHUTDOWN CONDITION

3.1 Irreversible investments, uncertainty, and the shutdown price

Beginning with Dixit (1989), powerful new tools have been developed to examine the entry and exit decisions (including temporary shutdowns) when there are irreversible investments and uncertainty. One of Dixit's (1989, p. 621) main examples of an irreversible investment is the firm-specific human capital lost if a firm fires a trained worker who must eventually be replaced at a future date. Dixit and Pindyck (1994) enrich Dixit's model in a number of ways. They allow for the possibility that a firm can "mothball" its capital by paying a sunk maintenance cost (M), which prevents the immediate rusting of its capital. (The hoarding of workers is an obvious way that firm-specific investment in human capital can be "mothballed"). In addition, the firm incurs a sunk reactivation cost R if it resumes operations. Such a reactivation fee would include the training of new workers, or perhaps having to increase advertising and promotions to attract customers who had switched to other firms. They show (p. 233) that the firm's shutdown price will equal:

[6] See Chavin and Hirschey (1994) for an introduction to the literature on goodwill and its impact on firm value. Regarding customer goodwill, they note (p. 177) that because consumers find it difficult to accurately assess firm quality, firms use investment and marketing decisions to signal quality. Even if a temporary shutdown does not directly harm a customer, it is likely to send a very negative signal about the overall quality of the firm (e.g., Flanagan and O'Shaughnessy, 2005).

$$P_S = C - \theta(M, R, \sigma),$$

where P_S is the shutdown or mothball price, and C is the per-unit operating costs (the traditional shutdown price). The option value of waiting, θ, depends positively on M and R and σ, the variance of prices. As we have discussed above, the cost of retraining workers (an element of R) is very substantial. The price at which a firm would reactivate also depends on M, R, and σ. Dixit and Pindyck (1994) provide numerical results (pages 235 - 237), which show that for modest values of M and R and plausible values of σ, P_S is well below the traditional shutdown price. They also find reactivation prices that are well above the traditional new entry price. Their numerical results indicate a wide range of prices over which firms may earn negative operating income yet remain active and an even wider range of prices over which a mothballed firm will remain inactive.

3.2 A simple illustration

By ignoring uncertainty (and thus ignoring option values), we can provide a much simpler illustration of how the omissions discussed in the previous section can affect the optimal shutdown condition. Let *H* be the firm investment in human capital (per worker) and assume only one type of worker. Assume short-run costs are $C(y) = my + wL(y) + F$, where *m* is the constant per-unit cost of materials, *w* is the per period wage, *L* is labor inputs, and *F* is current sunk capital costs. Assume the firm faces a demand curve $p(y, Z)$, where *Z* is a demand shifter. Suppose there is a temporary decline in demand to $p(y, Z')$ that is expected to last one period.[7] Note that the opportunity cost of retaining a worker is $w - H$, because any worker employed is one less worker that must be hired and trained once demand recovers. During the period of low demand, let y' denote the optimal output level (where MR = MC) assuming the firm chooses to produce. Also, let $L(y')$ represent the optimal level of workers if the firm produces y'. During the low demand period, the firm should operate and produce y' as long as revenues less avoidable costs exceed the saving in human capital investment, or:

$$p(y', Z')y' - my' - wL(y') \geq -H^*L(y') . \qquad (1)$$

[7] The firm knows the length of the temporary demand decline so there is no option value. It is straight forward to generalize this illustration to multiple types of labor (with different *H* values) and multiple periods. For example, with N periods, the left-hand side of equation (1) is simply multiplied by N.

The intuition is that with positive H, the firm should factor in a "credit" which equals the human capital saved from retaining $L(y')$ workers rather than shutting down and releasing its labor force. This is essentially an extension (to the shutdown decision of the firm) of Becker's (1962) idea that, because of human capital, the firm may continue to employ a worker even if the marginal product of that worker temporarily falls below the market wage. Note that for the traditional temporary shutdown condition, the right-hand side of equation (1) is zero, since H is ignored. Thus, the temporary shutdown price, found by treating equation (1) as an equality and solving for p, will clearly be lower than under the traditional condition. In fact, if H is large enough, the shutdown price can fall all the way to m, the price of materials (and all workers would be hoarded).

Suppose a temporary shutdown damages a firm's reputation, causing some customers to switch to other firms (and do not return after the shutdown). Denote the present value of these lost profits by π. Now the credit added to the right-side of equation (1) is simply: $-H^{*}L(y') - \pi$. When either H or π are substantial, the true temporary shutdown condition can depart radically from the traditional condition. Of importance for our empirical work, instead of operating losses being bounded at zero, they can become as large (in absolute value) as $H^{*}L(y') + \pi$.

3.3 Testable Hypotheses

The literature review in Section 2, together with the alternative approaches to the traditional temporary shutdown condition reviewed in Section 3, provide some testable hypotheses that we explore in the remainder of the paper.

Hypothesis 1: During the Great Recession, given the importance of irreversible intangible investments to modern firms, a substantial fraction of firms should have reported sizable operating losses. The intuition is that many firms likely made the calculation that it is optimal to accept operating losses in the short-run rather than temporarily shutting down, damaging intangible assets and lowering future profits.

Hypothesis 2: During the Great Recession, a low shutdown price, together with a high reactivation price (e.g., Dixit and Pindyck, 1994), suggests that temporary shutdowns should have been relatively uncommon.

Hypothesis 3: During the Great Recession, and immediately following, the incidence of permanent

shutdowns should have been very high, as large operating losses eventually overwhelmed many firms. An additional implication is that firms with insufficient liquidity should have been the most likely to exit.

Hypothesis 4: During the Great Recession, industries with the highest levels of human capital investments in workers should have had relatively high incidence of firms with sizable negative operating income.

The first three hypotheses (and especially the first two) are the key objectives of our empirical analysis. The final hypothesis arises directly from the Dixit and Pindyck (1994) analysis, as well as our simple illustration. It is challenging to test this hypothesis, given the lack of information on firm-specific human capital investments. We can, however, make some progress. The high-tech sector arguably has greater levels of human capital investment compared to other sectors in the economy (e.g., Colombo et al., 2014). In particular, this sector employs a disproportionately large fraction of scientists and engineers. We therefore predict that the high-tech sector should have exhibited a comparatively high incidence of firms reporting large negative operating income during the Great Recession.

4. DATA AND MEASUREMENT ISSUES

4.1 Quarterly data

Our principal data source is COMPUSTAT, the best available large-scale database for our purposes because it contains high-frequency quarterly information on virtually all publicly traded firms in all sectors of the economy. We focus on the Great Recession, arguably the single best period in recent history to explore temporary shutdowns, given the intensity and length of the economic downturn, particularly in cyclically sensitive industries. The Great Recession covers all of 2008 and much of 2009, and thus quarterly data should be of high enough frequency to capture temporary shutdowns if they do occur.

COMPUSTAT's unit of analysis is not the plant but the firm, which is appropriate for our focus on the frequency of operating losses. According to the traditional shutdown condition, the *firm* should not display negative operating income. In addition, firms do not report operating income at the plant level. An attempt to measure operating income at the plant level could easily overstate the incidence of operating losses because of problems measuring transfer prices and because individual plants do not need to be a profit

center. Attempts to measure operating losses at the plant level could also understate their incidence because many types of labor (e.g., the sales force) can be located primarily at the headquarters. Because a great many of the firms in our sample have but a single plant (see discussion below), and we find (with one exception) no temporary shutdowns for any firms, the plant versus firm distinction is not an issue for our conclusions regarding firm shutdowns.[8]

To be included in the main sample a firm must report quarterly sales and operating income in both 2006 and 2011. Firms do not have to be *continuously* operational during this period. In addition, we require that firms have, averaged over their quarterly data, positive operating income in 2006. Our objective is to exclude startup companies that have yet to achieve profitability. Rather, we want to focus on companies that had achieved positive operating income before the start of the Great Recession. We exclude firms in government, agriculture, and the financial sector, and we require that firms be incorporated domestically. Finally, while we do require firms to survive until at least 2011, we also create a separate sample to examine the many firms who permanently shut down during the Great Recession. Our selection rules result in a main sample of 2600 firms, with 1142 firms in the manufacturing sector and 1458 in non-manufacturing.

4.2 The distribution of firm size

Table 1 reports information on the distribution of total assets and sales (in millions of 2006 dollars) for the firms in manufacturing (Panel A) and non-manufacturing (Panel B). While the median firm is relatively large, a substantial fraction of our sample consists of very small firms. For example, in manufacturing, at the 10^{th} percentile, assets are only $30.5 million and quarterly sales are just $8.8 million.

4.3 Measure of operating income

Firms' reported operating income is an important variable in our study. To illustrate the conceptual nature of operating income, Table 2 shows an aggregate income statement for the sample firms in 2006, where sales

[8] The textbook discussion of temporary shutdowns is focused on the firm. While we do not believe that it is useful to look at negative operating income for plants (for the reasons we give above), it is of some interest to study the incidence of temporary plant shutdowns (which we cannot do with Compustat data). During recessions, it is possible that firms may utilize temporary plant-level shutdowns more frequently than firm-level shutdowns. For one thing, key workers may be transferred to other plants (and thus human capital is preserved) and reputation need not be damaged if the firm continues to produce output at other plants. Conceptually, a plant shutdown for a multi-plant firm may have similarities to a single-plant firm shutting down a shift, or stopping production of one (of multiple) assembly lines. For this reason, we do not view plant-level shutdowns to be as interesting as firm-level shutdowns.

are normalized to 1.00 and other items are expressed as a fraction of sales. Operating income (OPINC) is defined as sales less operating expenses. Operating expenses include cost of goods sold (COGS) and selling and general administrative expenses (SGA). As discussed in the Appendix, COMPUSTAT is careful to not allow COGS or SGA to be contaminated by capital charges. COGS include such avoidable costs as materials, energy, direct labor, salaries, and freight-in expenses. COMPUSTAT defines SGA as "all commercial expenses of operation (i.e., expenses not directly related to production) incurred in the regular course of business pertaining to the securing of operating income." SGA expenses include freight-out (shipping costs), salaries, advertising, and research and development. A large number of expenses appear below OPINC. In particular, the key unavoidable expenses (e.g., capital expenses such as depreciation and interest) appear after the computation of OPINC.

Table 2 shows that, in 2006, COGS amounted to 67.5% of sales in manufacturing and 71.1% of sales in non-manufacturing. SGA amounted to 16.9% and 13.3% of sales in manufacturing and non-manufacturing, respectively. After subtracting COGS and SGA, OPINC amounted to approximately 15.5% of sales in both manufacturing and non-manufacturing. So, on average, OPINC is a substantial fraction of sales in a non-recession year such as 2006. In contrast, net income, the last figure in the statement, is approximately 8.1% percent of sales in manufacturing and 5.7% in non-manufacturing. Thus, in 2006, OPINC was around two to three times larger than net income.

One component in SGA – research and development (R&D) – deserves scrutiny. On the one hand, R&D expenses are predominantly a flow of wages paid to the research staff and as such are avoidable costs of operation. On the other hand, R&D may be thought of as an investment that generates revenues or cost savings in the future. We are agnostic on how to treat R&D. Fortunately, R&D expenses are available in COMPUSTAT, allowing us to add back R&D to OPINC. While R&D expenses can be sizeable in the high-tech sector, they are typically small in other industries, particularly in non-manufacturing. As a result, adding back R&D to OPINC does not have a major impact on our findings, as we will show in our next set of tables.

We acknowledge that some non-avoidable expenses may be included in COGS and SGA. This is one of the reasons we focus on *changes* in operating income in the Great Recession. We expect that just prior to the Great Recession, our sample of firms should exhibit almost entirely positive OPINC (or at most small negative OPINC). If during the Great Recession, there is then a sharp jump in the incidence of negative

OPINC (and the magnitude of losses), this gives us some confidence that our measure of OPINC is capturing the failure of firms to cover avoidable costs during the recession.

4.4 Frequency and Magnitude of Negative Operating Income

We begin with the frequency of operating losses, as an obvious (but incorrect) explanation for infrequent temporary shutdowns is that firms rarely suffer operating losses. In addition, the size of operating losses sheds light on the extent to which shutting down may damage intangible assets, leading to a loss of future profits. Table 3 reports information on the frequency and magnitude of negative operating incomes for the firms in our sample. In Table 3, we do not remove R&D from SGA (we do so Table 4). Information for the manufacturing sector is reported in Panel A, and information for non-manufacturing in Panel B. The first two columns give the year and quarter, starting with the first quarter of 2007 (just before the recession) and ending with the last quarter of 2010. Column 3 reports the fraction of negative OPINC observations. The remaining columns provide information about the lower tail (2^{nd}, 5^{th}, and 10^{th}) of the distribution of quarterly operating income, as well as the median value, which is important for comparison purposes. In these last four columns, OPINC is scaled by beginning-of-period total assets.

In 2007, approximately seven percent of manufacturing firms, and six percent of non-manufacturing firms, report negative OPINC. Between 2007 and the peak of the Great Recession, there is a dramatic jump in the incidence of negative OPINC in manufacturing: in the first quarter of 2009, the incidence of negative operating income is 25.4%, more than 3.5 times greater than the incidence in 2007. The jump in non-manufacturing is not quite as large, but the incidence of negative OPINC more than doubles between 2007 and the first quarter of 2009. In addition, by the end of 2010, in both manufacturing and non-manufacturing, the incidence of negative OPINC has almost returned to 2007 levels, consistent with a slow economic recovery beginning by late 2009.

Just as important as the incidence of negative OPINC is the (absolute) magnitude of negative OPINC during the Great Recession. As one point of comparison, quarterly (scaled) OPINC at the 50^{th} percentile in 2007 averages 0.0345 in manufacturing and 0.0325 in non-manufacturing. Another point of comparison are the values of quarterly scaled OPINC at the 2^{nd} percentile in the distribution in 2007, which is -0.023 in manufacturing, and a bit larger (in absolute value) in non-manufacturing. In contrast, in the 4^{th} quarter of 2008, at the 2^{nd} percentile, scaled OPINC is -0.087 in manufacturing and -0.139 in non-manufacturing,

several times larger (in absolute value) compared to the values in 2007. Also in the 4th quarter of 2008, at the 5th percentile, the OPINC ratio is -0.042 in both manufacturing in non-manufacturing. To put this in perspective, the 5th percentile numbers are, in absolute value, well above the *median* value of quarterly OPINC in 2007 or 2010. Furthermore, even at the 10th percentile, quarterly OPINC is substantially negative in manufacturing at the peak of the crisis.

Table 4 is identical to Table 3 except we add R&D back to OPINC, as discussed above. To save space, we report information for only the two recession years (2008 and 2009). As expected, during the Great Recession, the frequency of negative (adjusted) OPINC is not as high in manufacturing; however, in non-manufacturing, there is almost no change compared to Table 3. In manufacturing, it is still the case that the incidence of negative OPINC is nearly four times as high at the peak of the Great Recession compared to 2007 (year not reported). Furthermore, in the 4th quarter of 2008, negative OPINC at the 2nd percentile is still very large (in absolute value) in both manufacturing and, particularly, non-manufacturing. In both sectors, at the peak of the Great Recession, negative OPINC at the 5th percentile is similar in (absolute) size to the median value of OPINC in either 2007 or 2010. So, while the R&D adjustment matters somewhat in manufacturing, it matters very little in non-manufacturing, consistent with the fact that R&D expenses are trivial in most non-manufacturing industries. The results in Tables 3 and 4 support our first hypothesis: during the Great Recession, given the importance of irreversible intangible investments, a substantial fraction of firms should have reported sizable operating losses.

Table 5 reports information on the incidence of negative operating income for the high-tech sector compared to the rest of manufacturing. The objective is to provide information pertaining to our fourth hypothesis: during the Great Recession, industries with the highest levels of human capital investments should have had relatively high incidence of firms with sizable negative operating income. The high-tech manufacturing industries are drugs (SIC 283), office and computing equipment (357), communications equipment (366), electronic components (367), scientific instruments (382) and medical instruments (384).[9] The results in Table 5 show that during 2008 and 2009, the high-tech sector had a substantially higher

[9] These six industries are commonly used to designate the high-tech sector in manufacturing (e.g., Brown et al., 2009). There is one large high-tech industry in non-manufacturing (software) which we do not consider.

incidence of negative operating income together with larger losses (e.g., at the 5th percentile). These results, while only suggestive, support our fourth hypothesis.

To summarize Tables 3, 4, and 5, the frequency and very large (absolute) size of negative OPINC values, calls into question a key prediction of the textbook temporary shutdown condition: namely, that firms should cease production rather than fail to cover operating costs. In practice, one might not be surprised to see some *incidence* of negative operating incomes (as exhibited in 2007 and 2010), perhaps simply because firms make forecasting errors. But the *magnitude* of operating losses in late 2008 and early 2009 are extremely large at the 2nd percentile and also substantial at the 5th percentile. These numbers suggest that a few hundred firms in our sample believed that it was optimal to keep operating in the Great Recession while facing losses far larger than what is predicted by the textbook shutdown condition. While not reported in the tables, a large fraction of these firms were relatively small firms,

4.5 The Frequency and Characteristics of Temporary Shutdowns

We now turn to an examination of temporary firm shutdowns. We should be clear about what we mean by a temporary shutdown. The textbook temporary shutdown is the stoppage of production due to a substantial negative shock to demand that, while temporary, is expected to last for a non-trivial amount of time. The perfect example is a recession. Brief work stoppages due to events such as model changeovers, inventory adjustments, or supply disruptions do not match the traditional description of a temporary shutdown and are ignored in our study.[10] Extreme seasonality of demand (e.g., an amusement park) may also lead to temporary shutdowns, but we see such closures as very different from the textbook temporary shutdown: seasonality is perfectly predictable and therefore firms can choose labor practices and human capital investments which fully account for future periods of low demand. In addition, shutting down due to seasonal declines in demand should not have reputational consequences.

Since the firm is the appropriate unit of analysis for measuring the frequency of operating losses, it is sensible to measure the incidence of temporary shutdowns at the firm level to provide comparisons with the incidence of negative OPINC. We note that shutdown information at the plant level is not available for our

[10] There is a literature that looks at supply disruptions and brief temporary shutdowns. For example, Gurara and Tessema (2018) explores how the loss of access to electricity may lead to work stoppage. Such work stoppage is very different from the textbook temporary shutdown and would be impossible to detect without having weekly or even daily production data.

data; that said, most of the small firms in our data appear to have but a single plant.[11] Quarterly data is a reasonable frequency for studying temporary shutdowns in the Great Recession, given that it lasted more than a year during which the decline in demand was severe in many industries.

One of our proxies for a temporary shutdown in period *t* is $SALES_{t-1} > 0$ and $SALES_t = 0$, with $SALES > 0$ by the end of 2011. We refer to this as a zero-sales incidence. Requiring $SALES_t = 0$ as a necessary condition for a temporary shutdown is stringent, but it may be appropriate for large portions of the non-manufacturing sector (e.g., transportation, wholesale, retail, finance and services) where firms cannot cease production at time *t* yet maintain $SALES_t > 0$ by drawing down finished goods inventories.

The possibility of measurement error in sales and the possibility that a manufacturing firm may cease production but still report a low level of positive sales by selling out of finished goods inventories suggests we also use a less restrictive definition of a shutdown. We cannot account for the possible role of finished-goods inventories because this data is not available in Compustat at the quarterly frequency. We therefore construct the ratio $SALES_t/SALES_{t-1}$ and examine all firms where $SALES_t/SALES_{t-1} < X$. We choose $X = 0.20$, or an 80% decline in sales, which we refer to as a "dramatic decline in sales." (As a robustness check, we also consider results for $X = 0.30$ and draw very similar inferences, as discussed below.) By choosing a fairly large value of X, we can be reasonably confident that we have a rough upper bound on the number of firms that potentially engaged in a temporary shutdown. We then examine each of these firms to determine if a temporary shutdown actually occurred.

Table 6 reports information on zero-sales incidences and dramatic declines in sales in the 2008-2009 period. The third column of the table gives the number of zero-sales incidences by quarter. For manufacturing, there are only two such instances; in non-manufacturing, there are only three instances. The last two columns of Table 6 report the number of incidences of a dramatic decline in sales (these values do not include the zero-sales shutdowns in column three). For the 2008-2009 period, there are 9 instances for

[11] We examined on-line information for all manufacturing firms with assets under $40 million. It was not always possible to determine the number of plants, as sometimes there was little information on firms that had been acquired or had failed in recent years. In the majority of cases, however, we could make a determination of whether or not a firm was a single-plant firm. Most firms under roughly $30 million in assets appear to be single-plant firms. This is not surprising, as these firms are often producing high-tech products where the value-to-weight ratio is very large. Some firms did have their production plant abroad and a few firms outsourced production. For firms over $30 million in assets, it became more common for firms to have two or more plants, largely because many of these firms had expanded their product lines through the acquisition of other companies.

manufacturing firms and 15 instances for non-manufacturing firms where sales decline by at least 80%. During this same period, there are 19 instances for manufacturing firms and 29 instances for non-manufacturing firms where sales decline by somewhere between 70% and 80%.

Table 7 lists the set of firms that account for the zero-sales incidences appearing in Table 6. There are four firms because one firm accounts for two separate events. The quarter in which the zero-sales occurrence began is listed in the middle column. We read the annual reports (and other news accounts) to determine the cause of the zero-sales events, which we summarize in the last column. For LKA Gold, the company does in fact discuss shutting down on two separate occasions. The other three firms are holding companies. In the case of BNS Holdings and Xstelos Holdings, zero sales arise because the firm sold all of its assets (and later acquired other assets). Natural Resources USA had a reorganization that also appears to have involved the sale of all its assets. These three firms should not be considered temporary production shutdowns but rather situations where asset holdings temporarily went to zero.

Table 8 lists the set of firms that account for all the incidences of 80% or larger declines in sales during the 2008-2009 period (reported in Table 6). Again, we read the annual reports and news articles to get an understanding of what caused the precipitous sales decline for each firm. We could not find a single case where a firm actually stopped production. Table 8 groups firms according to our understanding of why the firm experienced a sharp sales decline. The first set of firms have precipitous declines in sales in the same quarter in both 2008 and 2009 (and other years as well). It is clear from the data that these companies are extremely seasonal. Dover Motorsports runs few races in cold-weather months; Ambassador Group organizes student travel mainly in the summer months; and RAND Logistics is a bulk shipper on the Great Lakes, which is partially unnavigable during the winter months, leading to sharp declines in shipments. So these three companies account for six of the "dramatic sales declines" in the Great Recession (in Table 6). Even if these firms had zero sales (which they did not), the event would not be a good example of the traditional temporary shutdown, as discussed above.

The next set of companies are in highly cyclical industries, with two firms experiencing sharp declines in sales because they produced inputs (floor tile and furniture) connected to housing construction, which collapsed in the crisis. Also in this set is FreightCar America, a producer of railroad freight cars, the demand for which fell dramatically because of the sharp decline in railroad shipping. Nevertheless, these firms

continued operations in the face of these sharp demand shocks.

The next three companies are involved in oil and gas exploration, which is a highly volatile industry, and gas and oil prices dropped very sharply during the 2008-2009 crisis. The next two companies are young pharmaceutical firms in clinical trials and had no products to sell (and thus could not have shutdown). The next two companies depended on a single customer for most of their sales; that customer was either lost (the case of AEHR Test Systems) or the key customer's customers were lost due to the crisis (Air Transport Services Group). These companies, however, did not shut down. Mecklermedia Corp. downsized in 2009, selling off most of the company. Finally, we could not determine why American Power Group Corp. and Tristar Wellness Solutions had such precipitous declines in sales; there was, however, no discussion in the annual reports suggesting a temporary shutdown.

As a check of robustness, we relax our measure of a "dramatic decline" in sales to $SALES_t/SALES_{t-1} < 0.30$ (instead of 0.20), which generates another 48 observations (reported in Table 6) across manufacturing and non-manufacturing between 2008 and 2009. Once again, we read the annual reports and news articles to get an understanding of what caused the precipitous sales decline for each firm. The pattern is similar to Table 8. For nearly half of the observations, extreme seasonality of demand is the explanation for the sharp sales declines, including multiple amusement parks (e.g., Six Flags) and several companies distributing natural gas. There were also several companies who sold off large portions of the firm and a couple of companies in highly cyclical industries that were severely impacted by the Great Recession (e.g., lumber companies). The most interesting company was Netlist, INC, a DRAM producer who notes in its Annual Report that sales in the 4th quarter of 2008 fell sharply because of a "collapse in DRAM prices." Indeed, DRAM prices fell by more than fifty percent the second half of 2008 (and recovered in late 2009). This very large industry price decline, however, did not cause Netlist to halt production, despite extremely large operating losses.

To summarize, for nearly all the firms with "dramatic declines in sales", the decline is due to seasonality, extreme cyclicality, or loss of a key customer. In no cases did we find a discussion indicating that the "dramatic decline in sales" firms had temporarily shut down in response to these demand shocks. We thus conclude that temporary shutdowns were extremely rare for publicly-traded firms during the Great Recession. With the exception of LKA Gold (in Table 7), we could not find a single example of a temporary

shutdown. We note that many of the firms in our data set are small, single plant operations. Nevertheless, there is no evidence that even small firms (other than LKA Gold) found temporary shutdowns to be a viable option. The lack of temporary shutdowns stand in sharp contrast to the hundreds of firms in our sample experiencing large operating losses during the Great Recession. These findings strongly support our second hypothesis: during the Great Recession, a low shutdown price suggests that temporary shutdowns should have been relatively uncommon.

5. PERMANENT SHUTDOWNS AND SURVIVAL DURING THE GREAT RECESSION

5.1 Permanent shutdowns

A fair question to ask is what about *permanent* exits? If the incidence of negative operating incomes was as high as Table 3 indicates, surely many firms were forced to exit on a permanent basis? We find this to be the case, and the very large numbers of permanent exits stands in sharp contrast to the lack of temporary shutdowns, helping provide context to our main findings in the previous section.

We need to create a new sample to study permanent exits: we simply relax the assumption that firms remain active after 2010, retaining all other assumptions used to create the sample above. We thus capture the incidence of permanent exits across firms that were profitable prior to the Great Recession. Across both manufacturing and non-manufacturing, 27% of the firms that were profitable in 2006 are gone (for good) by the end of 2010.[12] This is an incredible rate of permanent exit for once profitable publicly traded firms, and it stands in stark contrast to the lack of temporary shutdowns during the Great Recession period. So, our results show that when firms are hit with a severe demand shock they almost never respond by temporarily shutting down. Instead, they continue to operate, often incurring severe operating losses, which not surprisingly ultimately proves fatal to a great many of these firms, which supports the first part of our third hypothesis regarding permanent exits.

[12] There are 3585 firms (1549 in manufacturing and 2036 in non-manufacturing) that pass the initial requirements for being included the sample, most notably they must have positive (average) operating income in 2006. Of these 3585 firms, 985 firms (407 in manufacturing and 578 in non-manufacturing) permanently exit the sample by the end of 2010. These permanent exits include both bankruptcies and mergers/acquisitions. Note that one consequence of large operating losses and insufficient internal liquidity is that firms who do not fail outright may be forced to merge with other firms in a stronger financial position.

5.2 Liquidity and survival in the great recession

We turn to an interesting extension of our findings: how did firms suffering severe operating losses survive the Great Recession, given that access to external finance was severely curtailed during this period? The most obvious answer is that they tapped into reserves of internal liquidity. There is a large literature on how cash holdings can be used to buffer investment in times of negative shocks to finance (e.g., see Brown and Petersen, 2015 and the survey in Almeida, Campello, Cunha and Weisbach, 2014). We add to this literature by considering how cash holdings reduced the likelihood of permanent exit for firms suffering negative operating income. As above, we focus on firm exits between the last quarter of 2007 and the end of 2010.

We estimate the following logistic regression:

$$EXIT_i = \alpha_1 NEGOPINC_i + \alpha_2 CASH_i + \alpha_3 NEGOPINC_i * CASH_i + \alpha_4 SIZE_i + \psi_j + e_{it.} \quad (2)$$

In the regression, $EXIT_i$ is a dummy variable equal to 1 if firm *i* exits after the 4th quarter of 2007 and before the end of 2010. $NEGOPINC_i$ is a dummy variable equal to 1 if the firm's average level of OPINC is negative during the crisis period. $CASH_i$ is the cash holdings on the balance sheet of the firm (scaled by assets) at the beginning of 2008. The main variable of interest is the interaction variable NEGOPINC*CASH. Finally, $SIZE_i$ is the log of the firm's total assets at the beginning of 2008. We also include a full set of industry dummy variables defined at the three-digit SIC level (ψ_j).

The results in Table 9 show that firms with negative OPINC have a much higher likelihood of exiting during the Great Recession. All else equal, moving from positive to negative OPINC increases the marginal probability of exit by 0.215. In terms of odds ratios (not reported), a firm with negative OPINC (but no cash reserves) is around five times more likely to exit than a firm with positive OPINC. This is a reminder that incidences of negative operating income are dire events for the firm. However, the estimated marginal effect on the interaction variable is -0.585, indicating that having a cash buffer substantially mitigates the effects of negative OPINC on firm exits, which supports the second part of our third hypothesis regarding permanent exits. Given that the average cash holdings ratio is high among our sampled firms (0.154), the implied impact of cash on reducing the likelihood of exit is substantial for the firms we study, other things held equal such as firm size and industry. In addition, the standard errors are small relative to the magnitude of the effects, indicating that the effects are not only economically substantial, but also statistically different from zero at well above the 1% level. Overall, these results have obvious implications for firms prone to suffering

negative operating incomes.

6. IMPLICATIONS

6.1 Liquidity management

Under the traditional temporary shutdown condition, the ability of firms to shed all variable (or avoidable) costs and shut down provides the firm an important measure of protection: losses are bounded by current sunk fixed capital costs. But this is not true if firms factor in lost future profits from damage to intangible resources: in this case, firms will likely find it optimal to operate with far larger losses, as indicated by our findings from the Great Recession. This evidence provides a new argument for why it is desirable for some firms to maintain large stocks of cash holdings: firms need to be in a position to protect themselves from very large temporary losses because the standard textbook conclusion regarding maximum short-run losses is wrong. Thinking more deeply on this issue, a key source of value of cash holdings is the ability to protect strategic assets during times of depressed demand.

6.2 Vulnerability to bankruptcy

Closely related to the above point on liquidity management, the location of the shutdown price has important implications for firm bankruptcy (and management preparation to avoid bankruptcy). Firm bankruptcies jump sharply during industry downturns, and there was a dramatic increase in the number of bankruptcies in the U.S. in both 2008 and 2009. As noted above, the traditional shutdown condition affords the firm the protection that losses are capped at current capital costs, which suggests that bankruptcies need not jump dramatically during industry downturns. In contrast, if this shutdown condition is wrong for the reasons we have discussed, firms will keep operating when losses are much greater than current capital costs. Notably, it is the firms who are most reliant on strategic intangible assets that should find it optimal to absorb large operating losses rather than temporarily shut down. Such a course of action, however, leaves the resource-based firm vulnerable to bankruptcy if it is not prepared to cover heavy losses for an extended period of time. Indeed, our analysis of permanent exits strongly suggests that large cash holdings were vital to the survival of firms enduring negative operating incomes during the Great Recession.

6.3 Teaching the temporary shutdown decision

Our findings suggest that the traditional temporary shutdown decision is badly flawed. In practice, firms

suffer losses far larger than indicated by the traditional temporary shutdown condition, and temporary firm shutdowns are rare even in dire conditions. In teaching the temporary shutdown condition, it seems vital to explain to managers that the traditional shutdown condition ignores the impact a temporary shutdown has on future profits because of startup costs (e.g., training new workers) and damage to firm relationships with customers and suppliers. The bottom line is that managers should view the temporary shutdown as an uncommon strategy, something that is likely not optimal even during dire times when current operating losses are very large.

6.4 The Areeda-Turner rule for predatory pricing

Areeda and Turner (1975, p. 733) argue that "a price below reasonably anticipated average variable cost should be conclusively presumed unlawful," a rule which is broadly accepted by numerous lower courts in the United States. A principal criticism of the Areeda-Turner rule is that it is too permissive, allowing predators to easily escape prosecution (e.g., Viscusi, Vernon and Harrington, 1995). Our analysis, however, suggests that the Areeda-Turner rule can be too restrictive. Rather than engaging in predation, firms selling at prices below average variable cost are likely optimally responding to a negative demand shock (e.g., seeking to preserve intangible resources).

7. CONCLUSIONS

The temporary shutdown condition is important because it provides guidance to managers on how to operate when facing a serious but temporary downturn in demand. The traditional temporary shutdown condition is arguably badly flawed because it ignores the negative impact a temporary shutdown can have on the firm's future profitability due to diminished competitive advantage, high startup costs (e.g., training new workers), and customer defections to other suppliers. In practice, the true shutdown price, together with the lower bound on operating losses, is likely well below what is indicated by the traditional shutdown condition.

We provide the first broad empirical investigation of the temporary shutdown decision. Specifically, using quarterly panel data on publicly traded firms, we explore the frequency and size of operating losses, as well as the incidence of temporary shutdowns, during the Great Recession. The frequency of negative operating incomes jumps dramatically in the Great Recession, with a very large fraction of firms reporting negative operating incomes in the 4th quarter of 2008 and the 1st quarter of 2009. Furthermore, for many

firms, the magnitude of operating losses (relative to assets) is very large. In addition, temporary firm shutdowns are exceedingly rare. These findings strongly suggest that the traditional shutdown condition is seriously flawed and that temporary shutdowns are rarely optimal for modern corporations, even during periods of sharp reduction in firm demand.

Our study suggests several unanswered questions for future research, and some of these unanswered questions point to the limitations of our study. We have focused on publicly traded firms because of our desire to have broad coverage and the ability to readily dig into the exact reasons why some firms report extremely large declines in sales. It would, however, also be desirable to analyze the temporary shutdown decision of private companies. Another limitation is that we do not have direct measures of the size of intangible resources such as firm-specific investment in human capital. Theory predicts that firms with the largest investments per worker should be willing to incur the largest operating losses during downturns; we believe that investigating this prediction with the appropriate data would be an important addition to the literature. A final limitation of our study is that it explores only firms in the U.S.; it would be valuable to explore the frequency of negative operating income and temporary shutdowns in other (non-U.S.) institutional environments.

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Appendix

The accounting definition of operating income

Operating income (OPINC) equals net sales less operating costs. Net sales are equal to gross sales (the amount of actual billings to customers for regular sales during the period) reduced by cash discounts, traded discounts and returned sales. Operating costs consist of cost of goods sold (COGS) plus selling and general administrative expenses (SGA).

The three basic elements of COGS are direct materials, direct labor, and indirect labor. Production line workers are typically categorized as direct labor while supervisors are likely to be classified as indirect labor. COGS includes such avoidable costs as freight-in expenses, raw materials, energy, wages of production workers, and some overhead labor such as supervisors.

COMPUSTAT describes SGA as "all commercial expenses of operation (but not directly related to production) incurred in the regular course of business pertaining to the securing of operating income." Common expenses include freight-out (shipping), commissions, advertising and research and development and some salary expenses. We view advertising expenses as a current period avoidable expense. The marketing literature typically finds "no carryover effects of advertising beyond one quarter" (e.g., Lillien, Kotler and Moorthy, 1992). In contrast, since R&D is viewed as an investment, we make an adjustment as described below.

Table Legend

Table 1. Distribution of firm size in 2006.

Table 2. Aggregate income statement for sampled firms in 2006.

Table 3. Distribution of operating income during the Great Recession.

Table 4. Distribution of operating income during the Great Recession: Adjust for R&D.

Table 5. Distribution of operating income during the Great Recession: High-tech industries.

Table 6. Incidences of Zero Sales and Dramatic Sales Declines in the Great Recession.

Table 7. Firms with temporary zero sales in 2008-2009.

Table 8. Firms with 80% or larger sales declines in 2008-2009.

Table 9. Logistic regressions on probability of exit in the Great Recession.

Table 1. Distribution of firm size in 2006

		Percentiles				
		2nd	5th	10th	25th	50th
Panel A. Full sample						
Firms	2600					
Total assets		6.658	15.098	35.038	142.968	667.952
Sales		1.874	4.762	10.104	39.722	153.698
Panel B. Manufacturing						
Firms	1142					
Total assets		4.996	13.131	30.501	109.934	481.275
Sales		1.736	3.949	8.801	31.684	121.848
Panel C. Non-manufacturing						
Firms	1458					
Total assets		8.752	18.754	42.989	187.357	812.797
Sales		2.041	5.717	11.874	46.366	188.482

The data is from Compustat. Values are in millions of 2006 dollars.

Table 2. Aggregate income statement for sampled firms in 2006

	Manufacturing	Non-manufacturing
Sales	1.0000	1.0000
-Cost of goods sold (COGS)	0.6746	0.7107
-Selling & General Administrative expenses (SGA)	0.1685	0.1330
Operating Income (OPINC)	0.1553	0.1564
-Depreciation and amortization	0.0439	0.0509
-Interest expense	0.0173	0.0231
+/-Non operating revenues/expenses	0.0124	0.0096
+/-Special items	-0.0044	-0.0068
=Pre-tax income	0.1022	0.0851
+/-Minority interest	0.0011	0.0016
-Income taxes	0.0293	0.0285
=Income before extraordinary items	0.0717	0.0551
-Preferred dividends	0.0001	0.0003
=Income before extraordinary items and common dividends	0.0716	0.0548
+/-Extraordinary items and discontinued operations	0.0090	0.0022
=Net income	0.0807	0.0572

The aggregate income statement is constructed from the fourth quarter of 2006 using data from Compustat. All values are expressed as a proportion of sales.

Table 3. Distribution of operating income during the Great Recession

Year	Quarter	Fraction negative opinc	Percentiles of OPINC/Assets			
			2nd	5th	10th	50th
Panel A: Manufacturing						
2007	1	0.075	-0.024	-0.007	0.005	0.032
2007	2	0.076	-0.027	-0.007	0.007	0.036
2007	3	0.052	-0.011	0.000	0.009	0.036
2007	4	0.082	-0.029	-0.012	0.005	0.034
2008	1	0.108	-0.041	-0.017	-0.001	0.030
2008	2	0.109	-0.036	-0.018	-0.002	0.032
2008	3	0.096	-0.046	-0.015	0.001	0.032
2008	4	0.183	-0.087	-0.042	-0.018	0.023
2009	1	0.254	-0.067	-0.041	-0.024	0.018
2009	2	0.188	-0.061	-0.036	-0.016	0.024
2009	3	0.133	-0.047	-0.021	-0.007	0.028
2009	4	0.124	-0.054	-0.028	-0.006	0.029
2010	1	0.123	-0.049	-0.022	-0.003	0.029
2010	2	0.091	-0.045	-0.016	0.002	0.034
2010	3	0.087	-0.052	-0.014	0.003	0.036
2010	4	0.100	-0.061	-0.025	0.000	0.033
Panel B: Non-manufacturing						
2007	1	0.055	-0.015	-0.003	0.009	0.031
2007	2	0.059	-0.028	-0.004	0.009	0.032
2007	3	0.061	-0.025	-0.004	0.009	0.034
2007	4	0.072	-0.038	-0.010	0.007	0.032
2008	1	0.087	-0.037	-0.011	0.001	0.029
2008	2	0.081	-0.041	-0.012	0.005	0.031
2008	3	0.087	-0.042	-0.014	0.003	0.031
2008	4	0.130	-0.139	-0.042	-0.010	0.027
2009	1	0.125	-0.090	-0.032	-0.006	0.025
2009	2	0.085	-0.039	-0.014	0.004	0.026
2009	3	0.078	-0.032	-0.010	0.004	0.028
2009	4	0.091	-0.046	-0.014	0.002	0.029
2010	1	0.098	-0.036	-0.011	0.001	0.028
2010	2	0.071	-0.026	-0.005	0.007	0.029
2010	3	0.070	-0.034	-0.008	0.005	0.031
2010	4	0.079	-0.039	-0.012	0.005	0.030

The data is from Compustat. Manufacturing industries have SIC codes 2000-3999.

Table 4. Distribution of operating income during the Great Recession: Adjust for R&D

Year	Quarter	Fraction negative opinc	Percentiles of OPINC/Assets			
			2nd	5th	10th	50th
Panel A: Manufacturing						
2008	1	0.069	-0.026	-0.007	0.006	0.037
2008	2	0.073	-0.027	-0.009	0.007	0.041
2008	3	0.069	-0.029	-0.006	0.009	0.040
2008	4	0.120	-0.057	-0.027	-0.007	0.034
2009	1	0.165	-0.045	-0.027	-0.011	0.025
2009	2	0.121	-0.046	-0.019	-0.005	0.031
2009	3	0.084	-0.026	-0.009	0.003	0.035
2009	4	0.087	-0.035	-0.011	0.003	0.040
Panel B: Non-manufacturing						
2008	1	0.078	-0.029	-0.009	0.005	0.031
2008	2	0.072	-0.037	-0.010	0.008	0.033
2008	3	0.075	-0.036	-0.012	0.005	0.033
2008	4	0.123	-0.138	-0.036	-0.008	0.029
2009	1	0.115	-0.081	-0.028	-0.005	0.027
2009	2	0.078	-0.035	-0.010	0.005	0.028
2009	3	0.071	-0.031	-0.008	0.005	0.030
2009	4	0.088	-0.045	-0.013	0.003	0.031

The data is from Compustat. Manufacturing industries have SIC codes 2000-3999.

Table 5. Distribution of operating income during the Great Recession: High-tech industries

Year	Quarter	Fraction negative opinc	Percentiles of OPINC/Assets			
			2nd	5th	10th	50th
Panel A: High-tech manufacturing						
2008	1	0.154	-0.060	-0.028	-0.015	0.027
2008	2	0.135	-0.053	-0.027	-0.010	0.029
2008	3	0.103	-0.061	-0.024	-0.002	0.030
2008	4	0.211	-0.079	-0.049	-0.023	0.021
2009	1	0.319	-0.082	-0.048	-0.033	0.015
2009	2	0.230	-0.073	-0.052	-0.028	0.021
2009	3	0.188	-0.077	-0.036	-0.012	0.026
2009	4	0.134	-0.081	-0.033	-0.008	0.029
Panel B: All other manufacturing						
2008	1	0.080	-0.027	-0.009	0.004	0.032
2008	2	0.092	-0.034	-0.012	0.002	0.034
2008	3	0.090	-0.034	-0.012	0.003	0.033
2008	4	0.166	-0.087	-0.037	-0.015	0.024
2009	1	0.217	-0.058	-0.035	-0.018	0.019
2009	2	0.162	-0.046	-0.025	-0.011	0.026
2009	3	0.099	-0.036	-0.014	0.000	0.031
2009	4	0.115	-0.045	-0.025	-0.004	0.029

The data is from Compustat. High-tech industries have three-digit SIC codes 283, 357, 366, 367, 382, and 384.

Table 6. Incidences of Zero Sales and Dramatic Sales Declines in the Great Recession

Year	Quarter	Zero-sales Incidences	Dramatic Sales Declines (Δsales < 80%)	Dramatic Sales Declines (70% < Δsales < 80%)
Panel A: Manufacturing				
2007	1	1	3	2
2007	2	0	1	0
2007	3	0	0	0
2007	4	0	3	0
2008	1	0	2	5
2008	2	0	0	1
2008	3	0	0	0
2008	4	0	1	4
2009	1	1	3	3
2009	2	0	1	2
2009	3	0	2	2
2009	4	1	0	2
2010	1	1	2	4
2010	2	1	0	0
2010	3	0	0	0
2010	4	0	1	2
Panel B: Non-manufacturing				
2007	1	0	3	5
2007	2	0	2	1
2007	3	0	0	3
2007	4	0	4	3
2008	1	0	1	1
2008	2	0	1	2
2008	3	0	0	2
2008	4	0	3	4
2009	1	2	5	8
2009	2	0	1	5
2009	3	1	1	2
2009	4	0	3	5
2010	1	0	5	3
2010	2	1	0	6
2010	3	0	0	3
2010	4	0	3	5

The data is from Compustat.

Table 7. Firms with temporary zero sales in 2008-2009

Firm	Quarter	Explanation
LKA Gold	2009 (Q1, Q3)	Small gold mining company; reports of shutdowns
Natural Resources USA	2009 (Q1)	Reorganization of holding company
BNS Holdings	2009 (Q4)	Holding company; sold all assets
Xstelos Holdings	2009 (Q1)	Holding company; sold all assets

Table 8. Firms with 80% or larger sales declines in 2008-2009

Firm	Quarter	Explanation
Highly seasonal firms		
Dover Motorsports	Q4 each year	Owns several auto racing circuits
Ambassadors Group	Q4 each year	Student travel company (summer main season)
RAND Logistics, Inc	Q1 each year	Bulk shipping on Great Lakes
Highly cyclical firms		
American Biltrite, Inc	2009 (Q2)	Housing inputs (floor tile)
Jennifer Convertibles, Inc	2009 (Q3)	Housing inputs (furniture)
FreightCar America	2009 (Q1)	Builds Railroad Freight Cars
Oil and gas exploration		
Venoco, Inc	2009 (Q2)	Volatile production (and large price swings)
Legacy Reserves, LP	2009 (Q1, Q4)	Volatile production (and large price swings)
Geopetro Resources Co.	2008 (Q4)	Volatile production (and large price swings)
Young pharmaceutical firms		
Pharmaseet, Inc	2009 (Q3)	Clinical trials (no products)
Biosante Pharmaceuticals	2008 (Q1); 2009 (Q1, Q3)	Clinical trials (no products)
Issues with major customer		
AEHR Test Systems	2009 (Q1)	Lost customer accounting for 80% sales
Air Transport Services Group	2008 (Q2)	Main customer lost most of it's sales
Corporate downsizing		
Mecklermedia Corp	2009 (Q1)	Sold off most of company
Unknown		
American Power Group	2009 (Q1)	
Tristar Wellness Solutions	2008 (Q1, Q4)	

Table 9. Logistic regressions on probability of exit in the Great Recession

Partial derivatives of probabilities (P[Exit = 1])		
Variable	Marginal effect	Standard error
NEGOPINC	0.215[a]	0.030
CASH	-0.093[b]	0.046
NEGOPINC*CASH	-0.585[a]	0.121
SIZE	-0.025[a]	0.004
Observations	2,650	
LR chi2 (p-value)	270.97 (0.000)	
Pseudo R^2	0.108	

The regression also includes industry fixed effects defined at the 3-digit SIC level. The superscripts [a] and [b] indicate statistical significance at the 1% and 5% levels, respectively. The data is from Compustat.