

# Scarring Recessions and Credit Constraints: Evidence from Colombian Plant Dynamics

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## Abstract

Using a rich dataset of Colombian manufacturing establishments between 1995 and 2004, we illustrate potential scarring effects of recessions operating through credit constraints. In contrast with the view that recessions are times of cleansing, we find that financially constrained businesses might be forced to exit the market during recessions even if they are highly productive. For instance, during recessions, an establishment with TFP at the lowest 10th percentile but not facing credit constraints has the same exit probability as a constrained plant with TFP at least as high as the 39th percentile. The gap is much smaller during expansions. The contribution of the paper is threefold. First, it evaluates the role played by credit constraints in explaining firm dynamics throughout the business cycle, a phenomenon the literature has dealt with mostly from a theoretical standpoint. Second, it sheds light on the implied long-run consequences of exits induced by lack of credit on efficiency. Finally, it is the only study we know of providing direct evidence to judge the empirical merits of proposed micro foundations behind the long-run consequences of crises.

## 1 Introduction

In the midst of the recent global financial crisis, economists have been once again forced to think about the long-run consequences of short-run fluctuations. Official projections that economic activity in many developed countries will remain depressed and unemployment will remain high for several years to come

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have bolstered interest in studying the potential long-run damage caused by recessions.<sup>1</sup>

The literature has dealt with long-run implications of recessions from two complementary perspectives: the analysis of aggregate trends and the analysis of firm behavior. Focusing on the dynamics of unemployment, employment, and economic activity, studies within the former approach have found empirical evidence suggesting that recessions leave permanent or long-lived scars. Meanwhile, the micro perspective has focused on how short-run fluctuations affect firm dynamics, and mostly from a theoretical standpoint. While early contributions to this branch of the literature pointed at aggregate long-run gains from recessions, the apparent contradictions between this view and the macro evidence have motivated recent work on crisis-times firm dynamics with potential negative aggregate consequences.

Our paper falls within the latter category of studies. We study the possibility that recessions shed some efficient producers out of the market, specifically those constrained by scant access to capital markets. We approach this question by characterizing the empirical relationship between exit, credit constraints, productivity, and the business cycle, using a rich dataset on Colombian manufacturing establishments. The exit of highly productive businesses has negative implications for aggregate efficiency. It may also explain long-lived effects of recessions on aggregate productivity if fixed entry costs make re-entry unlikely.<sup>2</sup> This is particularly relevant for Emerging Markets, where repeated exposure to financial crises may have led, on average, to lower aggregate productivity levels.

The fact that recessions bring long run costs to the economy has been established by a tradition of studies focusing on macro aggregates. Blanchard and Summers (1986, 1987) made the case that short run fluctuations in the unemployment rate left long lived scars on the natural unemployment rate in Europe during the 80s. They suggested an insider-outsider story: once a worker loses HIS job, remaining employed workers raise their wage targets, preventing the unemployed from getting their jobs back. Ball (1997) elaborated on these ideas showing that NAIRU increases during the 1980s in Europe were mainly the consequence of tight monetary policies aimed at reducing inflation. The implication was that, contrary to conventional wisdom, demand contractions alter natural unemployment rates. More recently, Ball and Hofstetter (2011) take a different look at hysteresis in unemployment by examining large changes in Latin American and Caribbean unemployment rates. They find that large increases in trend unemployment are always associated with deep recessions caused by demand contractions.

Another set of macro-level studies has focused specifically on financial crises. Abiad et al. (2009) and the WEO group (2009) look at the medium term output dynamics following banking crises. They find that, on average, although output growth does return to the pre-crisis rate, the output level remains below the pre-crisis trend in the medium run. Findings by Cerra and Saxena (2008)

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<sup>1</sup>For instance, the US' Congressional Budget Office is projecting that unemployment in the US will only return to its long run level by 2015.

<sup>2</sup>Dickens (1982), for instance, points at permanent productivity losses from recessions.

indicate that recoveries are weak when output contractions are associated with a financial crisis, leading to significantly lower growth in the aftermath of the associated recession. These findings suggest that lack of access to financing may be one of the mechanisms preventing output recovery to its prior trend.<sup>3</sup>

Meanwhile, analyses of consequences of recessions on the basis of firm behavior focused for a long time on the notion that recessions may have “cleansing” effects. This tradition can be traced back to the Schumpeterian idea of creative destruction. Caballero and Hammour (1994), for instance, characterize the potential of recessions as times of cleansing, on the basis that recessions may push firms exhibiting outdated technologies out of the market.<sup>4</sup> A related strand of the literature notes that during recessions there is a reduction of the opportunity cost of engaging in activities that will contribute to future productivity gains, thus providing another potentially positive consequence of recessions (e.g., Cooper and Haltiwanger, 1993; Aghion and Saint Paul, 1998).

The literature suggesting that crises have “cleansing” effects in general assumes perfect financial markets. The difficulties faced by some producers in accessing credit may partly explain the apparent contradictions between the macro empirical literature and the cleansing effects literature. Results in the macro literature pointing at financial crisis as particularly costly in the long run would be consistent with this mechanism. More tightly related, Barlevy (2003) argues that credit constraints might lead to an inefficient allocation of resources, particularly in bad times. From an empirical standpoint, firms with relatively high productivity, but which in fact are credit-constrained, may be forced out of the market during recessions. This is the mechanism that we study.

More recently, Ouyang (2009) suggests another channel to explain potential scarring effects of recessions. Based on the observation that recessions disproportionately affect young businesses, her insight is that recessions force the exit of young businesses and thus prevent them from reaching their full potential. In her calibrations, this scarring effect of recessions dominates their cleansing effect. The mechanism we propose may be closely related to Ouyang’s, since credit constraints may be one of the reasons forcing young businesses out of the market during bad times.<sup>5</sup> A related piece of evidence is provided by Aghion, Fally and Scarpetta (2007), who find that, conditional on survival, credit access helps new firms expand.

Our paper contributes to this literature by explicitly evaluating the role

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<sup>3</sup>Calvo, Izquierdo and Talvi (2006) provide one rationale for this behavior by showing that output collapses following financial crises are accompanied by a protracted decline in investment. The fact that investment ratios remain well below pre-crisis levels has long-run growth implications consistent with the fact that countries that have faced financial crises do not recover to pre-crisis trends.

<sup>4</sup>Similar results are reported in Mortensen and Pissarides (1994), among others.

<sup>5</sup>Our paper is also related to Aghion et al. (2009). There, firms invest both in short run projects and in long-term growth enhancing projects. Countercyclical fiscal policy increases the size of the market during recessions, thus boosting the latter investment, particularly so in industries relying more on external financing. Even though their focus is on the impact of countercyclical fiscal policy, their model suggests that, in absence of such policy efforts, recessions affect investment in long-term growth-enhancing projects in credit constrained sectors.

played by credit constraints in explaining firm dynamics throughout the business cycle, and by shedding light on the implied long-run consequences on efficiency. It is also the only study we know of providing micro evidence to judge the empirical merits of proposed micro foundations behind the long-run consequences of crises.

We find that credit-constrained but nevertheless high productivity units may be forced out of the market during recessions, while other less productive but unconstrained units may survive. In particular, exit probabilities for more constrained plants are significantly higher (both in a statistical and an economic sense) vis-à-vis those for unconstrained plants, throughout the set of estimations outlined below. We estimate that, during downturns, the exit probability of an unconstrained establishment with TFP at the 10th percentile is matched by that of a constrained establishment with TFP ranging from the 39th to the 86th percentile, depending on the specification. The survival premium for unconstrained businesses is much smaller during expansions. These findings indeed suggest potential scarring effects of recessions stemming from credit market imperfections. In this sense, our results are a step toward reconciling the micro and macro evidence regarding the long-run consequences of recessions. Moreover, they also add to the evidence linking credit constraints and economic development.

The rest of the paper is organized as follows. Section 2 presents our theoretical background and describes the empirical model that we estimate. Section 3 describes the data. Sections 4 and 5 present our main results and some extensions, followed by concluding remarks in section 6.

## 2 Conceptual framework

A central issue in our paper is the possibility that profitable productive units are forced out of the market by imperfect access to credit. This may be the case if, for instance, credit is necessary to finance costs that need to be incurred before operation yields revenues, or to cover temporary losses when a firm faces a bad shock of a temporary nature. This section sketches a simple extension of the Melitz (2003) model of firm dynamics that delivers this prediction.

Our extension first introduces credit in a way that is innocuous for Melitz' results, and then introduces a financial friction from where our key predictions are derived. It is worth pointing that credit contracts in our model take very specific forms, that keep the model analytically tractable but are admittedly restrictive. Caggese and Cuñat (2011) present a different extension of the Melitz model that introduces financial frictions in a more flexible way. While their focus is on the impact of financial frictions for exports, their model does imply that, as we argue, financial frictions may push efficient producers out of the market. Their model could thus also be used to motivate our focus on how credit constraints affect the probability that a firm exits the market. Our simpler model, in any case, does offer some value added beyond Caggese and Cuñat's, as we show that credit constraints that are heterogeneous across firms may imply that some unconstrained firms may survive despite being less profitable

than some exiting constrained counterparts.

## 2.1 Melitz' model

We begin with the Melitz (2003) model of firm dynamics. We first simply present the original model, keeping Melitz' original notation, for comparability and so that the reader can refer to that original paper for further details. We then add our extensions. We focus our exposition of the original model and our extensions on the exit decision, which is the central interest of the paper, but the appendix solves for the equilibrium with and without financial frictions.

The Melitz' environment is one with monopolistic competition. In each period, there is a pool of potential entrants deciding whether to pay a fixed entry cost  $f_e$ . After paying  $f_e$ , an entering firm receives a draw of productivity,  $\phi$ , from a probability density  $g(\phi)$  with associated cumulative probability function  $G(\phi)$ . The firm uses this information to decide whether to go on to actually produce, or to rather exit the market.

A firm uses labor,  $l$ , to produce output, with a technology  $q(\phi) = (l - f)\phi$ , where  $f$  is a fixed cost of production. Per period profits depend solely on the firm's productivity level and, once the firm chooses its optimal level of labor, they can be written as :  $\pi(\phi) = \frac{r(\phi)}{\sigma} - f$ , where  $r(\phi)$  is revenue of a firm with productivity  $\phi$ , and  $\sigma (> 1)$  is the elasticity of substitution between varieties in consumers' utility. So, the firm chooses to not pay  $f$ , and thus exit the market, if the observed  $\phi$  is such that  $\pi(\phi) < 0$ . Since  $\phi$  is constant across periods for any given firm, a firm that decides to produce in its first period will not choose to exit in any future period.

Given these assumptions, a firm decides to exit if its productivity falls below a cutoff level,  $\phi < \phi^*$ , where the cutoff is given by  $\pi(\phi^*) = 0$ . This is the implication of the model we focus on in this paper, so we leave the rest of the model's solution for the Appendix. Aggregate productivity,  $\bar{\phi}$ , is calculated from the distribution of productivity truncated at  $\phi^*$ .

Up to this point, we have simply reproduced a fraction of the Melitz model for the closed economy. We now proceed in two steps: we first modify the model to introduce credit in an explicit manner, but with no credit imperfections, and then introduce credit market imperfections. To be able to model credit in the model without having to move into a fully dynamic setting (Melitz' assumptions are such that each period can be analyzed separately) we will model credit in a very specific way that requires narrowing the range of values  $f_e$  can take to  $f_e < f$ . As stated above, Caggese and Cuñat's (2011) model shows that similar results can be derived under less restrictive assumptions.

## 2.2 Credit in Melitz' model

One question the model does not tackle is how are the upfront fixed costs of entering, and those of producing each period, paid for. Since we are interested in the effects of restricted access to credit, we will introduce credit by assuming that, at the beginning of a firm's life, all of these costs are paid for with credit.

This will have no effect of the results under our initial assumption that credit markets are perfect.

In particular, suppose that potential entrants have no equity, so that entering firms pay fixed costs of entry using credit extended by a bank (the "entry debt contract"). The entry debt contract stipulates that the firm pays the bank back in the first period, after its revenue is realized. Moreover, in each period the per period fixed costs of production for those firms that after entering decide to stay in the market are paid for before actually producing, with new credit ("per period debt contracts"). Per period debt contracts are paid back once revenue is realized, and they must be paid in the order in which they were agreed upon and as soon as revenue is realized. Revenue collateralizes debts, so creditors can seize it when it becomes available. Our assumptions are such that any given credit contract can be liquidated, at the latest, one period ahead. We further assume that, when revenues exceed what the firm has to pay to its creditors, those profits are paid as dividends so that we don't need to keep track of increasing equity. To simplify notation, we will re-define  $f_e$  and  $f$  to be the fixed costs including the interest payments the firm is supposed to make to the respective bank.

With these assumptions, we have that:

1. It is still the case that an entering firm will decide to exit the market, without starting to produce, if its productivity is such that  $\pi(\phi) < 0$ , and stay producing otherwise. An exiting firm defaults on the debt it contracted to pay the fixed entry cost.

2. The firm that does not exit liquidates the entry debt contract in the first period of its life.

3. If  $r(\phi) > f_e + f$ , then the firm also fully pays the first period's per period debt contract upon receiving that period's revenues. Otherwise, it liquidates that contract in the second period, using revenue from that period. To produce that second-period revenue, it enters into a second period per period debt contract. After that period's revenue is realized, the outstanding debt from the first period is liquidated, and the remaining revenues are used to paid the second period debt and, if possible, to distribute profits. If revenues cannot fully pay for the second period debt, then the outstanding amount is paid for with third-period revenues, and so on.

It is still optimal for a firm with  $r(\phi) > f(> f_e)$  to stay in the market. (Other results of the model, captured by equations (6) to (8) in the Appendix, also remain unaltered under this condition.) This is because we have assumed that credit markets are perfect, so that these firms can access the loans they need to enter the market or operate.

Though we do not model banks explicitly, it is indeed optimal for banks to make the loans, even though it is known that some firms will decide to exit without producing, thus defaulting on their entry debt contracts. For an entering firm, the free entry condition implies that its expected profits are enough to pay the bank back the agreed  $f_e$ . After entry, only firms that know their revenues will fully cover  $f$  request a per period debt contract. The interest rates the banks charge for these loans, which we take as exogenous here, cover the risks

they incur: that an entering firm turns out to not be profitable and thus closes down without producing, or that a profitable firm is hit by an exogenous "death shock". So, in the aggregate banks do not incur losses. Since all loans can be paid for at most one period later, and banks are allowed to seize the revenues of firms to which they have extended loans for up to two periods, they are assured they will recover the funds —except for the two contingencies mentioned above, that they cover against through interest rates.

### 2.3 Introducing financial frictions

We now introduce a financial friction that affects a fraction of the firms in the economy. In particular, for some firms it will be the case that: 1. banks can only seize revenue in the period in which the contract was signed, not in future ones, and 2. any given bank does not extend a new loan to a firm that has not fully liquidated previous debt contracts with the bank. Whether a given firm falls in this category of constrained firms is also revealed, together with the firm's productivity level, once the entry cost is paid for. The probability that a firm is revealed constrained is given by  $\alpha$ . For firms that are revealed constrained, banks will only be willing to enter into a per period debt contract in the first period if the firm's productivity is such that its revenues are enough to fully liquidate both the entry debt contract and the per period debt contract within the period. That is, if  $\pi(\phi) = r(\phi) - f \geq f_e$ . The implication is that the survival productivity cutoff for constrained firms,  $\phi_c^*$  is now given by  $\pi(\phi_c^*) = f_e$ . Unconstrained firms, meanwhile, only exit if their per period profits are negative (as in the baseline model). There is, then, a survival cutoff productivity defined by  $\pi(\phi_u^*) = 0$  for unconstrained firms. The appendix shows that:

$$\phi_u^* = \phi_u^*(\phi_c^*) = \phi_c^* \left( \frac{f}{f + f_e} \right)^{\frac{1}{\sigma-1}} < \phi_c^* \quad (1)$$

The central implication of the introduction of this type of financial friction is the coexistence of two different survival productivity cutoffs, one for unconstrained firms and a larger one for the constrained. Financially constrained firms thus choose to exit the market with greater probability than financially unconstrained ones. Moreover, financially constrained firms with productivity in the  $(\phi_u^*, \phi_c^*)$  range exit the market despite being more productive than some unconstrained firms that are able to survive.

This result is the focus of this paper. It implies that credit constrained firms may be forced out of the market even if more productive than surviving unconstrained firms. This is a source of inefficiency, as it ceases to be the case that it is the least efficient producers that exit. Our model cannot deal with the question of whether this asymmetry is starker during recessions. This is because, to keep the analysis static (as in Melitz' original formulation) we have assumed firms face no shocks after they have entered and learned their initial levels of productivity and access to credit markets. However, it should be generally the case that negative shocks that reduce firms' cash flow (such as negative aggre-

gate demand shocks) make it more likely that a firm has to resort to credit to pay for its fixed costs of operation. In this sense, the problems arising from imperfect credit access that our model has pointed at should be more acute during recessions. In fact, Caggese and Cuñat (2011) present a model of firm dynamics under financial frictions that similarly relies on Melitz' model, but where firms are subject to shocks between one period and the next. Their simulations indeed show that credit constraints only bind when firms face negative shocks. Their model also delivers the prediction that financial frictions push otherwise profitable firms out of the market, though financial frictions in their framework affect all firms.

### 3 Empirical model

Our main purpose is to explore empirically how the probability of a plant exiting the market is affected by credit constraints, and how this relationship is altered by the business cycle. We start from the canonical model without financial frictions, in which a plant exits the market if the present discounted value of its net profits falls below zero. The probability that a plant exits the market is then the probability that its expected gross profits fall below fixed operating costs. Assuming that those fixed costs follow a normal distribution, we represent the probability that a plant exits by a Probit model. In particular, we follow Eslava et al. (2009) in modeling the decision to exit in a given period  $t$  as a function of the determinants of current and future profitability known by the plant at time  $t$ .<sup>6</sup>

Starting from these basic insights, we estimate a model where the probability of exiting the market at time  $t$  is a function of current total factor productivity (TFP), a measure of the size of the plant, sector and year dummies, and a measure of the extent to which the firm is subject to credit constraints. The link between TFP and exit is crucial in aggregate terms: exit improves aggregate TFP if, as predicted by theory, it is the least productive units that exit the market. Given this and our central interest in the effect of credit constraints, we focus not only on how those constraints affect exit directly, but also on whether or not the effect varies depending on how productive the plant is. This also responds to the basic motivation that we expect credit constraints to impact exit especially for technologically disadvantaged units, which may need credit to acquire the technology necessary to stay profitable.

Our basic empirical specification can be written as:

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<sup>6</sup>Using even more detailed information on Colombian manufacturing establishments, Eslava et al. (2009) estimate a model of plant exit as a function of a detailed list of plant-level market fundamentals. The plant characteristics they consider include TFP, demand shocks, input prices, and demand elasticities, as well as measures of trade regulations faced by the establishment. They find all of the market fundamentals they consider to matter for exit. Furthermore, they find the effect of market fundamentals to be enhanced by market reforms undertaken at the beginning of the nineties.



$$\Pr(x_{jt} = 1) = \Pr\left(\sum_s \alpha_s d_s + \sum_{t=t_0}^T \alpha_t d_t + \beta * size_{jt} + \gamma * tfp_{jt} + \sigma * constrained_j \leq u_{jt}\right), \quad (2)$$

where  $x_{jt}$  takes a value of 1 if plant  $j$  exits in year  $t$ , and zero otherwise;  $d_s$  are a set of three-digit sector dummies;  $d_t$  are a set of year dummies;  $size$  and  $tfp$  are measures of plant characteristics that should affect  $j$ 's chances of surviving;  $constrained_j$  is a measure of credit constraints facing plant  $j$  (defined later); and  $u_{jt}$  is a normally-distributed error term.

A word is necessary on the inclusion of size as a control in this model. In the absence of a full set of measures of fundamental determinants of exit, size has been found to affect the probability that an establishment exits the market: smaller plants are more likely to exit (e.g., Gibson and Harris (1996), Bernard and Jensen (2007) and Baggs (2005)). One possible reason for this finding is that size acts as a proxy for plant characteristics that theory suggests may affect exit even in the absence of frictions; for instance, idiosyncratic demand shocks are one determinant of both a plant's scale and its chances of surviving. It is under this rationale that we include size as a control in our empirical model. However, it may also be the case that size is a proxy for the effect of frictions that may affect smaller units more directly. One of those frictions is precisely credit constraints: smaller productive units are expected to be more financially constrained than others (e.g., Gertler and Gilchrist, 1994, use firm size to proxy for capital market access). Thus, size may capture part of the effects of being constrained that we are trying to measure. To that extent, our estimate of  $\sigma$  captures the effect of being constrained beyond that of size, and may be a lower bound for the overall effect of credit constraints on a firm's chances of exiting the market. In some of the extensions of our model, we focus directly on size categories as proxies for credit constraints.

Note that we are also interested in evaluating the potentially differential effects of credit constraints in good vs. bad times (defined later), and for more and less productive establishments. Given the non-linear nature of model (2), the effect of our measure of credit constraints on the probability that plant  $j$  exits depends on the phase of the cycle and on  $tfp$ , even without including explicit interaction terms between credit constraints and these elements of the model. More specifically, the marginal effect of a measure of credit constraints on the probability that plant  $j$  exits in period  $t$  is:<sup>7</sup>

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<sup>7</sup>Though this derivation is exact only for continuous proxies of credit constraints, the insight that the point in time at which the effect is evaluated matters also applies for discrete proxies of constraints.

$$\frac{\partial \Pr(x_{jt} = 1)}{\partial \text{constraine } d_j} = f\left(\sum_s \alpha_s d_s + \sum_{t=t_0}^T \alpha_t d_t + \beta^* \text{size}_{jt} + \gamma^* \text{tfp}_{jt} + \sigma^* \text{constraine } d_j\right) \sigma \quad (3)$$

where  $f$  is the normal density function. This marginal effect clearly depends on the specific values at which the other covariates, including the time dummies and  $\text{tfp}$ , are evaluated. We obtain the marginal effect of our measure for constraints during good times by setting the year dummies for bad years at zero, and the rest of the year dummies at the fraction of total good-times observations represented by each particular year.<sup>8</sup> We obtain the bad-times marginal effect in an analogous manner. Similarly, we examine the effect of credit constraints for productive units with different levels of  $\text{tfp}$  by evaluating  $\text{tfp}$  at different levels. Note that, with this approach, the difference in the marginal effect of credit constraints between good and bad times, and between more and less productive plants, comes from the density of at-risk plants at each phase of the cycle.

Alternatively, one can also consider the potentially asymmetric effect of good vs. bad times more directly, by adding to the specification interaction terms between the measure of credit constraints and the phase of the cycle. Interactions with  $\text{tfp}$  can also be considered to assess how the effects of credit constraints depend on a plant's technological stance. Our second baseline model, summarized in equation (4), follows this approach. Here, we allow the effect of credit constraints to vary directly with good and bad times, and with  $\text{tfp}$ . In contrast with equation (2), this variation would occur even with a fixed density of at-risk units.

Our model with direct changes in the effect of credit constraints over the phase of the cycle can be written as follows:

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<sup>8</sup>Equivalently, we set the term :

$$\sum_{t=t_0}^T \alpha_t d_t$$

at a weighted average of the estimated  $\alpha_t$ , where bad years are given a weight of zero and each good year is given a weight corresponding to the fraction of good-time observations represented by that specific year.

$$\Pr(x_{jt} = 1) = \Pr \left( \begin{array}{l} \sum_s \alpha_s d_s + \beta * size_{jt} + \gamma * tfp_{jt} \\ + \sigma_1 d_{constrained, Bad\_t} + \sigma_2 d_{unc, Bad\_t} + \sigma_3 d_{unc, Good\_t} \\ + tfp_{jt} * (\kappa_1 d_{constrained, Bad\_t} + \kappa_2 d_{unc, Bad\_t} + \kappa_3 d_{unc, Good\_t}) \end{array} \leq u_{jt} \right) \quad (4)$$

Here,  $d_{constrained, Bad\_t}$  is a dummy with a value of 1 for observations that correspond to constrained firms in bad years,  $d_{unc, Bad\_t}$  is a similar dummy for plants in unconstrained firms during bad times, and  $d_{unc, Good\_t}$  is a dummy for plants in unconstrained firms during good times. Our left out category is that of plants for constrained firms during good times.<sup>9</sup>

## 4 Data

The data we use come from two separate sources. First, we use plant-level information on exit, inputs and outputs, constructed from the Annual Manufacturing Survey by Eslava et al. (2004, 2009, and 2010). Eslava et al. (2004), generate a consistent panel for 1982-1998. They have recently generated a version of the panel updated to 2004, which is the one we use. We provide below a brief description of these data (see Eslava et al, 2004 for details). A second source of information we use is the Superintendencia de Sociedades database (Supersociedades for short), which reports balance-sheet information for large firms for the period 1995-2005.

The Annual Manufacturing Survey (AMS) covers all manufacturing establishments with 10 or more employees. In the panel we use, the values of output and materials were deflated using very rich plant-level data on prices.<sup>10</sup> The panel also reports consumption of energy in physical units, hour-adjusted employment, and a measure of the capital stock constructed through perpetual inventory methods. We use the above listed measures of physical quantities to construct measures of TFP as log residuals from a KLEM production function. In calculating TFP, we use factor elasticities previously estimated by the same authors through an instrumental variable approach (Eslava et al. 2004). Following Eslava et al. (2009), we flag a plant as exiting in year  $t$  if the plant reported positive production in year  $t$  but not in year  $t+1$ .<sup>11</sup>

<sup>9</sup>This model does not include time dummies, which would exhibit multicollinearity with our dummies for plants in good and bad times.

<sup>10</sup>We do not have direct access to the plant level prices used by Eslava et al., but to the deflated quantities they calculated. Given this restriction, we do not fully replicate the very detailed exit model estimated by Eslava et al. (2009) for the period 1982-1998. This is the reason why we use size as a proxy for market fundamentals other than TFP, such as demand shocks.

<sup>11</sup>For the purposes of interpreting our results, it is important to keep in mind that a business

Since the measures of physical quantities we use have been calculated with plant level prices as deflators, our measure of TFP should capture physical efficiency, or TFPQ as it has been called lately in the literature (Hsieh and Klenow, 2009; Foster et al., 2008). In absence of plant level prices to deflate output and inputs, the productivity residual (termed TFPR in absence of plant level deflators) mixes efficiency with idiosyncratic price differences. A plant with high TFPR can be a low TFPQ but high price unit. Being able to properly measure TFPQ is important in our context because while the survival of high efficiency plants is enhancing in terms of aggregate performance (arguably also in terms of welfare), the same is not necessarily true for the survival of high price plants.

As for the Supersociedades data, Supersociedades is the government office in charge of overseeing corporations. The unit of observation is the firm. The criteria for including a firm in the database have changed over time. All firms with assets or income over a certain level (20,000 or 30,000 monthly minimum wages, depending on the period) are included in the dataset, as are branches of multinationals. Up to 2006, smaller firms were included if an inspected corporation owned more than 20% of the firm. Firms that do not satisfy these criteria may also be included if the Superintendent decides so, and the number and characteristics of firms included under this criterion varies substantially over time. As a result of the changing criteria for inclusion, some firms appear intermittently, while others (the largest) are included every year.

We use financial information from the Supersociedades dataset to construct our baseline measures of credit constraints. Following Hsieh and Parker (2007), we proxy for financial constraints with a dummy variable that separates firms according to their coefficients of correlation between a firm's net operating profits (a proxy for cash flows) and its purchases of fixed capital over the period for which we have Supersociedades' information. In constructing the coefficients of correlation between investment and net profits we use information on net profits from Supersociedades, and information on purchases of fixed assets (machinery, equipment, and buildings) from AMS data, adding up all plants that belong to the same firm. Our baseline measure of constraints is a dummy that takes the value of one for firms for which this correlation coefficient is in the upper third of the distribution, and zero for those firms in the lowest two thirds (as in Hsieh and Parker, 2007). All of the establishments owned by a given firm are assigned the same value for this dummy. Notice that, while we study plant-level exit, we measure firm-level constraints. The changing language we use below refers to this contrast: while we discuss plant exit and plant performance, when discussing credit constraints we refer to the firm, rather than the plant.

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may stop production without ceasing to exist legally. Since a unit that stops production but remains legally alive can resume production without having to re-pay part of the costs involved in entering, the costs associated with the type of exit we look at are a lower bound for the actual costs of exit, especially in the long run. On the other hand, ceasing production is a necessary step to actually closing a business. The type of exit we examine is thus likely highly correlated with actual plant closures. This is particularly true for the larger firms, for which the fixed costs of keeping the plant open are likely very high.

The rationale behind our proxy for credit constraints is straightforward: a firm that faces higher financial constraints is bound to rely more heavily on internal funding to finance investments, and should thus show positive and relatively high correlation between investment and net profits. The correlation could actually be negative in the absence of financing constraints, if businesses want to undertake investments precisely during bad times, when the opportunity costs of dedicating resources and effort to improving technology are lower (Cooper and Haltiwanger, 1993; Aghion and Saint Paul, 1998). Given these arguments, identifying financial constraints from the extent to which investment correlates with cash flows is a standard practice. It is however, also one subject to large controversy, so we now discuss in detail the advantages and limitations of our approach.<sup>12</sup>

It is first important to highlight that our strategy separates firms into more and less constrained, rather than indicating that some firms are constrained and others are not.<sup>13</sup> Moreover, our measure of credit constraints is constant over time. Separating plants into more and less constrained, as opposed to using a continuous measure of the intensity of constraints, helps us mitigate concerns about endogeneity in our estimations. Credit constraints can be endogenous to the performance prospects of a firm: if one of a firm's establishments is at risk of closing, this may affect the firm's access to funding in financial markets. They can also be endogenous to the state of the economy, with banks being less wary of extending credit when the times are bad. However, our measure of constraints is not affected by either a firm or the economy facing bad times, given that it does not vary over time. Moreover, marginal differences in exit probability across plants may imply changes in our measure of constraints only for plants that are close to the threshold we use to divide the constrained from the unconstrained.

Another shortcoming of measuring credit constraints by the correlation between investment in cash flows, as noted in Schiantarelli (1996), is that current cash flows (or in our case current net profits) may be correlated with future profitability. To that extent, even unconstrained firms may rationally respond to increases in cash flows by undertaking additional investments. This has two implications for our results. First, it provides an additional reason to prefer the dichotomous constant measure that simply divides plants between more and less constrained, rather than trying to precisely measure the depth of constraints and their variations over time. By using a measure that is constant over time, we eliminate the possibility of a plant moving from our constrained group to our unconstrained group as a result of having observed a positive shock to profitability that the plant deemed permanent, but that may in fact be uncorrelated with financial constraints. Second, we have a noisy measure of constraints, potentially implying an attenuation bias in our estimation of the effects of credit constraints. This latter implication must be kept in mind when interpreting our results.

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<sup>12</sup>See Schiantarelli (1996) and Hubbard (1998) for discussions.

<sup>13</sup>Despite this, we refer throughout the paper to "constrained" and "unconstrained" firms, for ease of exposition.

Other approaches to measuring financial constraints have been suggested. One is to separate businesses according to size, where the underlying argument is that large firms are unlikely to face constraints. We conduct some exercises based on this approach. In samples with large numbers of publicly traded companies, one could treat these as less constrained than the rest. This is not feasible in our case, however: less than 50 companies in the manufacturing sector were listed in the stock market during our sample period. Petersen and Rajan (1995) suggest the use of trade credit as a measure of credit constraints, by making use of trade credit the producer forgoes significant discounts for early payment. Casual evidence suggests, however, early payment does not make an important difference for Colombian manufacturers. Thus, in the Colombian case, producers generally make full use of the trade credit lines they are extended. In sum, while the investment-cash flows correlation approach is far from perfect as a measure of credit constraints, it is also the best available alternative for our case. By using it to classify firms into more and less-constrained over the whole period, rather than to measure the intensity of constraints precisely, we hope to mitigate some of the concerns raised in the literature.

Given the above description, our baseline estimations are restricted to plants in the AMS that belong to firms for which there is information in the Super-sociedades database. Our baseline dataset thus covers plants of relatively large manufacturing firms for the period 1995-2004.<sup>14</sup> The period covers the deepest recession faced by the country since the 1930s, which occurred at the end of the 1990s. Despite the mentioned data restrictions, in this baseline scenario we have 8,497 firm-year observations. Descriptive statistics for this baseline sample are presented in Table 1, for the pooled sample (Panel A) and splitting it into observations from constrained and unconstrained firms (Panels B and C). It is interesting to see that constrained firms are on average smaller in size and less productive, and that they exhibit considerably larger exit rates: 2.3% vs. 1.6%. Notice also that less than 2% of the plants in this sample exit the market over the relevant period; the low rate of failure is related to the focus on large firms. This focus is also reflected in an average plant size of 85. Focusing on large establishments has shortcomings we discuss in further sections. It also has one advantage, however. Given our definition of exit, we may flag as exiting a plant that has not left the market but has contracted beyond the 10-employees threshold imposed by the Annual Manufacturing Survey. This is an unlikely event for a large plant. However, later in the paper we explore extensions of our model that allow for the coverage of smaller units.

Finally, we split our sample into good and bad years in terms of economic activity. We use seven different criteria, from previous literature, to distinguish bad times (recessions or crises) from good times. We define bad times as years for which at least four of the seven criteria coincide in flagging a recession. The seven criteria look at GDP, GDP growth, and the occurrence of banking crises or Sudden Stops. Details are explained in the appendix. Table 2 summarizes

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<sup>14</sup>Though both sources have information for 2004, 2003 is the last year for which we can say if a plant survives another year or not.

the results. We end up identifying one period of recession (1998-2001), corresponding to the crisis period in Emerging Markets following the collapse of Russia.

## 5 Baseline results

### 5.1 Estimating equation (2)

Using the baseline dataset described above, we estimate model (2). Our focus is on how the exit probability depends on our credit constraint measure after controlling for TFP, size and time and sector effects. As mentioned before, the credit measure is a dummy variable equal to one for firms in the upper third of the investment-net profits correlation distribution. Estimation results for this specification are reported in Table 3, Panel A.

As will be the case throughout the paper, we find that smaller and less productive plants face larger chances of exiting the market. This is consistent with previous findings in the literature (e.g., Eslava et al., 2009; Bernard and Jensen, 2007). Our focus here, however, is on the role played by credit constraints, and their potentially asymmetric effects in good vis-a-vis bad times. We obtain a positive and significant coefficient for our credit constraint dummy: other things equal, establishments belonging to credit constrained firms are more likely to exit.

Given the nonlinear nature of the model we are estimating, the actual effect of credit constraints varies across observations, depending on plants’ characteristics and aggregate shocks (see, for instance, the expression for the marginal effect of constraints in equation (3)). We are particularly interested in the inter-relationships between credit constraints, phases of the economic cycle, and productivity. To assess these inter-relationships, we present our results in a variety of ways—which we will replicate throughout the paper for different specifications—. First, Panel B of Table 3 presents predicted exit rates, based on our estimation of equation 2, for constrained and unconstrained plants during different phases of the cycle. Furthermore, these exit rates are evaluated at different levels of plants’ TFP: the mean, the 10th percentile, and the 90th percentile of the TFP distribution (we call the two latter “low” and “high” TFP, respectively). In turn, Panel C shows differences between the exit rates presented in Panel B, and evaluates their statistical significance. Figure 1 evaluates the effects presented in Table 3 in a more general way, by looking at predicted exit rates over the full relevant range of TFP. Panel A of Figure 1 presents these exit rates for constrained and unconstrained plants during normal times, while Panel B differentiates between good and bad times.<sup>15</sup> Panel C presents differences in exit rates between constrained and unconstrained plants, separately for good times and for bad times—that is, the grey (black) line in

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<sup>15</sup>The evaluation of effects in good vs. bad times is explained in footnote 9. Exit rates during “normal times” are estimated by setting each of the time dummies at the fraction of total observations represented by the respective year.

panel C is the difference between the solid and dotted grey (black) lines in panel B—. Meanwhile, Panel D presents exit hazard differences between good and bad times, separately for constrained and unconstrained plants—the solid (dotted) line in panel D is the difference between the black and grey solid (dotted) lines in panel B—.

A first approximation at our question points at sizeable effects of constraints on firm dynamics. The gain in the probability of survival from being unconstrained is close to 0.4% for the average TFP firm during normal times (Panel A, Figure 1). This gain is large compared with the 1.8% exit rate for this sample; it is in fact equivalent to a 22 % increase in the probability of exit.

Panel A of Figure 1 further shows that the role of constraints is even more important for firms with low productivity. For a firm at the 10th percentile of the TFP productivity distribution, the gain from being unconstrained is 0.8%, compared to the 0.4% gain for the average TFP plant. The decreasing effect of constraints along the TFP distribution suggests low chances that the highest productivity units are forced out of the market due to constraints. However, we show below that the differential exit rates between the constrained and the unconstrained are sufficiently marked at crucial sections of the distribution to imply inefficient exit. Furthermore, the finding that the effect of constraints decreases markedly with TFP is not constant across the different specifications and samples we evaluate below.

We are obviously also interested in understanding the role of the business cycle in this story (Panel B in Table 3 and Figure 1). We find that exit is more likely during recessions for plants of all productivity levels, supporting the view that downturns are times of increased restructuring. Moreover, we continue to find a positive and significant effect of belonging to a firm in the upper third of the constraints distribution: firms that we flag as more constrained face a larger chance of exiting the market, at any level of TFP. Most interesting, this effect is larger during bad times. In particular, moving from unconstrained to constrained status during bad times increases the probability of exiting the market by 0.6% for the average TFP plant (or a 40% rise in the probability of exit); the figure drops to 0.3% during good times.<sup>16</sup> Differences between constrained and unconstrained units decrease with increases in TFP, for both good and bad times (Panel C, Figure 1). Similarly, the negative effect of bad times on firms' chances to survive diminishes as TFP goes up.<sup>17</sup>

These findings imply an aggregate inefficiency coming from financial constraints: constrained firms exit the market even when they are sufficiently productive to have survived in the absence of constraints. Put differently: some firms exit while being more productive than others that survive, solely because they face financial constraints. Though the positive effect of financial constraints on exit decreases with the level of TFP in this estimation, we shall see below

<sup>16</sup>Both differences are significant at the 10 percent level (Panel C, Table 3).

<sup>17</sup>Others have also found that negative shocks affect more productive firms less strongly, in different contexts. For instance, Bloom et al. (2009) find that an increase in imports from China affects the chances of survival by European firms, but that the effect decreases with firms' TFP.



that more flexible specifications show differences in this pattern over the cycle.

## 5.2 Estimating the model with interactions (Equation (4))

The model in Table 3, although non-linear by nature given the use of a Probit specification, ignores the possibility that the effect of credit constraints depends on the phase of the economic cycle, even for a given density of at-risk plants. In this subsection, we look at a more flexible model with explicit interactions (Equation (4)). The model includes interaction terms between TFP, the credit constraints dummy, and good and bad times' dummies. The results from this estimation are presented in Table 4 and Figure 2 (following the same formats and conventions of Table 3 and Figure 1, respectively.)

Looking at normal times (Panel A, Figure 2) we continue to find that credit constraints increase the probability that a plant exits. We also find that this effect varies considerably over the cycle and over the TFP distribution. For the average plant in terms of TFP, the increase in exit probability from being constrained is 0.9% in bad times and 0.2% in good times (Panel B, Table 4). Moreover, it is statistically significant only in bad times. The flip side of this relationship is that bad times hit constrained firms much harder than unconstrained firms. The difference is starker than in the results from the less flexible specification in Equation (2). For an average TFP firm, moving from good to bad times increases the exit rate by 0.7% for unconstrained firms. The figure is twice as large for constrained firms. The increased probability of exiting during recessions relative to good times is statistically significant for both constrained and unconstrained firms.

Compared with the model without interactions, the quantitative differences are evident. For instance, note the large difference between good and bad times in terms of the survival probability premium for unconstrained firms (Panel C in Table 4 and Figure 2). For an average TFP plant, this premium is over four times larger in bad times compared to good times (0.9% vs. 0.2%). In contrast, in the model presented in Table 3, the bad times premium only doubled that of good times. These results suggest that the direct interaction between credit constraints and the business cycle should not be ignored. Both the role of credit constraints and that of the business cycle are boosted in this less restrictive specification.

To grasp the potential scarring effects of recessions implied by these findings, we build the following counterfactual. We take the predicted exit probability of an unconstrained firm with low TFP (10th percentile), and estimate what TFP level would leave the exit probability unaltered if the firm were to move from unconstrained to constrained status. Results suggest that, during bad times, TFP would have to increase to that of the 39th percentile in order to leave the exit rate unchanged. The same statistic for good times is a move in TFP to the 17th percentile. In other words, during bad times, moving from unconstrained to constrained status has a quantitative effect equivalent to reducing productivity from the 39th percentile to the 10th. We see this as strong evidence of scarring effects of recessions operating through financial constraints.

The results reported so far on the effects of credit constraints are a lower bound of their actual role, for two reasons. On the one hand, the regressions are controlling for the size of the firms, a variable that has been often used to capture credit constraints. That is, some of the effect we want to estimate is actually captured through the firm size variable. On the other hand, we are focusing on a sample of large firms, i.e., a sample with firms that are all likely to have some degree of access to credit. We address concerns arising from these issues in the next section.

## 6 Expanding the Dataset

As discussed above, one problem with our measure of credit constraints is that it is based on balance-sheet information, available only for large firms. As such, we are identifying the effects we are interested in out of the limited variation in the degree of credit access across large firms. Moreover, we are focusing on a set of establishments that are probably not the key target group when interested in the effects of credit constraints. This is a problem that plagues the literature on financial constraints, since balance-sheet information is generally available only for large firms, in some cases even only those firms that are publicly listed.

Given the central interest on smaller establishments, we try to overcome this limitation in this section by bringing in smaller establishments present in the Annual Manufacturing Survey but not in the Supersociedades data. We overcome the difficulty of not having access to financial information for the firms that own these establishments by using information on the size of the establishments. Our departing point, consistent with several papers in the literature (e.g., Gertler and Gilchrist, 1994) is that small units are more likely to be credit constrained. We thus add to our previous sample all establishments belonging to firms that do not report to Supersociedades, and code small establishments as being constrained. It is important to highlight that these establishments are brought in while also keeping in all of the units present in our original sample; for the latter, we keep the initial definition of constraints. We define “being small” as having 20 or less employees on average over the period for which we observe the establishment in the AMS.<sup>18</sup> The rationale for proceeding in this manner is to define as constrained only establishments for which we are fairly sure their level of access to credit is much lower than that of plants owned by firms that we code as unconstrained. Note, for instance, that the 20 employees mark is significantly lower than the 25th percentile in terms of employment for the baseline sample (even lower when compared to the subsample of unconstrained plants in the baseline, see Table 1). For completeness, we also add firms in the AMS with more than 20 employees that do not report to Supersociedades, but consider them to be unconstrained given that they surpass the 20

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<sup>18</sup>Establishments with 20 or less employees are close to a third of the firms for which we have Annual Manufacturing Survey information. Our measure of labor comes from the Annual Manufacturing Survey, so we only have employment in the manufacturing activities of the unit.

employee cut-off point.<sup>19</sup>

Descriptive statistics of our variables of interest for this expanded sample are shown in Table 5. Note that the time frame used here is the same as in the previous section. The exit rate for this expanded sample is above 7%, a much higher rate when compared to the less than 2% exit rate for the larger firms in our baseline case. It is also worth pointing at the reduction in the average number of employees in this sample (approximately 29 employees), compared to our baseline (approximately 85 employees). Average TFP has also gone down, though only by 7 log points.

Table 6 presents results of re-estimating equation (4)—our preferred specification—for this expanded sample.<sup>20</sup> As before, Panel A reports regression results and Panel B selected predicted exit rates. While most results are qualitatively analogous to those discussed above, the role of credit constraints appears larger. For a plant with average TFP, moving from unconstrained to constrained status during bad times doubles the exit rate, from 4.2% to 8.6% (Panel B, Table 6). This absolute increase of 4.4 percentage points is much larger than the corresponding increase in the chances of exiting during good times: only 2 percentage points (Panel C of the same Table). Moreover these survival premiums for unconstrained plants are much larger than those observed in Table 4, and they are significant at the 1% level. Interestingly, there is no significant increase in the probability of exit of unconstrained plants between good and bad times, whereas there is a significant increase (of 2.2 percentage points) in the probability of exit for constrained plants. It thus seems that unconstrained plants are better able to cope with shocks than constrained plants. Both the large survival premium for constrained plants and the very marked differences between bad and good times are replicated at all levels of TFP (Panels C and D, Figure 3.)<sup>21</sup>

Our findings in this section imply even larger potential costs of financial constraints, in terms of aggregate efficiency, than our findings in previous sections. Consider, for instance, the counterfactual of the previous section: for an unconstrained but low TFP (10th percentile) firm, we estimate the exit hazard and then calculate the increase in TFP necessary to leave this hazard unaltered when switching to constrained status. The result is a move to the 86th percentile of TFP during bad times and to the 42nd percentile in good times. Even more worrisome in terms of aggregate efficiency, however, is how the combined effect of constraints and recessions varies over the distribution of TFP in this sample. While for the Supersociedades sample the bad times increase in a constrained plant's probability of exiting was much lower for high productivity plants than for low probability ones, the same is not the case for this sample with smaller plants. High productivity constrained plants face a similar increase in their

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<sup>19</sup>This assumption, if anything, should play against finding effects of credit constraints, as there is a risk that some of these firms could indeed be constrained.

<sup>20</sup>As noted before, added plants are split into constrained plants with a size of 20 employees or less, and unconstrained plants with a size of more than 20 employees.

<sup>21</sup>Moreover, formal tests of the differences in exit probabilities between good and bad times for constrained vis-à-vis unconstrained firms measured at average TFP levels are significant at the 1% level. In other words, differences in the curves shown in Panel D are significant at the 1% level.

chances of exiting during a recession than low productivity plants (Panel B, Table 6). This suggests that, contrary to the case of large firms, small units have a harder time insuring against the effects of credit constraints by becoming highly productive.

Despite these revealing results, a word of caution is warranted. Credit constraints are much more loosely measured in Table 6 than in our baseline exercises. Moreover, by adding size to the definition of constraints, the current extension partially mixes in an effect that we were separating in our previous exercises. Adding these facts to the change in sample, it is clear that results in this section are not fully comparable to those in Tables 3 and 4. It is still interesting to point out that, after adding the smaller and lower-TFP plants that we consider in this sample, we find increased potentially scarring effects of recessions.

## 7 Concluding remarks

Financial frictions play a crucial role in explaining how firms adjust to short term macroeconomic fluctuations. We find, for the case of Colombia, that potential scarring effects of recessions are likely boosted by credit market imperfections. While we find throughout a family of empirical specifications that low productivity firms are the most likely to exit the market, there are further differences across firm exit probabilities explained by their degree of access to financial markets. Particularly in bad times, constrained firms exhibit a larger exit probability than unconstrained firms with similar market fundamentals. With a reduced sample but an accurate measure of credit constraints (Table 4), this difference is nearly 0.9 percentage points for the average TFP plant, equivalent to a 60 percent increase in the exit rate (the exit rate for unconstrained firms in bad times is 1.5%). In good times, this difference is cut to 0.2 percent, or a 25% increase in the exit rate. Alternatively, in a specification with a larger sample but incorporating a looser credit constraint definition, this difference is 4.4 percentage points in bad times-or an increase of 105 percent in the exit rate relative to that of unconstrained firms in bad times-and 2 percentage points in good times-or an increase of 46 percent in the exit rate.

Our results point at aggregate TFP losses from recessions. In particular, we show that during a recession, credit constrained units may be forced to leave the market despite being much more productive than some of their surviving but unconstrained counterparts. This has a negative impact on aggregate TFP. Moreover, the losses may translate into long-term scars to the extent that re-entry is unlikely due to high entry costs. In this sense, the evidence we have presented helps reconcile aggregate trends suggesting long-run consequences of short-run fluctuations with theoretical predictions from the firm dynamics literature emphasizing cleansing effects of recessions. In particular, our findings point at a channel where the scarring effects of recessions operate through financial constraints that might leave permanent marks on aggregate TFP levels.

While our paper does not explore the determinants of credit constraints,

it is likely that they are associated with firm size, geographical location, and previous ties with the financial system. Previous studies have in fact pointed at the association between these firm characteristics and lack of access to credit. Some of these associations suggest additional dynamic costs to the economy from the exit of financially credit constrained establishments. In particular, at an aggregate level, the persistence of low levels of financial penetration may be partly explained by the exit of young and small establishments. Exit prevents those establishments from reaching a scale that would allow them wider access to credit. It also truncates their chances of ever establishing a relationship with financial institutions that may prove self-perpetuating, and destroys the value implicit in the still fragile relationships some of the exiting plants may have created with the financial system.

Several policy implications emerge. First, countercyclical policies become more relevant in a world where long-run outcomes are dependent on the cycle. Second, based on our evidence, the role of financial frictions explaining this outcome is quite relevant. Thus, financial reform intended at deepening credit markets might help mitigate the long-run consequences of bad times. Moreover, reducing the frequency of recessionary periods, such as those provoked by international supply-side financial crises that invariably force more firms into credit constraints should be beneficial in terms of increasing average productivity levels. Thus, measures pointing to financial stability are also desirable. More research is needed to enhance our understanding of the consequences of credit constraints, particularly for smaller firms for which financial information is not as readily available as it is for their larger counterparts.

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## APPENDIX

### Model details

It is easy to show that  $\bar{\pi}$ , the average level of productivity, actually equals  $\pi(\bar{\phi})$ . In stationary equilibrium, the  $M$  constant mass of entrants will equal the mass of firms that exit, and free entry will guarantee that the average present discounted value of profits, net of the entry cost, equals zero. It is assumed that, even if a firm does not choose to exit, it is exogenously forced to leave the market with probability  $\delta$ . The equilibrium is characterized by a combination of  $\phi^*$ ,  $\bar{\phi}$ ,  $\bar{\pi} = \pi(\bar{\phi})$ , and  $M$ .

In the version of the model without financial frictions, these four values are derived from the following four conditions :

- Aggregate productivity:

$$\bar{\phi} = \left[ \frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi^{\sigma-1} g(\phi) d\phi \right]^{\frac{1}{\sigma-1}} \quad (5)$$

- Free entry (FE), ensuring that the level of entry drives the expected value of entering to zero:

$$\bar{\pi} (1 - G(\phi^*)) \sum_{t=0}^{\infty} (1 - \delta)^t = f_e \quad (6)$$

- Zero cutoff profits (ZCP), derived from the fact that per period profits for the cutoff firm with  $\phi^*$  will be zero:

$$\begin{aligned} \bar{\pi} &= \frac{r(\bar{\phi})}{\sigma} - f \\ &= \frac{r(\phi^*)}{\sigma} \left( \frac{\bar{\phi}(\phi^*)}{\phi^*} \right)^{\sigma-1} - f \\ &= \frac{f}{\sigma} \left( \frac{\bar{\phi}(\phi^*)}{\phi^*} \right)^{\sigma-1} - f \end{aligned} \quad (7)$$

where the first row uses the fact that  $\bar{\pi} = \pi(\bar{\phi})$  and the first order conditions of the firm's profit maximization problem; the second row uses the fact that under monopolistic competition the ratio of revenues between two firms (in this case firms with  $\bar{\phi}$  and  $\phi^*$ ) is a function of the respective ratio of productivities, with elasticity  $(\sigma - 1)$ ; and the last row uses the zero profit condition for the firm with productivity  $\phi^*$

- Aggregate equilibrium, ensuring that total revenue equals (exogenous) total factor payments  $L$ :

$$L = R = M\bar{r} = M\sigma(\bar{\pi} + f) \quad (8)$$



The last equal sign again makes use of the first order conditions, that ensure that  $\pi = \frac{r}{\sigma} - f$ .

Consider now the case with financial frictions. Since the production technology is not affected by the financial friction, the profit function and the first order conditions of the firm's profit maximization problem are unaffected by the introduction of this friction. Profits for a firm with productivity  $\phi$  can thus still be written as  $\pi(\phi) = \frac{r(\phi)}{\sigma} - f$ . It is, then, the case that:  $r(\phi_u^*) = \sigma f$  and  $r(\phi_c^*) = \sigma(f + f_e)$ . Using this, and the fact that in the monopolistic competition equilibrium  $\frac{r(\phi_1)}{r(\phi_2)} = \left(\frac{\phi_1}{\phi_2}\right)^\sigma$ , we obtain that:

$$\phi_u^* = \phi_u^*(\phi_c^*) = \phi_c^* \left( \frac{f}{f + f_e} \right)^{\frac{1}{\sigma-1}} \quad (9)$$

That is, not only  $\phi_u^* < \phi_c^*$ , but there is a monotonic relationship between the two cutoff levels.

With these elements at hand, we can now characterize how the system of four equilibrium equations (5) to (8) is affected by the introduction of the financial friction:

- Aggregate productivity under financial frictions:

$$\bar{\phi}_{ff} = \left[ \alpha \left( \frac{1}{1 - G(\phi_c^*)} \int_{\phi_c^*} \phi^{\sigma-1} g(\phi) d\phi \right) + (1 - \alpha) \left( \frac{1}{1 - G(\phi_u^*)} \int_{\phi_u^*} \phi^{\sigma-1} g(\phi) d\phi \right) \right]^{\frac{1}{\sigma-1}} \quad (10)$$

- FE<sub>ff</sub>:

$$\bar{\pi} [\alpha (1 - G(\phi_c^*)) + (1 - \alpha) (1 - G(\phi_u^*))] \sum_{t=0}^{\infty} (1 - \delta)^t = f_e \quad (11)$$

- ZCP<sub>ff</sub>:

$$\bar{\pi} = \frac{f}{\sigma} \left( \frac{\bar{\phi}_{ff}(\phi_u^*)}{\phi_u^*} \right)^{\sigma-1} - f \quad (12)$$

where we have taken advantage of equation (1) to write  $\bar{\phi}$ , which depends on both  $\phi_u^*$  and  $\phi_c^*$ , solely as a function of  $\phi_u^*$ .

- Aggregate equilibrium:

$$L = R = M_{ff} \bar{r} = M_{ff} \sigma (\bar{\pi} + f) \quad (13)$$

Making use of these results, the following implications of the introduction of this financial friction can be derived:

1. The introduction of financial frictions makes expected per period profits go up, as a result of the diminished competition implied by the exit of some profitable but credit constrained units. This is proven in the Appendix.

2. The steady state mass of firms goes down. This can be seen from equation (13) and the fact that  $\bar{\pi}$  increases. This implies a loss in welfare from the reduction in the number of varieties consumers can consume.

To see that expected profits go up when financial frictions are introduced, we depict the FE and ZCP conditions in the  $(\phi_u^*, \bar{\pi})$  space, for both the case without financial frictions and that with financial frictions. The case without financial frictions corresponds to the original Melitz model (and is equivalent to the extended model under the assumption that  $\alpha = 0$ ), and is represented by the two solid lines in Figure A. The fact that FE has an increasing slope while that of ZCP is decreasing is demonstrated in Melitz' paper. The intuition for the slope of FE is actually quite evident: higher  $\phi_u^*$  implies a reduced probability of survival after entry, so the expected profits need to be higher to make the net value of entry go back to zero.

The two dotted lines correspond to the case with financial frictions ( $\alpha > 0$ ).  $FE_{ff}$  lies above FE because, for any value of  $\phi_u^*$ ,  $\phi_c^* > \phi_u^*$ . As a result of the implied decrease in the probability of survival after entry, the level of  $\bar{\pi}$  that drives the net value of entry to zero is higher for any level of  $\phi_u^*$ .  $ZCP_{ff}$  also lies above ZCP because, for any given level of  $\phi_u^*$  the level of  $\bar{\phi}$  is now higher (given more strict selection for the constrained firms). It is thus clear that the equilibrium level of  $\bar{\pi}$  is higher in the presence of financial frictions, compared to the case in which these frictions are absent. (The overall effect on the cutoff productivity level for unconstrained firms cannot be determined from this figure).

### Good vs. bad times

We consider seven criteria to separate good from bad times. We list those criteria below. We end up defining bad times as years that satisfy at least three of the seven criteria listed below.

- a. Bad times are years with negative annual per capita GDP growth.
- b. Bad times are years with negative annual GDP growth.
- c. Trough to Peak strategy (e.g. Braun and Larrain): Calculate the cyclical component of GDP with an HP filter. For this, we used GDP data going back at least to 1960 and up to 2008. Calculate the standard deviation of the cyclical component. Identify troughs defined as cases when the cyclical component is more than one standard deviation below zero. Then go back in time until we find a peak, defined as a year when the cyclical component is larger than the two adjacent observations. The recession years (bad times) start one year after the peak and end at the trough.
- d. Bad times are years with at least two consecutive quarters with negative GDP growth.
- e. Bad times are Sudden Stop years. We use the definition by Calvo, Izquierdo and Mejia (2008). Systemic Sudden Stops are phases defined by the following conditions: (i) There is at least one observation where the year-on-year fall in capital flows lies at least two standard deviations below its sample mean; (ii) A Sudden Stop starts the first time the annual change in capital flows falls one standard deviation below the mean (iii) The Sudden Stop phase ends once the annual change in capital flows exceeds one standard deviation below

its sample mean.

f. Bad times are years with banking crises. The starting dates of banking crises are years when at least one of the following conditions holds: there are extensive depositor runs; the government takes emergency measures to protect the banking system, such as bank holidays or nationalization; the fiscal cost of the bank rescue is at least 2 percent of GDP; non-performing loans reach at least 10 percent of bank assets. Following these definitions Dell'Ariccia Detragiache and Rajan, (2008) find a banking crisis inception date in 1999 for Colombia. They propose a banking crisis dummy taking the value of 1 for the crisis inception year and the two following years, under the hypothesis that the real effects of the crisis take some time to disappear.

g. Bad times are years where the cyclical component of GDP is one standard deviation below zero. The cyclical component is calculated as in c.

**Table 1. Descriptive Statistics****Panel A. Baseline case (1995-2004)**

	(1)	(2)	(3)	(7)	(8)	(9)
	N	Mean	S.D.	P25	P50	P75
Exit Dummy	8,497	0.0182	0.1338	0	0	0
TFP	8,497	1.3057	0.9205	0.7518	1.2265	1.7613
Dummy for Constrained Firms	8,497	0.3029	0.4596	0	0	1
Log Labor	8,497	4.4428	1.1622	3.7612	4.4543	5.1930

**Panel B. Baseline case for constrained plants (1995-2004)**

	(1)	(2)	(3)	(7)	(8)	(9)
	N	Mean	S.D.	P25	P50	P75
Exit Dummy	2,574	0.0233	0.1509	0	0	0
TFP	2,574	1.2854	0.9971	0.7313	1.2009	1.7429
Log Labor	2,574	4.3922	1.1307	3.6889	4.4427	5.1417

**Panel C. Baseline case for unconstrained plants (1995-2004)**

	(1)	(2)	(3)	(7)	(8)	(9)
	N	Mean	S.D.	P25	P50	P75
Exit Dummy	5,923	0.0160	0.1256	0	0	0
TFP	5,923	1.3145	0.8851	0.7632	1.2385	1.7654
Log Labor	5,923	4.4648	1.1751	3.8067	4.4659	5.2149

**Note:** Dummy for Constrained Firms is 1 if the plant is in the upper third of the correlation between investment and net profits.

**Table 2. Years of Recession (Bad times)**

Negative annual per capita GDP growth	1998, 1999, 2001
Negative annual per capita GDP growth	1999
Trough to peak strategy	1998, 1999, 2000, 2001, 2002
Two or more quarters with negative GDP growth	1998, 1999
Sudden Stop	1998, 1999, 2000
Banking Crisis	1999, 2000, 2001
Years with cyclical component below 1 std deviation	1999, 2000, 2001, 2002, 2003, 2004
Years that satisfy at least four criteria	1998, 1999, 2000, 2001

**Table 3. Exit Probability as a Function of Credit Constraints**

Panel A. Probit Estimations		Panel B. Predicted Exit Rates			
			Low TFP	Mean TFP	High TFP
TFP	-0.2751*** (0.0472)	Unconstrained, bad times	2.9% (0.4%)***	1.5% (0.2%)***	0.7% (0.2%)***
Log Labor (t-1)	-0.1680*** (0.0331)	Constrained, bad times	4.0% (0.7%)***	2.1% (0.4%)***	1.0% (0.3%)***
Dummy for Constrained	0.1432** (0.0727)	Unconstrained, good times	1.3% (0.3%)***	0.6% (0.2%)***	0.3% (0.1%)***
Constant	-1.5548*** (0.2694)	Constrained, good times	1.9% (0.4%)***	0.9% (0.2%)***	0.4% (0.1%)***
Sector Effects	YES	<b>Panel C. Exit rate differentials (Mean TFP)</b>			
Time Effects	YES	Constrained - Unconst. (Bad times)	0.6% (0.3%)*		
Observations	8,497	Constrained - Unconst. (Good times)	0.3% (0.2%)*		
		Bad - Good times (Unconstrained)	0.9% (0.2%)***		
		Bad - Good times (Constrained)	1.2% (0.3%)***		

**Notes:** \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, robust standard errors in parentheses. Dummy for Constrained Firms is 1 if the plant is in the upper third of the correlation between investment and net profits. Low and High TFP are respectively the TFP values at the 10th and 90th percentile of the plant TFP distribution.

**Table 4. Interacted Model**

Panel A. Probit Estimations		Panel B. Predicted Exit Rates			
TFP	-0.2547*** (0.0787)		Low TFP	Mean TFP	High TFP
Log Labor (t-1)	-0.1723*** (0.0323)	Unconstrained, bad times	2.9% (0.5%)***	1.5% (0.3%)***	0.7% (0.3%)**
Unconstrained* Bad Times	0.1661 (0.1502)	Constrained, bad times	4.5% (1.0%)***	2.4% (0.5%)***	1.2% (0.5%)**
Constrained * Bad Times	0.3622** (0.1692)	Unconstrained, good times	1.7% (0.3%)***	0.8% (0.2%)***	0.4% (0.1%)***
Unconstrained * Good Times	-0.0615 (0.1467)	Constrained, good times	2.0% (0.5%)***	1.0% (0.3%)***	0.5% (0.2%)**
TFP * Unconstrained * Bad Times	-0.0197 (0.1154)				
TFP * Constrained * Bad Times	(0.0153) (0.1293)				
TFP * Unconstrained * Good Times	-0.0139 (0.1069)				
Constant	-1.0828*** (0.1852)				
Sector Effects	YES				
Time Effects	NO				
Observations	8497				
		<b>Panel C. Exit rate differentials (Mean TFP)</b>			
		Constrained - Unconst. (Bad times)		0.9% (0.5%)*	
		Constrained - Unconst. (Good times)		0.2% (0.3%)	
		Bad - Good times (Unconstrained)		0.7% (0.3%)**	
		Bad - Good times (Constrained)		1.4% (0.5%)***	

**Notes:** \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, robust standard errors in parentheses. Dummy for Constrained Firms is 1 if the plant is in the upper third of the correlation between investment and net profits. Low and High TFP are respectively the TFP values at the 10th and 90th percentile of the plant TFP distribution.

**Table 5. Descriptive Statistics for the expanded dataset**

	(1)	(2)	(3)	(7)	(8)	(9)
	N	Mean	S.D.	P25	P50	P75
Exit Dummy	31,024	0.0704	0.2558	0	0	0
TFP	31,024	1.2116	0.9850	0.5927	1.1346	1.7303
Dummy for Constrained Firms	31,024	0.4815	0.4997	0	0	1
Log Labor	31,024	3.3821	1.3172	2.4849	3.2581	4.2485

**Notes:** Dummy for Constrained Firms is 1 if the plant is in the upper third of the correlation between investment and net profits for establishments reporting in AMS as well as in Supersociedades, or if the plant has less than 20 employees. For plants with 20 or more employees reporting in AMS but not in Supersociedades the Dummy for Constrained Firms is zero.



**Table 6. Interacted Model Using the Extended Dataset**

Panel A. Probit Estimations		Panel B. Predicted Exit Rates			
			Low TFP	Mean TFP	High TFP
TFP	-0.1990*** (0.021)	Unconstrained, bad times	6.3%	4.2%	2.6%
Log Labor (t-1)	-0.1809*** (0.011)	Constrained, bad times	(0.5%)*	(0.3%)*	(0.3%)*
Unconstrained* Bad Times	-0.2251*** (0.055)	Unconstrained, good times	11.8%	8.6%	5.8%
Constrained * Bad Times	0.1190*** (0.041)	Constrained, good times	(0.6%)*	(0.4%)*	(0.4%)*
Unconstrained * Good Times	-0.1665*** (0.048)		7.0%	4.3%	2.4%
TFP * Unconstrained * Bad Times	0.0181 (0.039)		(0.5%)*	(0.2%)*	(0.3%)*
TFP * Constrained * Bad Times	0.0334 (0.030)	Constrained - Unconst. (Bad times)		4.4%	
TFP * Unconstrained * Good Times	-0.0164 (0.036)	Constrained - Unconst. (Good times)		(0.5%)*	
Constant	-0.7891*** (0.045)	Bad - Good times (Unconstrained)		2.0%	
Sector Effects	YES	Bad - Good times (Constrained)		(0.4%)*	
Time Effects	NO			-0.2%	
Observations	31,024			(0.3%)	
				2.2%	
				(0.4%)*	

**Panel C. Exit rate differentials (Mean TFP)**

**Notes:** \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, robust standard errors in parentheses. Dummy for Constrained Firms is 1 if the plant is in the upper third of the correlation between investment and net profits for establishments reporting in AMS as well as in Supersociedades, or if the plant has less than 20 employees for establishments only reporting in AMS. For plants with 20 of more employees reporting in AMS but not in Supersociedades the Dummy for Constrained Firms is zero.

Figure 1: Baseline model

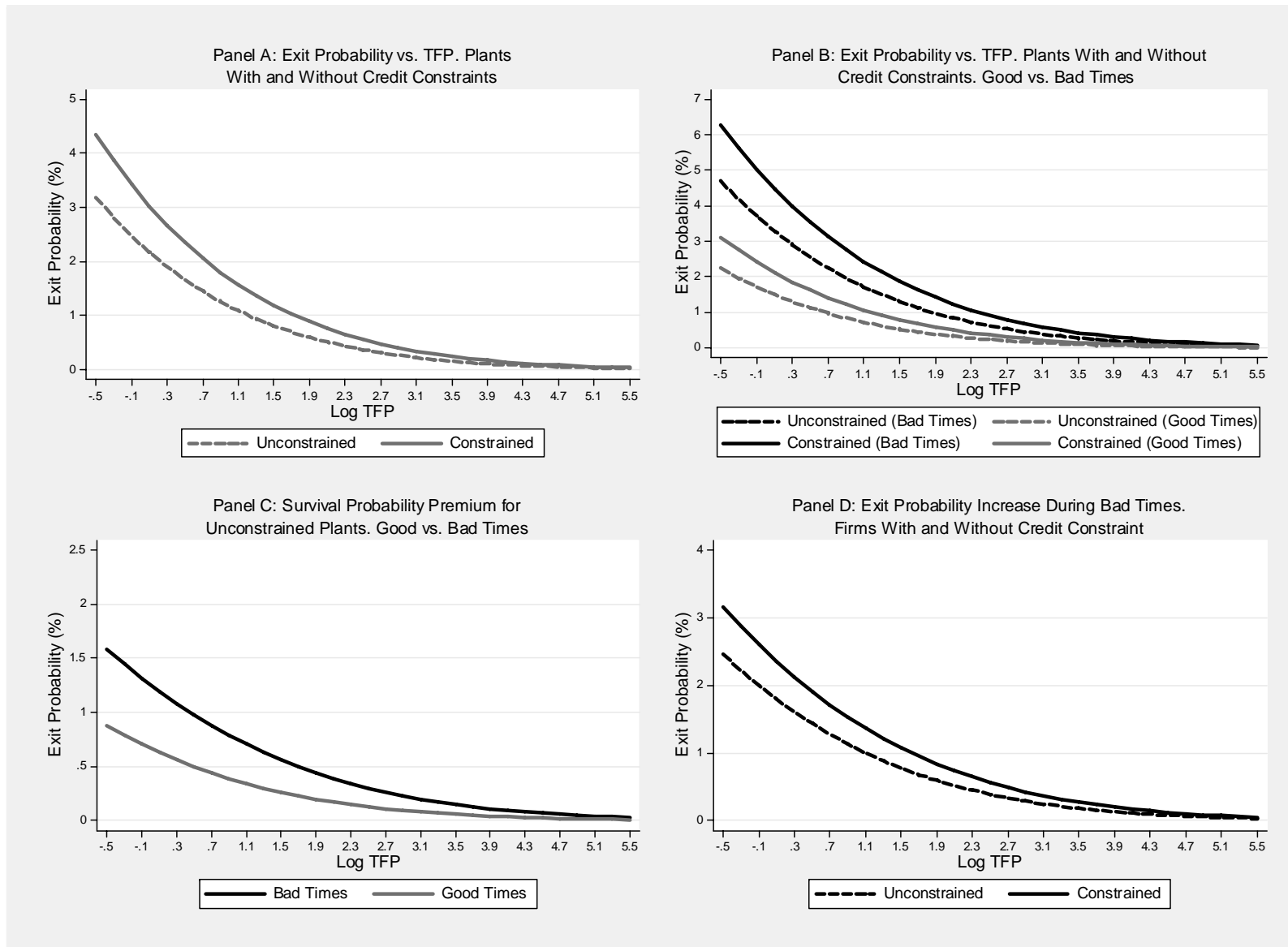


Figure 2: Baseline interacted model

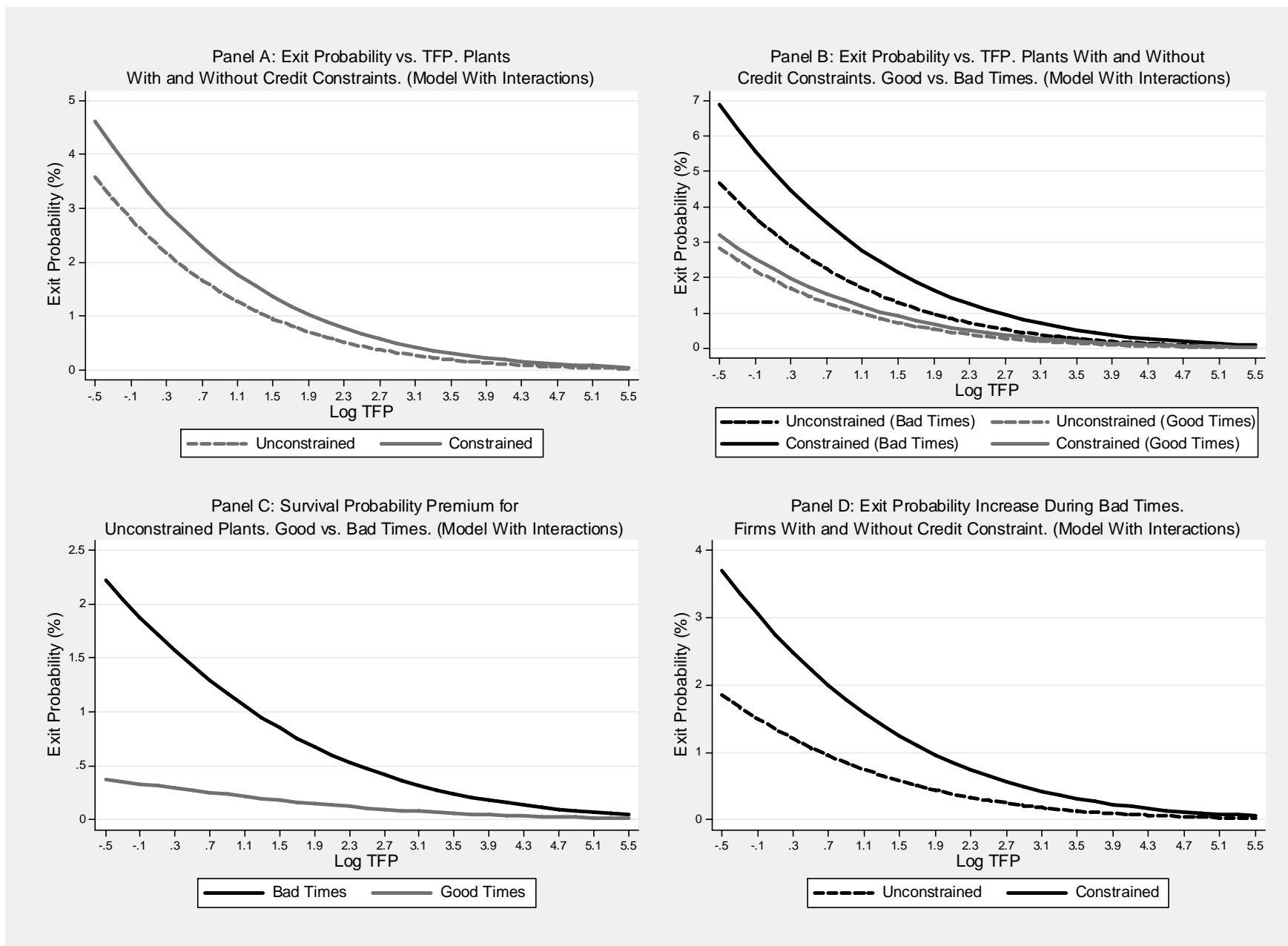


Figure 3. Extended Dummy of Credit Constraints

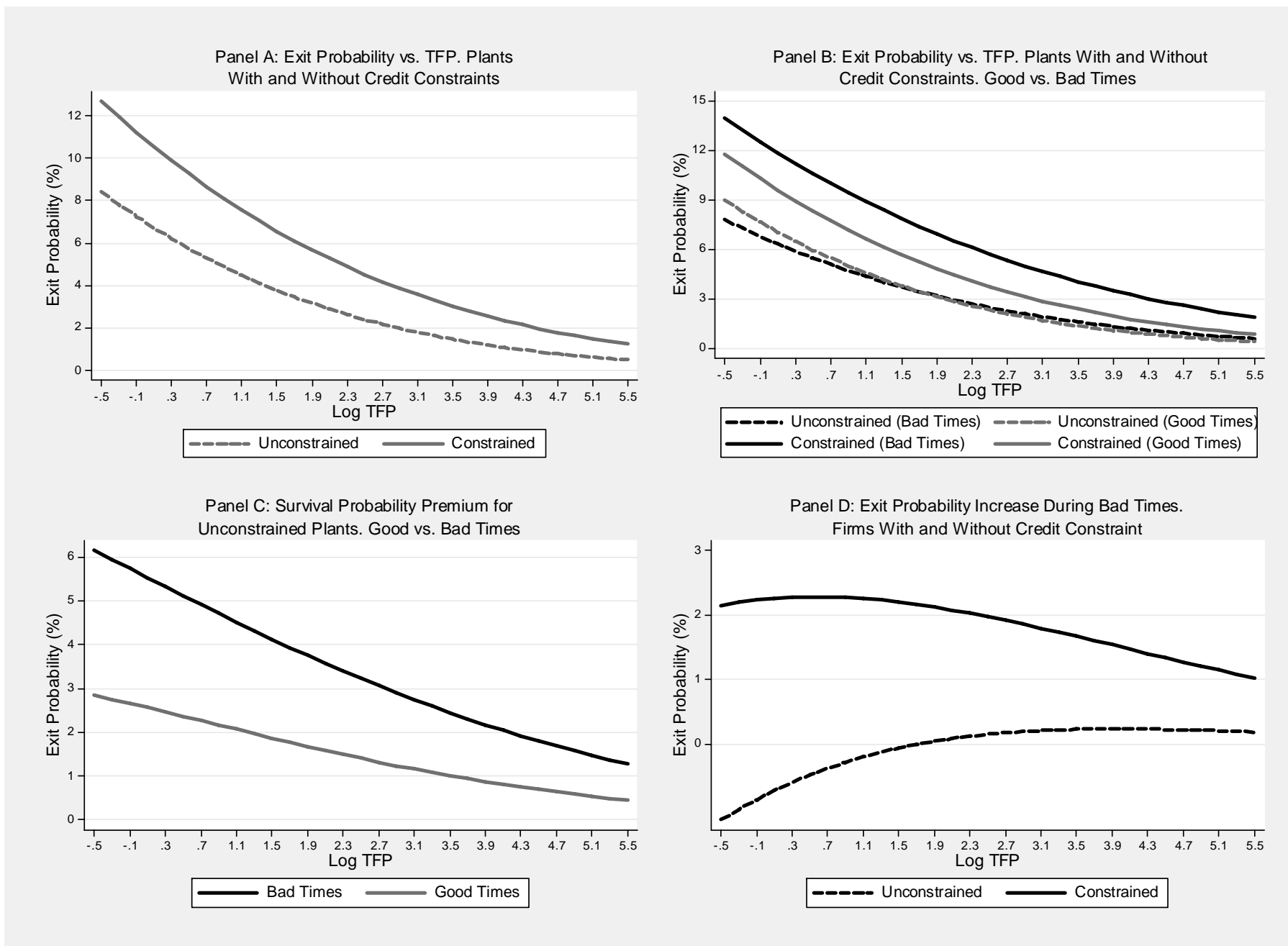


Figure A. Equilibrium ZCP and FE conditions, with and without financial frictions

