Understanding the Credit Multiplier: The Working Capital Channel

Heitor Almeida, Daniel Carvalho and Taehyun Kim*

July, 2018

We provide novel evidence that frictions in the financing of working capital can lead firms to significantly amplify and propagate the effect of economic shocks over time. We propose a new approach to identify this firm credit multiplier that compares how a same firm responds to permanent shocks differently when these shocks are initiated in the period in which they are predicted to be most profitable (their "main quarter"). Our analysis implements this test with oil price shocks and provides extensive evidence supporting our identification strategy. Our results suggest that the financing of working capital can be an important channel for understanding how the credit multiplier affects economic activity.

*We thank Hengjie Ai, Alexandre Baptista, Angie Low, Peter DeMarzo, Emilia Garcia-Appendini, Dirk Jenter, John Moore, Greg Udell, Ryan Pratt, Merih Sevilir, James Weston, and seminar participants at the Cass Business School, Edinburgh Business School, George Washington University, Indiana University (Kelley), Washington University at St Louis (Olin), UCLA (Anderson), University of Illinois at Chicago, University of Colorado at Boulder, University of Kentucky, USC (Marshall), CEPR Spring Symposium in Financial Economics, FIRS Annual Conference, Minnesota Corporate Finance Conference, RCFS 2018 Bahamas Conference, SFS Cavalcade Conference, NTU Finance conference, and the Annual Young Scholars Finance Consortium for helpful comments. Heitor Almeida is from the University of Illinois at Urbana-Champaign, Daniel Carvalho is from Indiana University, and Taehyun Kim is from University of Notre Dame.

An important question in finance and economics is the role of credit markets in shaping economic activity. An influential idea in this context is the existence of a financial accelerator or credit multiplier effect (e.g., Bernanke and Gertler (1989), and Kiyotaki and Moore (1997)). In the presence of financing frictions, economic shocks are both amplified and propagated over time because they lead to changes in firms' balance sheets. Despite the importance of this idea, we have limited direct evidence on both the significance of this credit multiplier effect and the specific economic channels through which it works in practice.

In this paper, we study how frictions in the financing of working capital can amplify and propagate over time the effect of economic shocks on firms. When firms need to pay for inputs in advance of production, their production capacity depends on their ability to finance short-term investments in working capital, and credit constraints can amplify the effects of economic shocks on firms' sales. For example, consider the case of a retailer that needs to purchase inventories prior to sales, faces constraints on its ability to finance this short-term investment, and experiences an adverse shock to its profitability. As the firm's profits and net worth are reduced, the constrained retailer finds it harder to finance its inventories and is forced to sell less, what leads to a further reduction on profits, net worth, production capacity, and so on. Therefore, the adverse effect of the shock on the firm's ability to finance its sales can lead to a credit multiplier effect, which amplifies and propagates the drop in firm sales over time. While a financial accelerator effect operates at the aggregate level, it relies on the existence and importance of this type of firm-level mechanism. We focus on proposing and testing micro-level implications of a specific firm-level multiplier driven by a working capital channel.

Our focus on this working capital channel contrasts with the empirical literature on the firm-level implications of financing frictions, which typically analyzes the financing of firms' long-term investment. This focus is motivated by the intuition that the financing of working capital can be important in creating a more immediate and direct effect of financial conditions on real output, a point emphasized by previous research on the macroeconomic implications of financial frictions over the business cycle or during crises.[1] Another central motivation for this focus is the importance of inventories and accounts receivables on firms' balance sheets, what creates a need for the financing working capital in a range of industries such as construction, retail, and

[1] We discuss these literatures in greater detail below.

manufacturing.[2] While the short-term nature of these investments might facilitate their financing, firms might face challenges financing these needs during periods of adverse economic conditions or liquidity problems, when the previous credit multiplier might become relevant.

Testing the importance of the credit multiplier requires analyzing how initial drops in the production of a constrained firm induce further drops in their production capacity in a feedback process that can amplify and propagate over time the effect of initial conditions. Previous micro-level research on financing constraints has focused on analyzing the immediate effect of initial funding shocks on firm decisions, without an explicit analysis of how these real effects might feedback into further funding constraints or might be propagated over time.[3] This makes it challenging to infer the importance of a credit multiplier from previous micro-level evidence on financing constraints.[4]

We propose a novel test to identify the importance of a credit multiplier driven by the working capital channel. This test can be used to study the working capital channel in a broad sample of economic shocks, and it can also detect the propagation of economic shocks over time through the credit multiplier mechanism. Our identification strategy explores the existence of predictable differences in firm profitability due to seasonality. Firms have "main quarters", the quarters in which they are most profitable. These quarters can be identified using only historical data and predict significant within-year fluctuations in firm profitability for the typical firm (Chang, Hartzmark, Solomon, and Soltes (2017)). Our analysis considers how a permanent economic shock (input price or demand shock) affects a given firm differently over time when the shock is initiated in the firm's main quarter.

---

[2] Receivables and inventories represented approximately one third of total assets (book value) on average for U.S. listed nonfinancial firms between 1980 and 2016. The product market in which firms operate often creates the demand for investments in these assets. We discuss examples in greater detail in Section 3.

[3] For example, one line of research has built on the influential work of Fazzari, Hubbard, and Petersen (1988) and attempted to isolate the effect of shifts in the availability of internal funds, conditional on the availability of investment opportunities (e.g., Rauh (2006), and Almeida and Campello (2007)). Other studies have searched for shifts in firms' financial conditions with shocks the supply of capital by lenders (e.g., Lemmon and Roberts (2010), Duchin et al. (2010), and Almeida et al. (2012)) or shocks to the value of firms' collateral (e.g., Gan (2007), Chaney, Sraer, and Thesmar (2012)).

[4] Carvalho (2015) analyzes how funding problems propagate within an industry during a downturn through an industry credit multiplier (but not the propagation over time). Huber (2018) provides evidence on the propagation over time of banking shocks during the recent financial crisis. Bergman, Iyer, and Thakor (2017) study how funding shocks to farming during the 1980s farm debt crisis propagate into other local sectors through a local credit multiplier. This literature does not consider the role of the working capital channel as a mechanism for this financial amplification and uses different approaches than the one proposed in this paper.

To motivate our test, we build a model of working capital constraints. This model adapts Kiyotaki and Moore (1997) to a context in which firms need to pay upfront for inputs and their profitability is subject to short-term cycles (seasonality). Firms have a working capital constraint when they want to finance upfront their inputs before the cash from sales arrives, but face a binding limit on how much they can borrow and produce (throughout the cycle). Shocks affect the sales of constrained firms by changing this borrowing limit on production (production capacity). We first consider how the immediate (e.g., same quarter) effect of shocks on firms' sales changes when firms are hit in their main quarter. We show that sales of constrained firms are likely to be more responsive (in percentage terms) to an economic shock that happens in their main quarter. This result is due to within-year fluctuations in a firm's ability to fund short-term investments associated with production. In a quarter with higher profitability (main quarter), a constrained retailer that needs to finance inventories prior to sales can generate more profits with a same investment in inventories. Therefore, this retailer should find it easier to borrow and leverage its net worth in the main quarter, and its (same quarter) production capacity should be more sensitive to shocks affecting its net worth in this period.

We then consider the effect of a permanent economic shock on firm sales over the entire subsequent year (cycle). In particular, we analyze whether the average percentage change in sales over the year depends on whether the shock is initiated in the firm's main quarter, or not. This result is key for our identification strategy, and it builds on the previous (same-quarter) result. When firms are constrained, the initial effect of the shock on firms' production capacity and cash flows is important in determining their net worth and production capacity throughout the cycle as they need funds to finance their working capital. Therefore, if a shock leads to a greater initial drop in the sales of a constrained firm when initiated in the main quarter, it has a bigger impact on the net worth and the sales of the firm in the rest of the cycle. This differential effect over the entire cycle captures the stronger financial amplification effect induced by the greater initial drop in production capacity and net worth. In contrast, in the absence of working capital constraints and a credit multiplier, the effect of the permanent shock over the entire cycle of a firm is unlikely to be related in this systematic way to the initial timing of the shock. Thus, seasonality can play a central role in helping identify the credit multiplier.

In order to further illustrate our identification strategy, consider the following example. Suppose that firms have either Q4 or Q2 as their main quarter (Q4- or Q2-type firms). Imagine that firms are affected by a permanent input price increase (shock) initiated during Q2. When firms are constrained, shocks initiated during Q2 should lead to a stronger immediate (percentage) drop in sales for Q2 firms. When the subsequent Q4 arrives, firms that are initially more affected at Q2 will have experienced a stronger deterioration of their balance sheets in response to the shock. Therefore, a stronger credit multiplier will lead the effect of the shock over the entire subsequent year to be stronger for Q2 firms.

This analysis contrasts with the case in which firms are unconstrained and there is no credit multiplier. In this case, even if the permanent shock that initiates in Q2 has a stronger immediate effect on Q2 firms, the effect of the shock on firm sales over the entire subsequent year should not be systematically stronger for Q2 firms. When firms reach the subsequent Q4, Q4 firms are now in their main quarter and there is a symmetric effect of the opposite sign. The main-quarter effect leading to a stronger a response by Q2 firms in Q2 is offset by the same main-quarter effect leading Q4 firms to respond more in Q4, and the difference between the effects for Q2 and Q4 firms over the entire cycle cancels out.

In principle, considerations such as adjustment costs or long-term investment could break down this last symmetry argument in the unconstrained case. However, as long as these alternative considerations do not lead firms to adjust in a systematically different way when permanent shocks are initiated in their main quarter, our identification strategy still allows us to isolate a credit multiplier effect. We discuss why this hypothesis is plausible and address the possibility that it might be violated in practice with important checks on our empirical analysis. We also note that our approach does not rely on a specific mechanism for the stronger immediate effect of shocks on the main quarter. The important point for identification purposes is that this stronger immediate response would not translate into a differential effect over the entire cycle in the absence of the previous credit multiplier.

We implement our test using oil price shocks. We start by constructing industry-specific shocks by identifying industries with cash flows that significantly decline (increase) after oil price increases (decreases). We then examine how the within-industry sensitivity of firms to these permanent shocks changes when firms are initially hit in their main quarter. We take advantage of the recurring oil price shocks in our data to control for fixed differences across firms in their sensitivity to shocks. By combining firms' responses to multiple shocks over time, one can isolate the effect of being hit inside the main quarter from potential differences in the sensitivity of different types of firms to shocks in general. Seasonality allows us to identify the credit multiplier by measuring how the *same firm* responds to shocks that happen inside or outside its main quarter.

Our model illustrates how a strong dependence on external funds for the short-term financing of inputs is an important necessary condition for the relevance of the working capital channel. The credit multiplier takes place because of changes in firms' ability to access this external funding. We use firms' reliance on borrowing from their suppliers (accounts payable) as a proxy for this type of outside financing, but also consider the role of short-term debt.[5] It is reasonable to expect firms to finance short-term investments in working capital with short-term liabilities and both firms' financing patterns and anecdotal evidence suggest that smaller firms largely rely on payables for these purposes (Petersen and Rajan (1997)).[6] While our model does not distinguish between these two sources of funding, previous research on trade credit has suggested that payables might be especially relevant for firms facing liquidity problems. One main reason for this importance is the idea that suppliers potentially benefit more than other lenders from the customer's recovery. Another possibility is that payables might be more expensive than bank credit for small firms and used as a source of financing of last resort.[7]

Motivated by the previous considerations, we separately implement our test in samples of smaller firms with a strong dependence on payables and short-term debt. The results show that oil shocks lead to significantly larger drops on firms' sales in the short- and longer-term when firms are hit during their main quarter. Moreover, both these effects are only present in the subgroup of firms that significantly rely on external funds from suppliers. Therefore, our test implies a significant working capital channel only in the subgroup of firms strongly relying on payables. This result is consistent with the previous literature on trade credit and is also consistent with the characteristics of these firms in our data.

---

[5] We exclude the largest firms because it has been argued that the importance of accounts payable among these firms is more driven by other considerations, such as ensuring the quality provided by suppliers, as opposed to financing needs.

[6] For example, *The Economist* (Oct 12, 2017) states that: "Suppliers, of course, have always needed to finance the gap between production and payment." Outside the largest firms (top tercile), payables represent on average 73% of the combined value of payables and short-term debt in the balance sheet of U.S. firms between 1980 and 2016. See Section 2.3 for a more detailed discussion.

[7] For example, see Petersen and Rajan (1997), Wilner (2000), Cunat (2007), and Giannetti, Burkart, and Ellingsen (2011).

As a key robustness check on our results, we also examine these patterns among several groups of firms where we should not expect the working capital channel to be relevant. We first consider smaller firms with a limited dependence on payables or short-term debt. We then consider other groups of firms which are unlikely to face binding working capital constraints such as large firms, firms with high cash balances, firms with high payout ratios, and rated firms.[8] Across all these different groups, we do not detect the previous responses. It is unlikely that alternative interpretations for our results would both generate the previous robust responses and lead them to be relevant only among smaller firms that strongly rely on payables.

We then show that the previous drops in sales are matched with drops on firms' reliance on short-operating assets (accounts receivables and inventories) and also with drops in their use of accounts payable. These patterns further support the idea that the drop in sales we document is matched with reductions in the upfront financing of inputs by firms. Additionally, we provide direct evidence against the predictions of leading alternative explanations for our findings based on adjustment costs or the response of longer-term investment to shocks.

Overall, our analysis suggests that these results capture the importance of a credit multiplier driven by a working capital channel. Our estimates imply that the magnitude of these effects is significant - typical increases in oil prices reduces the sales of firms with high exposure to the working capital channel by approximately 1.5-2.0 percentage points more (over a one-year horizon) than in a benchmark case with reduced amplification effects. As a final step, we also build on our framework to quantify a lower bound on the magnitude of the multiplier implied by our results. Our results imply that an initial drop of 10% in the sales of a constrained firm translates at least into an additional 5.5% drop in the sales of the firm during the subsequent semester through the previous credit multiplier. While this effect is concentrated in a small subset of firms in our data of listed firms, this subset resembles a large number of private firms outside our data in terms of smaller size and high reliance on accounts payables.

Our paper makes two main contributions to previous micro-level research examining the real implications of financing frictions. First, it proposes and implements a new test for examining the importance of the credit multiplier in amplifying and propagating economic shocks at the firm level. In particular, the idea of using seasonality to identify the credit multiplier is new to

[8] While identifying firms that should be constrained ex-ante based on these characteristics can be challenging, this falsification test only relies on identifying firms which are unlikely to face binding constraints.

the literature. Second, it provides direct evidence that financing frictions can have important effects on firms through the financing of working capital.[9] This analysis of working capital considerations distinguishes our paper from the literature that focuses on the impact of financing frictions on long-term investment. We also complement previous research on the macroeconomic implications of financial frictions by proposing and testing micro-level implications of a specific firm-level multiplier driven by a working capital channel.[10] Our results suggest that the working capital channel can be broadly relevant in constraining the sales of U.S. firms during adverse conditions and can induce a significant credit multiplier.

Finally, our evidence also complements recent research on the importance of household balance sheets and aggregate demand conditions (Mian and Sufi (2014)). As emphasized by Giroud and Mueller (2017), firm balance sheets can be important in the transmission of these demand effects into the real economy, and our results suggests a specific mechanism through which firm balance sheets can amplify and propagate these demand shocks over time.

1. A Model of the Working Capital Channel

As a first step in our analysis, we formalize the intuition behind our empirical test. We use a model which adapts the framework analyzing the credit multiplier in Kiyotaki and Moore (1997, hereafter KM) and show how our test isolates a working capital multiplier in this framework. After presenting these results, we discuss potential issues with our identification strategy outside our model and explain how we address them in the implementation of our test.

1.1. Basic Structure and Different Steady States

We adapt KM to a context where firms need to finance their inputs upfront and face seasonal (cyclical) variation in their profitability. The model is a partial equilibrium model and we focus

[9] Our focus relates to a few studies analyzing the effect of credit supply shocks on firms' exporting activity during financial crises and suggesting that a working capital constraint can be relevant for exporting activity during such events in Japan and Peru (Amiti and Weinstein (2011), and Paravisini et al (2015)). Our evidence is also consistent with recent research suggesting that the demand for delayed payments by firms' customers can expose financially constrained firms to significant liquidity risks (Barrot (2016)).

[10] While drops in long-term investment can lower aggregate demand and have other indirect effects on economic activity, this working capital effect can directly lower output through supply conditions (marginal costs and production capacity). For example, see Mendoza (2010), Jermann and Quadrini (2012), and Mendoza and Yue (2012), and the references therein for models highlighting the importance of this channel in driving the effect of financial conditions on economic activity. This working capital channel has also been emphasized as important for understanding the effect of monetary policy shocks (Barth and Ramey (2001) and Christiano, Eichenbaum, and Evans (2005)). These literatures argue that incorporating a working capital channel allows models to do a better job in matching broad empirical patterns.

on a credit multiplier effect that operates at the firm level. We assume that some inputs are fixed (e.g. capital) and focus on firms' choice of variable inputs over its cycle. One can interpret the model as capturing fluctuations on firms' production decisions within a year conditional on an initial set of fixed longer-term conditions. Firms have to purchase the variable input m_t at the beginning of each period *t* to generate revenue $y_t = A_t f(m_t) = A_t m_t^{\varepsilon}$ at the end of that period, where $A_t > 0$ and $0 < \varepsilon < 1$. This revenue is net of costs from using fixed inputs. Since these other inputs are fixed, changes in y_t capture changes on sales (conditional on A_t). The price of the variable input is fixed over time and given by *p*.

Firms maximize their value and are subject to the following constraints. In order to produce, firms need to finance the variable input at the beginning of each period. They can do this by using their internal funds or by borrowing in a credit market.[11] We assume that firms firm can promise to repay only $\theta \times y_t$ at the end of the period, where $0 < \theta < 1$. This constraint captures in a simple way the idea that their income is not perfectly pledgeable. A fundamental point here is that firms' can credibly repay more when they are expected to generate more income. This leads to variation on firms' ability to finance inputs and leverage on their net worth within their cycle.[12] For simplicity, the interest rate is zero and firms face no cost in their borrowing in addition to the previous constraint.[13] We follow KM in assuming that, at the end of each period, the firm has to pay out at least a share γ of the income generated during that period. This avoids a scenario in which firms save in perpetuity and never pays dividends. One can interpret this payout as also capturing funds used for longer-term investment, which we do not model here explicitly. Firms can save over time by holding liquid assets. We denote firms' net worth at the start of each period *t* as w_t (value of these assets). Firms are endowed with an exogenously given net worth at the start of the first period.

[11] This captures a need to invest in short-term assets (receivables and inventories) prior to collecting the cash from sales and reflects characteristics of product markets in which firms operate or the nature of their production process. We motivate and illustrate the empirical relevance of this assumption in Sections 2.4 and 2.5.

[12] For example, the models in Holmstrom and Tirole (1998) and Tirole (2006) are based on a version of this constraint derived from a moral hazard problem between the lender and the borrower. We discuss the robustness of the results to variations of this constraint below.

[13] We assume that firms face an arbitrarily small cost of raising external finance to break a potential indifference between using internal or external funds. A version of our model with a positive interest rate and a spread paid by firms over this interest rate (possibly zero) leads to the same predictions discussed below.

We follow the approach in KM of focusing on firms in a steady state. Intuitively, this steady state is intended to capture a short-term cycle by the firm. Firms can be both in a constrained or an unconstrained steady state. If firms have sufficiently high net worth, their decisions will be unconstrained and given by $y_t^{'}(m_t^{FB}) = p$. However, when firms' net worth is not sufficiently high, they face a limit on how much input they can use. This limit m_t^* is given by:

$$m_t^* = \frac{w_t}{p - \theta b_t(m_t^*)} \quad (1)$$

where $b_t(m_t^*) = A_t f(m_t^*)/m_t^*$ captures the average profitability of inputs and $p - \theta b_t(m_t^*)$ can be interpreted as a minimum required down payment on the financing of the input. Firms need to have some "skin in the game" when financing the input, because of the limit on their ability to credibly repay. This down payment captures the minimum amount of internal funds required per unit of input. If the firm uses all internal funds to finance the input, it will buy m_t^* units.

This expression implies that this down payment is lower when firms are more profitable and can repay more. Consequently, constrained firms borrow more aggressively to finance their sales, i.e. they have higher leverage or a larger multiplier on their net worth when they are more profitable. When firms are constrained by this limit (face a binding working capital constraint) their net worth in period *t+1* can be determined as $w_{t+1} = (1-\gamma)(1-\theta)y(m_t^*)$. This captures the effect that firms' production decisions have on their subsequent net worth. This last condition and Equation (1) describe the dynamics of a constrained firm and illustrate the two-way feedback between their production decisions and net worth. Firms' current net worth determines their current production, which then affects their subsequent net worth, and so on.

We focus on a situation where there are two states *H* and *L* and the only difference between these states is the value of A_t, where $A_H > A_L$. The firm alternates into the other state with probability one at the start of each period in a way that is intended to capture seasonality in their profitability. In Appendix A, we show that if $\gamma(1-\theta) > 1-(A_L/A_H)\varepsilon$, there exists a unique constrained steady state. In this steady state, the firm is constrained in both states and cannot grow out of this constraint over time. We also show that there exists an unconstrained steady state, where the firm reaches the previous unconstrained decisions in every state. These are the same decisions that would take place in a version of the model without the input timing gap in production. This unconstrained steady state exists if $(\gamma(1-\rho)+\rho)(1-\theta)<1-\varepsilon$, where $0<\rho(A_L, A_H)<1$. Intuitively, despite the need to pay upfront for inputs, the firm grows out of the constraint by building net worth over time. A key distinction between these two steady states is that firms remain dependent on external funds in the constrained case, while they only rely on internal funds to fund inputs in the unconstrained scenario.[14]

1.2. Analysis of Shocks and Identification of Credit Multiplier

We now illustrate the logic for the identification of the working capital multiplier in this framework. We consider the effect of an unexpected permanent input price shock in an analogous way to KM and analyze the log-linearized response to this "zero-probability" shock around the steady state. In other words, we assume that the firm does not anticipate the possibility of this future shock. This is a simplifying assumption, which is meant to capture a situation in which the firm does not fully hedge its exposure to the shock even when the shock is anticipated with some probability. While we focus on an input price shock, our main results also hold if we examine a demand shock, i.e. a change in A_S.

We assume that the firm is initially in one of the previously analyzed steady states with price p at $t=0$ and consider the effect of a one-time and permanent change to its input price that takes place at the beginning of $t=1$. We denote the new price as $\widetilde{p}$ and consider the effect of a marginal shock. Let $y_t^*(s)$ denote the value for the firm's revenue in period t if the firm had remained in the original steady state. Let $y_t(s)$ denote the actual value for the firm's revenues in period t with the shock. Both these values can potentially depend on the state at $t=1$ (s_1), i.e. the state when the shock takes place. We measure the response to the shock in period t as $\widetilde{y}_t(s_1) \equiv \frac{\partial y_t(s_1)}{\partial \widetilde{p}} \times \frac{p}{y_t^*(s_1)}$. This elasticity is evaluated at the initial steady state ($\widetilde{p}=p$) and captures the marginal percentage effect on sales from a given price shock, i.e. a given percentage increase in the input price.

[14] Recall that there is an arbitrarily small cost in using external funds. An unconstrained firm builds internal net worth over time and eliminates this need for (slightly expensive) outside financing. We could allow the borrowing constraint to also depend on a collateral value tied to firms' capital as long as it was still relaxed by increases in the expected income generated by the firm

We examine how the average effect of the shock over the entire cycle of the firm depends on the specific state in which this permanent shock was initiated. This average effect is given by $\tilde{y}_{12}(s_1) \equiv (1/2)(\tilde{y}_1(s_1) + \tilde{y}_2(s_1))$. We also consider how $\tilde{y}_1(s_1)$ (immediate effect of the shock) depends on this initial condition and the connection between this immediate effect and the previous average effect. We show the details in Appendix A and here focus on describing the key results and their intuition.

We first consider the case of a firm initially in the constrained steady state. We show that the shock leads to a stronger drop in sales when it takes place in the high state ($\tilde{y}_1(H) < \tilde{y}_1(L) < 0$). This stronger *percentage* drop is not a direct consequence of the fact that firms have more sales on the high period, a point that we further illustrate below. Instead, it captures firms' ability to leverage their net worth more aggressively in the high period due to their higher profitability in that state (lower down payment). When input prices increase, firms' funding capacity m_t^* reduces because firms need more internal funds to finance the input (increased down payment). A one dollar increase in the price requires an additional one dollar in internal funds per unit of input, and the percentage increase in these required internal funds is larger when firms initially have more leverage or use less internal funds.[15]

The central result for our analysis is that the shock leads to a stronger average drop in sales over the entire cycle when initiated in the high period ($\tilde{y}_{12}(H) < \tilde{y}_{12}(L) < 0$). The average effect of the shock over the entire cycle can be decomposed into two parts: a direct effect and a multiplier effect. The direct effect captures the direct impact of having a higher price on firms' decisions in each period of the cycle. This effect is the same when the shock is initiated in high or low periods. In both cases it captures an average of direct effects in the high and low states. The important point here is that the direct effect of the shock on a given state (high or low) does not depend on the specific timing of when it was initiated in the past.

However, there is also an indirect or amplification effect of the shock in the second period. Because a price increase (drop) reduces (increases) firms' production in the first period, it leads to a lower (higher) net worth in the second period. This lower (higher) net worth further reduces

[15] This effect would not be present in a case where firms' capacity to repay is a fraction θ of the value of the input (traditional collateral constraint) and the down payment is $(1-\theta)pm^*$. Intuitively, this result would still hold with collateral constraints as long as the firm's ability to repay also increases with the expected income.

(increases) firms' ability to produce in the second period. Thus, average responses over the cycle are subject to a credit multiplier effect - an endogenous change in net worth in response to a shock further affects the firm. The key point here is that the importance of this credit multiplier effect depends on the magnitude of the immediate effect in the first period. When the immediate effect of the shock is stronger, this amplification effect is stronger. Therefore, the difference $\tilde{y}_{12}(H) - \tilde{y}_{12}(L) < 0$ captures the incremental significance of the credit multiplier effect when the shock is initiated in the high state. This is the key result that we use to empirically analyze the credit multiplier.

These results change when the shock affects firms in an unconstrained steady state. The interaction of the immediate effect of the shock with the initial state is unclear. In general, it depends on the functional form the revenue function (third-order derivative). For example, with a Cobb-Douglas functional form, we have that $\tilde{y}_1(H) = \tilde{y}_1(L)$. But the most important and robust result here is that the average effect of the shock does not depend on the state in which the shock is initiated ($\tilde{y}_{12}(H) = \tilde{y}_{12}(L)$). This last result holds even if the immediate effect of the shock is different across the scenarios. The effect of the shock on subsequent high and low periods does not depend on the timing of when the shock is initiated. In contrast with the previous case, there are only direct effects of prices in each period but no propagation of effects over time. Independently of these direct effects, we have that the average of the high and low effects will be the same across scenarios. Therefore, the previous pattern isolating a credit multiplier should not be present if the firm does not face a binding working capital constraint.

1.3. Identification of Working Capital Channel

The key result for identification purposes is that a stronger immediate effect of shocks on firms should only predict an average effect throughout the cycle in the presence of the credit multiplier. The previous model illustrates why it is natural to expect the immediate effect of the shock to be stronger when initiated in the main quarter. In a version of the previous model with a more general borrowing constraint, it is not necessarily the case that shocks will have a stronger response when initiated in the main quarter. But it is still the case that a stronger immediate response for shocks initiated in the main quarter only leads to a greater average response over the entire cycle when firms are constrained and there is a credit multiplier effect. While we study the effect of a permanent shock, our identification strategy is designed to test how these initial temporary differences in firms' balance sheets are propagated and amplified over time (credit multiplier).

The main threat to the identification of the credit multiplier with the previous result is the possibility of other dynamics in the unconstrained case due to issues such as adjustment costs or long-term investment. The key assumption we need for our test is that these considerations do not affect firms' responses to shocks in a systematically different way when shocks are initiated in the main period. We discuss this issue in greater detail in Section 3.7 and address its possibility in our empirical analysis in several different ways.[16]

1.4. Production Cycles

An important issue with the previous model is the assumption that production cycles take place within a period, which is intended to capture a quarter or a semester. In practice, some production cycles in the industries that we analyze such as construction and manufacturing should span many periods. For example, a manufacturing firm could take longer than one semester to deliver an order or a construction company could need more than one semester to finish a project. In this case, the logic in our model can still be applied in the following way. Imagine that the company has a collection of incomplete orders (or projects) at any period. In each period, the firm completes a subset of these orders, collecting the cash, but this requires a short-term investment in working capital or upfront payment for inputs within that period. A shock in a given period can affect firms' ability to complete orders within that period and further limit its ability to complete future orders. The high state will capture the period in which firms have higher profitability and complete a larger volume of projects. Similarly, one can imagine that firms contribute to ongoing projects that are away from completion in each period, and need to pay upfront for inputs within each period before they collect the cash on the contributions made during that period. For example, construction companies typically bill their clients for their work on a project as they complete it. In these scenarios, while production cycles can be longer term, firms need to make short-term investments to complete or make progress on projects within each period.

[16] For example, consider the case of adjustment costs. There is not a clear prediction for the connection between the costs and benefits from adjusting an input and A_l, as the link between A_l and the first-best input response to shocks is unclear.

2. Data, Samples, Summary Statistics, and Examples

We describe the databases and samples used in the paper. We use listed firms because our analysis requires using current and historical quarterly financial statements on firms. We start with data from COMPUSTAT's North America Fundamentals Quarterly. Following standard practice in the literature, we exclude financial firms (SIC codes 6000 to 6999) and regulated utilities (SIC codes 4900 to 4999). We implement our test using oil price shocks and are interested on industries with a negative cash-flow exposure to oil price increases. We therefore also exclude the petroleum and natural gas industry, which is defined using the Fama-French industry classification (SIC codes 1311, 1381, 1382, 1389, 2911, and 2990).

2.1. Industry Oil Betas and Oil Shocks

We start the construction of our overall sample by dropping the largest firms in our data (top 33%) in terms of size, measured using the one-quarter lag of total assets (*atq*). It is natural to imagine that working capital constraints are less relevant among these firms. Consistent with this view, previous research has suggested that the importance of account payables among the largest firms is less driven by financing needs. Instead, it is more motivated by economic considerations such as ensuring the quality provided by suppliers (Klapper, Laeven, and Rajan (2012)). While we use these largest firms in some of our falsification tests, we exclude them while constructing the main samples for our analysis. This exclusion is also motivated by the fact that we use the importance of accounts payable to capture firms need to externally finance their inputs (see below for more details).

As previously explained, we focus on industries with a negative cash-flow exposure to oil price increases. We estimate industry oil betas (3-digit SIC codes) and exclude all industries with a positive beta. As a first step in this process, we estimate firm-level oil betas using a regression of $\Delta CashFlow$ on *Oil Price Growth*. $\Delta CashFlow$ is the difference between *Cash Flow* in quarter *t* and its average value between quarters *t-1* and *t-4*. *Oil Price Growth* is the change in the average price of oil (deflated) between quarters *t* and *t-1* and captures a quarterly innovation in oil prices.[17] When measuring quarterly oil prices, we start with monthly data on spot crude oil prices (West Texas Intermediate (WTI) dollars per barrel) and then deflate prices and compute

[17] We use the past four quarters to reduce the influence of seasonality on the previous cash flow of firms. Our results estimating the effects of oil shocks follow an analogous approach.

average prices. We use all years of available data for each firm and estimate industry betas as the average of these firm-level betas in the industry. While we use data from the entire sample to estimate industry betas more precisely, we only use within industry-quarter variation in the estimation of all our main results.[18]

We construct industry-level oil price shocks as *Oil Shock* = *Oil Price Growth* × *Oil Exposure*, where *Oil Exposure* is the absolute value of the estimated industry oil beta and is fixed over the sample. These industry-specific shocks are predicted shocks based on the differential sensitivity of the cash flows of industries to innovations in oil prices. The use of crude oil prices allows us to capture changes in conditions which are largely determined outside the industry and are comparable over time. Note that negative oil betas might not only capture the direct effect of higher input prices but also reflect reduced demand by customers directly affected by higher oil prices. As explained in Section 1, the results motivating our test also hold in the context of such demand shocks and we refer to oil shocks as input price shocks for simplicity.

2.2. Measuring Seasonality

We capture the seasonality in firms' profitability using the variable *Main Quarter*, an indicator that equals one in the firms' most profitable quarter. We use only historical data to identify firms' main quarter. Our goal is to capture predictable patterns in their profitability within a calendar year. For each calendar year, we use data on the previous five calendar years (twenty quarters) to identify a firm's main quarter. We follow the approach in Chang, Hartzmark, Solomon, and Soltes (2017) and first rank these twenty quarters in terms of their profitability (*Cash Flow*). Note that each quarter (Q1, Q2, Q3, and Q4) is ranked five times and, for example, can be in the five top positions among the twenty quarters (ranks one to four). We then estimate the average rank for each quarter and define the main quarter as the quarter with the lowest average rank (highest average position). The use of an average rank, as opposed to an average cash flow, reduces the influence of individual quarters with abnormal cash flows in this classification. We show in our analysis that main quarters identified from historical data with this intuitive approach predict strong seasonal patterns on firms' profitability and also discuss potential reasons for these seasonal patterns that we take as given.

[18] This is analogous to a common approach of focusing on large events known to be important ex-post (e.g. an international banking crisis) and analyzing cross-sectional patterns within these events. Our industry shocks constructed with these betas capture a broad range of fluctuations in industry conditions.

The construction of the main quarter variable requires that firms have non-missing quarterly data on cash flows for all the past five years (twenty quarters). We restrict our sample to firms with such non-missing data and limit our sample period to 1980-2015. After imposing these last restrictions, we arrive at the overall sample used in our analysis. This overall sample covers 3,170 firms and has 46,185 observations over this 36-year period.

2.3. Financing of Working Capital

We interpret the timing gap between the purchase of inputs and the cash from sales this gap as originating from a demand for short-term assets such as receivables and inventories prior to sales. As firms are paid by customers with some delay they need to finance inputs prior to the collection of the cash from sales, and need to make short-term investments in accounts payable. Examples of industries where this is relevant include manufacturing, construction, and services. Alternatively, firms might need to buy or produce inventories prior to final sales and the collection of cash. For example, this can be important in industries such as retail and manufacturing.

Table 1 shows the importance of payables and inventories in our overall sample. On average, these two assets combined represent 33% of firms' total assets. We discuss specific examples in greater detail in Section 2.5, but note that is plausible to expect the investments associated with these assets to be often short-term investments, with returns within a semester or quarter. The typical maturities of receivables are shorter than 90 days (Klapper, Laeven, and Rajan (2012)). A retailer that needs to acquire inventory (finished goods) prior to sales might acquire some of its inventory well in advance, but might need to acquire a significant portion of its inventory near sales because of uncertainty about conditions at the time of sales. A manufacturer investing in inventory (unfinished goods) prior to the delivery of an order will also need short-term investment near the completion of the order and the collection of some of the cash.

Our framework illustrates that the credit multiplier we analyze should only be relevant for firms that significantly rely on external financing to fund these short-term investments. Intuitively, the working capital channel is driven by changes on firms' ability to externally finance their inputs. We use the firms' reliance on accounts payable as a proxy for this type of outside financing among smaller firms, and also consider the potential role of short-term debt. It is plausible to expect firms to finance these short-term investments in working capital with short-term liabilities. Payables are typically short-term liabilities and, among smaller U.S. firms, have been interpreted as an important source of funding for these short-term investments (Petersen and Rajan (1997)). The main other source of short-term funding in firms' balance sheets is short-term debt, which will incorporate credit-line drawdowns for the financing of inputs. In our overall sample described above, payables represent on average 78% of the combined value of payables and short-term debt. In this sample, payables are also more important in the financing of receivables and inventories at the margin. An increase of $1.0 in these short-term assets over a one-year period is financed with $0.43 in payables and $0.12 in short-term debt.[19]

Our model does not distinguish between different external sources of credit to fund working capital needs. However, previous research on trade credit suggests that firms facing short-term liquidity problems are particularly dependent on funding from suppliers (payables) as opposed to short-term borrowings from other lenders such as banks. A common explanation for this effect in the trade credit literature is the idea that suppliers can benefit more from the recovery of their customers because of their product-market relationships. Consequently, they are more willing to lend to firms experiencing liquidity problems. Another possibility is that payables might be more expensive than bank debt and used as a last resort for smaller firms in need of funding, but this last view has been debated in the literature.[20]

Motivated by these considerations, we construct groups of firms (top and bottom) based on the importance of both payables and short-term debt. More specifically, we first rank firms using *Supplier Financing*, the ratio of accounts payable to sales. We examine the top and bottom terciles of our overall sample using the average value of *Supplier Financing* in the previous four quarters (sorted by year). We use quarterly sales data when computing this ratio but annualize it (i.e., divide it by four) to capture a percentage of annual sales. Recall that we have excluded the largest firms before constructing these groups. We use the ratio of accounts payable over sales because this captures the importance of these liabilities as a share of firms' overall production.[21]

[19] We separately predict *Payables/Sales* and *Short-Term Debt/Sales* using year fixed effects the sum of *Receivables/Sales* and *Inventory/Sales*. In their sample of small business, Petersen and Rajan (1997) also find that payables are important at the margin in the financing working capital with similar patterns to the ones here reported.
[20] For example, see Petersen and Rajan (1997), Wilner (2000), Cunat (2007), and Giannetti, Burkart, and Ellingsen (2011) for discussions of these issues.
[21] Firms might need financing for different types of variable inputs and using a ratio based only on a subset of costs (e.g. costs of goods sold) would not capture the overall importance of outside financing for inputs that we have in mind.

We then follow an analogous approach with short-term debt and construct top and bottom groups using *Short-Term Debt/Sales*, the ratio of short-term debt to sales.

An alternative approach would be to rank firms based on the importance of receivables and inventories. However, as our model illustrates, firms can finance short-term investments in production internally or externally, and unconstrained firms might finance these investments largely based on internal funds. Therefore, it is important to consider firms with significant amounts of these assets that are externally financed, and are potentially exposed to changes in borrowing constraints.

Our construction of these groups is *not* motivated by an analysis of the monotonicity of the effects across different types of firms. Instead, our goal is to identify broad groups of firms where the working capital channel could be relevant and groups where we should not expect this channel to be relevant. The analysis of these last groups provides an important check on our identification strategy for isolating a working capital multiplier.

2.4. Summary Statistics and Characteristics of Firms in Different Groups

Table 1 provides summary statistics on our overall sample and the four previous subsamples based on the importance of financing from suppliers and short-term debt. First, consider the two groups based on the importance of payables. Note that the importance of supplier financing (as a percentage of annual sales) is highly concentrated among firms in the top supplier financing group. There is a significant contrast in the average value of this ratio between the top (27% of annual sales) and bottom groups (3% of annual sales). These top supplier financing firms carry significant amounts of inventory and receivables, which represent on average 34% of their total assets (combined). These assets are also important for the bottom supplier financing group (27% of total assets), but they are matched with limited external short-term financing both from suppliers and other lenders.

Firms with high supplier financing are smaller, younger, less profitable, but have higher *Q* and do not have significantly lower investment. These patterns show that firms with high supplier financing have characteristics that one would intuitively expect among firms that experience liquidity problems. Of course, these characteristics do not imply the existence of liquidity problems.[22] On the other hand, firms that significantly rely on short-term debt are older, larger, have lower *Q* and have similar cash flows. This suggests that smaller firms with high short-term debt are more mature firms with lower risk, and do not have the characteristics that one would expect to be associated with liquidity issues. As in the case of supplier financing, firms in the bottom short-term debt group have a limited use of external short-term financing.

2.5. Industries with High Supplier Financing, Examples, and Anecdotes

We describe the industries with the highest concentration of top supplier financing firms, and use them to provide examples and anecdotes that illustrate the importance of the financing of working capital. Table 2 lists the industries with a high share of firms in the top supplier financing group (see Table 1). Since our results capture the effects of oil shocks, we also list the industries with a high share of firms which are both in the top supplier financing group and have a significantly negative oil beta (below median within industries with negative betas). We describe the importance receivables and inventories in each of these industries and consider both broader and narrower industry definitions: 48 Fama-French industries and 4-digit SIC codes.

An important set of industries in these lists include manufacturing industries naturally exposed to lags in the production process, i.e. a gap between the start and end of production. This includes industries such as aircraft parts, defense, shipbuilding, electrical equipment, steel works, and machinery. In these industries, firms will need to cover significant costs before they can deliver orders. This can require significant short-term investments in inventories in the period near the delivery of orders, when sales are typically recognized, and a significant portion of the cash from the sale is often collected. Moreover, these firms also often extend short-term trade credit to buyers of the goods they produce (Ng, Smith, and Smith (1999)), what also creates a need for short-term investments in receivables near sales. As Table 2 shows, both inventories and receivables are important in these industries.[23]

[22] In the context of the model in Section 1, these differences can be interpreted as capturing different conditions reflected in the parameters γ and θ. A higher need to fund longer-term investment opportunities can be interpreted as a higher value for γ. The younger age, smaller size, and lower profitability should naturally lead to lower θ.

[23] In these industries, these short-term investments near sales are also matched with longer-term investments in inventories and receivables. Firms might stock finished goods (inventories) in anticipation of future demand and start working on orders well in advance of the delivery and might provide longer-term financing to buyers through their captive finance subsidiaries (Murfin and Pratt (2017)). Our analysis does not rely on an assumption that these longer-term investments are not important. The key point for the analysis is the significance of the previous short-term investments near sales.

While this set of industries is important in Table 2, there are many examples outside of manufacturing. Two leading examples that cover many narrow industries in Panels B and C are construction and retail. In the context of retail, a central issue is firms' need to purchase inventories prior to sales. This illustrated by the importance of inventories in the retail industries in Panels B and C. While retailers might invest in inventories well ahead of time, uncertainty about future demand conditions limits their ability to do so and short-term investments near sales are typically relevant. For example, Zales Corp (ZLC) is a company that specializes in jewelry retailing in the U.S. with an emphasis on diamond products and their 2013 10-K emphasizes this issue: "Any failure by us to manage our inventory effectively, including judgments related to consumer preferences and demand, will negatively impact our financial condition …"

Receivables are important in the construction industries, where firms typically bill their clients as they complete their work, creating a demand for short-term investments during a project and near its end. As firms bill their clients after the work is completed during a project, they need to finance inputs prior to collecting the cash. If a significant portion of the cash is paid at the end of the project, a similar demand will emerge near the project's completion. For example, Dycom Industries Inc (DY) is a provider of construction, maintenance, and installation services for telecommunication companies. Their 2017 10-K discusses these issues: "We have significant amounts of accounts receivable … We extend credit to customers as a result of performing work under contract prior to billing for that work… working capital needs may increase… where project costs, primarily associated with labor, equipment, materials, and subcontractors, are required to be paid before the related customer balances owed to us are invoiced and collected. "

We analyzed the annual financial statements of firms in these industries and found that they often discuss liquidity issues associated with the funding of working capital needs. For example, Sterling Construction Company Inc (STRL) is a heavy construction company that specializes in water and infrastructure projects. Their 2016 10-K mentions that: "We may need to raise additional capital in the future for working capital… and we might not be able to do so in favorable terms or at all, which would impair our ability to operate our business…We must manage our liquidity carefully to fund our working capital." Another example is Big 5 Sporting Goods Corporation (BGFV), a leading sporting goods retailer in the western United States. Their 2016 10-K explains that: "Our leveraged financial position means our ability to obtain financing in the future for working capital… might be impeded.” In the discussion of their liquidity needs they state: “Our principal liquidity requirements are for working capital…”

3. Results

3.1. Empirical Specification

We examine how the effect of oil price shocks on the sales of firms depends on predictable differences in their profitability due to seasonality. We estimate the following specification:

$$\Delta \log(Sales)_{ijt,t+3} = \theta_{jt} + \beta OilShock_{jt} \times MainQuarter_{ijt} + \gamma' X_{ijt} + \varepsilon_{ijt} , \qquad (2)$$

where $\Delta\log(Sales)_{ijt,t+3}$ is the average value of the log of sales between quarter *t* and *t+3* minus its average value between quarter *t-1* and *t-4*, θ_{jt} is an industry-quarter fixed effect, *Oil Shock* is an industry-level oil price shock taking place in quarter *t* (see Section 2.1), *Main Quarter* is an indicator that equals one in the firms' main quarter (see Section 2.2), and *X* denotes a vector of control variables (described below). The coefficient of interest is β and tells us the differential effect of the oil price shock on firms' sales when the shock takes place in their main quarter. The outcome variable $\Delta\log(Sales)_{ijt,t+3}$ measures the response of firms' sales over the entire cycle (year) of the firm after the shock, as previously motivated in the discussion of our test. We also examine the immediate response of firms to the shock by analyzing $\Delta\log(Sales)_{ijt}$ as the outcome variable. This variable is the log of sales in quarter *t* minus its average between quarter *t-1* and *t-4*. This immediate response is based on one quarter but we also examine immediate responses over two-quarter periods.

As discussed in Section 4.2, the industry-level oil price shock is determined as *Oil Shock* = *Oil Price Growth* × *Oil Exposure*, and reflects the interaction of innovations in oil prices with the (negative) sensitivity of industries' cash flows to such shocks. Our results compare how a same industry oil shock differentially affects firms in a given industry over time and contrasts the response of firms inside and outside their main quarter at the initial time of the shock. Recall from Section 2 that firms' main quarter captures their quarter (Q1, Q2, Q3, or Q4) with greatest profitability and is defined using only historical data (prior to quarter *t* and the shock). The controls in the estimation of Equation (2) include *Main Quarter* and its interaction with each of the oil control variables (*Oil Price Growth* and *Oil Exposure*). We also control for the average value of *Q* between quarter *t-1* and *t-4* to capture potential expectations of such shocks.

An important issue for interpreting the estimates from this specification is the connection between firms' production cycles in practice and in our framework in Section 1. One possibility is that firms go through multiple complete production periods within a year as in the model in Section 1. For example, one can imagine a retailer that acquires inventories a few months prior to sales. However, as discussed in Section 1.3, one can also imagine that production cycles are longer and firms complete a subset of ongoing orders or projects within a quarter (semester) or, similarly, contribute to these orders in each quarter. Manufacturing firms in this situation will typically recognize their revenue when they deliver the goods, as opposed to when they receive the order. Construction companies in this context would typically recognize their revenue when they make progress on projects or at the end of projects.[24] Therefore, our measure of firms' main quarter will capture the periods in which they are more profitable in completing or executing orders (projects). The response of sales will also capture the completion or execution of these orders over time.

Another issue is the source of variation in seasonality used in the estimation of these effects. These differences are likely to capture heterogeneity in factors such as the product markets and geography. The main reason we include industry-year fixed effects in Equation (2) is to ensure that we contrast the responses of different firms to a same shock, which is constructed at the 3-digit SIC code. Our goal is not to entirely control for differences in product markets across firms, as these differences are important to create variation in firms' main quarter, and should remain relevant within an industry-year (3-digit SIC code).

One potential concern with the estimation of Equation (2) is that it could be capturing differences across types of firms in their sensitivity to oil price shocks, as opposed to differences on how a same type of firm responds at different points of its cycle. To see this potential concern, denote firms with their main quarter in Q1, Q2, Q3, and Q4 as Q1-, Q2-, Q3-, and Q4-type firms, respectively. Imagine now that more oil price shocks take place in Q4 or that there are more Q4-type firms than other types of firms. The results could then be estimating the

[24] For example, see "SEC Staff Accounting Bulletin: No. 101 – Revenue Recognition in Financial Statements", *Security Exchange Commission*.

differential sensitivity of Q4-type firms to oil shocks. If both oil price shocks and firms' main quarters were distributed in a completely symmetric way across the four quarters, the estimation of Equation (2) would not be capturing these differences across firm types in their sensitivity to oil shocks. However, in the absence of this complete symmetry, the previous results could be (at least partially) explained by such differences across firm types.

In our main specification, we address this concern by including fixed effects for the previous four different firm types (e.g., Q2-type firm). We include indicators that equal one for each of these types of firms as controls, in addition to the interactions between each of these indicators and the previous oil variables (*Oil Price Growth*, *Industry Oil Beta*, and *Oil Price Shock*). After these controls are included, identification captures how a same type of firm responds to shocks when the shock happens to take place in its main quarter or not. This is exactly the prediction we want to analyze in our test.[25] This approach is feasible because a same type of firm gets shocked inside and outside its main quarter over time, so we can control for fixed differences in the sensitivity of firm types to shocks. For example, one can compare the effect of a shock on Q4- versus Q2-firms under two conditions: during Q4 and Q2. The fact that we have frequent shocks that can be compared over time (oil price changes) is important here.

3.2. Supporting Evidence

We start by providing direct support for the key building blocks for our main results. Table 3 shows that oil shocks (*Oil Price Growth*) are important in all four quarters and that main quarters are well distributed across all these quarters. The distribution of these variables is not completely symmetric with respect to different quarters but these patterns show that firms are frequently affected by oil shocks inside and outside their main quarters. This is important for the implementation of the previous empirical strategy. Table 4 shows that the main quarter variable (constructed using historical data) predicts large differences in firm profitability within a quarter-industry. The results are based on linear regressions predicting *Cash Flow* and *Profit Margin*

[25] A potential related approach would be to include firm fixed effects interacted with the oil variables. Note that conditional on the previous type, other firm characteristics will not predict whether firms are inside or outside their main quarter at any point in time. Therefore, our approach already addresses the concern that *Main Quarter* is correlated with fixed firm characteristics, potentially unobservable, that could predict the effect of oil shocks. The inclusion of interactions between firm fixed effects and oil shocks also creates an incidental parameters problem that one cannot address by using the demeaned data (approach that works with the inclusion of firm fixed effects without such interactions). This problem could bias the estimates and standard errors (e.g., see Wooldridge (2002, Ch. 15)).

using *Main Quarter* and industry-quarter fixed effects (3-digit SIC code). We include fixed effects for different firm types (see Section 3.1) in our main specification but also report the results without this control. The reported coefficient of *Main Quarter* is scaled to capture its magnitude. We divide the estimated coefficient by the mean of *Cash Flow* or *Profit Margin* in the overall sample (see Table 1). In all these results, we find that firms' main quarter is associated with predictable differences in profitability that are economically large. These differences represent between 70-90% and 30-40% of the mean of cash flows and profit margins, respectively. This confirms the view that the seasonality we analyze is important and captures patterns that are known ex ante. We also find that firms' sales increase by 4-5% in the main quarter. Together with the previous pattern on profit margins, this implies that operating costs increase by 1.5-2.5% in the main quarter.

As discussed in Section 3.1, these differences in seasonality within a 3-digit SIC code are likely to capture heterogeneity in factors such as the product markets and geography which could, for example, be related to annual cycles in the demand for firms' products or firms' exposure to weather conditions. We found that firms frequently discuss these issues explicitly in their annual statements.[26]

Table 4 also shows that firms have significantly higher operating assets (sum of accounts receivables and inventories) and accounts receivables in their main quarter. Moreover, these percentage increases have similar magnitudes to the implied increases in operating costs discussed above. This supports the idea that firms make greater short-term investments in working capital and borrow more from suppliers to fund these investments near quarters with more sales (main quarter). The weaker differences for short-term debt also reinforce the view that firms rely more on supplier financing at the margin to fund these short-term investments.

Table 5 shows that the industry oil shocks analyzed in our results capture significant and persistent changes to firms' cash flows. The results are based on linear regressions predicting different cash-flow outcome variables with *Oil Shock* and controls. The controls include quarter

[26] For example, consider the construction company discussed in Section 2.5 (Dycom Industries Inc (DY)). Their 2017 10-K explains that: "Our revenues and results of operations exhibit seasonality as we perform a significant portion of our work outdoors… extended periods of adverse weather, which are more likely to occur during the winter season, impact our operations during the fiscal quarters ending in January and April." As construction companies are located in regions with different weather cycles, these different cycles should translate into differences in their seasonality.

fixed effects, *Oil Exposure*, and the average value of *Q* between quarters *t-1* and *t-4*. We analyze changes in cash flows in the quarter of the shock and the entire year after the shock in an analogous way to the sales effects in Section 3.2. These variables are defined using changes in *Cash Flow* over the respective periods. We scale the estimated coefficient of *Oil Shock* by multiplying it by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). This coefficient is also divided by the mean of *Cash Flow* in the overall sample. The results show that typical oil price increases (decreases) are associated with economically important drops (increases) in the cash flows of firms significantly exposed to oil prices (cash-flow change equals approximately 10-15% of cash-flow mean). The results also show that these effects are persistent over a one-year horizon.

A final important issue for our analysis is firms' potential ability to hedge the effects of these oil shocks on their decisions using financial and hedging policies. Our analysis should only detect a credit multiplier among smaller firms if they do not fully hedge the impact of the previous cash-flow changes associated with oil shocks. Previous research has both provided direct evidence that smaller firms do not typically fully hedge such shocks as well as discussed intuitive explanations for this behavior. For example, Rampini, Sufi, and Viswanathan (2014) provide evidence that airlines hedge only a limited portion of their fuel-cost exposure to oil prices (with derivatives) and that oil-price hedging is less common when firms are likely to face financing constraints. They emphasize the point that firms hedging these price shocks need to make significant payments in case commodity prices do not adversely affect them and financing constraints might limit firms' ability and willingness to do so. More broadly, previous empirical evidence on hedging policies has found extensive evidence that hedging policies are used only to a limited extent among smaller firms (Froot, Scharfstein, and Stein (1993), and Stulz (1996)).[27]

3.3. Main Results: Oil Shocks, Seasonality, and Firm Sales

[27] This idea that hedging is costly and limited among financially constrained firms is also consistent with anecdotal evidence on firms exposed to commodity price risk. For example, consider again the construction company discussed in Section 2.5 (Dycom Industries Inc (DY)). Their 2017 10-K discusses their exposure to fuel costs and their limited ability to fully hedge this exposure: "higher fuel prices may negatively affect our financial condition and results of operation … there can be no assurance that, at any given time, we will have financial instruments in place to hedge against the impact of increased fuel costs." They mention the previously discussed costs of hedging to justify this exposure.

We estimate Equation (2) using the two samples of firms described in Sections 2.3 and 2.4. As previously discussed, we use these samples to identify broad groups of firms where the working capital channel could be relevant. We also examine important falsification tests for our identification strategy by estimating this same specification in other samples. The estimated coefficient of *Oil Shock* × *MQuarter* is scaled to better capture its magnitude. We multiply this coefficient by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in the sample). This allows us to interpret the results as capturing the effect of a typical oil shock on a firm with significant (negative) exposure to oil prices.

Table 6 reports the results. Panel A shows the effects for top supplier financing firms. We find that oil price shocks lead to a significantly larger drop in the sales of firms over the subsequent year when firms are initially hit in their main quarter. There is also a stronger immediate (percentage) drop in firms' sales when they are hit inside their main quarter. These effects are both economically important and have comparable magnitudes. These patterns match the detailed predictions of the working capital multiplier analyzed in Section 1. The results imply that typical increases in oil prices reduce the sales of firms by approximately 1.5-2 percentage points more (over a one-year horizon) when firms are initially hit in their main quarter. The results are also not sensitive to the inclusion of the firm type fixed effects (interacted with shocks) as described in Section 3.1. Once we include these fixed effects, the results capture the differential effect of shocks on a same type of firm when the shock hits the firm inside its main quarter.

Panel B shows these effects in the sample of firms that significantly rely on short-term debt. We find that both previous effects are not present among these firms. Therefore, our test implies that the working capital channel is not significant in this group and is only relevant in the previous group of firms that strongly rely on supplier financing. These findings are consistent with the previous literature on trade credit and with the characteristics of these two groups of firms in our data as discussed in Section 2.4.

A key robustness check for our test is the analysis of these same patterns in groups of firms where the working capital channel should not be relevant. This provides important falsification tests for our seasonality-based identification strategy. Our first falsification test considers the groups of firms with low supplier financing or short-term debt described in Sections 2.3 and 2.4.

Firms in these groups have a limited dependence on external funds to fund short-term investments in working capital. Recall that the credit multiplier should only be relevant when this dependence on external funds is significant. The results show that both the average and immediate effects of the shock are not differentially more important when firms are hit inside their main quarter in these groups. The estimated effects are both statistically and economically insignificant in these subsamples.

Table 7 examines the results above for high and low supplier financing firms with alternative subsamples. These different subsamples are constructed in an analogous way to the ones in Table 1 using different cutoffs for the importance of *Supplier Financing*. As in the samples in Table 1, we first drop the largest firms and then sort the remaining firms using the importance of supplier financing. We also follow our previous approach of using a same cutoff for both size and supplier financing. For example, while examining firms in the top and bottom quartiles of supplier financing, we first drop firms in the top 25% in terms of size, and then rank the remaining firms into these quartiles. These results with alternative cutoffs confirm the findings from Table 6. Firms in the top supplier financing group (top 25% or 40%) are more affected both immediately and over a one-year horizon when the shock initially hits them inside their main quarter. Both of these patterns are economically important and only present in the top supplier financing group. The effects are economically limited and statistically insignificant in all bottom supplier financing groups. The economic magnitude of the effects in these alternative top groups is similar to the one in the previous results and comparable between short- and longer-term responses (as in the previous results).

Table 8 provides a second set of falsification tests for our identification strategy. We analyze the results among firms that are unlikely to face binding working capital constraints, including the largest firms that we excluded from our previous analysis. We define the largest firms using the previous cutoff (top 33%) for firms' total assets. This ensures that the firms in these results are the ones excluded in our previous analysis. We also examine groups of firms with high *Cash* and *Payout* as well as firms that have a long-term public debt rating (*Rated*). We also use the top 33% cutoff for these alternative variables and have found similar results in the Internet Appendix when we used the top 25% and 40% cutoffs to construct each of these groups. As in our previous samples, we exclude industries with positive betas from this analysis (variable cutoffs are determined using all firms).

While using these characteristics to identify firms that are constrained ex-ante is challenging, our tests are only based on the idea that firms in the previous groups are unlikely to be constrained. For example, it is hard to imagine that firms with very large cash holdings or payout ratios do not have funds to finance important short-term liquidity needs that can disrupt their production.[28] These results show that our test does not detect a working capital channel in these samples. Oil shocks do not have a differential immediate (percentage) effect on sales when firms are hit in their main quarter. Firms initially hit in their main quarter are not more affected over the subsequent year by these adverse oil shocks. This provides additional evidence that our results are not present among firms unlikely to be exposed to a credit multiplier.

Overall, this collective evidence suggests the importance of a working capital multiplier. In order to explain these results, alternative explanations first need to rationalize the robust interaction of firms' main quarter with the longer- and short-term responses of firms' sales to oil shocks. These explanations then need to explain why such effects would only exist in the narrow subset of firms in our data which might plausibly be exposed to the working capital channel.

3.5. Robustness of Sales Effects

We discuss and address a few potential issues with our previous results. We first consider a longer horizon (two quarters) for firms' immediate responses. Our previous analysis of these immediate responses focuses on one-quarter responses. But it might take some time for shocks to affect firms' decisions and we consider this alternative longer horizon. Table 9 reports these results. We estimate the previous effects in Table 6 (Panels A and C) with *ΔLog Sale (t,t+1)* as the outcome, which measures the average log of sales in quarters *t* and *t+1* minus the average for this variable between quarters *t-1* and *t-4*. The immediate sales responses of firms hit in their main quarter remains important and comparable in magnitude to the annual sales responses. As in the previous results, this response is only relevant for firms in the top supplier financing group.

[28] The idea that is simpler to identify firms likely to be unconstrained has also been emphasized in recent research challenging common measures of financing constraints (Farre-Mensa and Ljungqvist (2016)).

Another issue is the dynamics of the oil shock. Suppose that the shock becomes weaker over time and has a stronger direct effect on firms when they are inside their main quarter. In this context, the average effect over the entire cycle could be explained by the fact that firms initially hit outside their main quarter will have their main quarter only at a latter point of the cycle. This argument could rationalize an average effect conditional on a stronger immediate response during the main quarter. We address this concern by examining the dynamics of our previous sales effects. More specifically, we examine the importance of sales effects four quarters after the shock (quarter *t+4*). Notice that firms hit by the shock during their main quarter (in quarter *t*) return to their main in quarter *t+4*. If the results capture the dynamics of the oil shock as in the previous alternative interpretation, they should be much weaker in quarter *t+4* (delayed effect) when compared to quarter *t* (immediate effect). In contrast, if our results capture a credit multiplier effect from a persistent shock, they should remain significant at *t+4* and at least comparable to the effect at *t*.

We examine these possibilities by estimating the previous effects with *ΔLog Sale (t+4)* as the outcome, which measures the log of sales in quarter *t+4* minus the average for this variable between quarters *t-1* and *t-4*. Table 9 reports these results, which show that the effects at quarter *t+4* remain similar to the ones in quarter *t* (time of the shock). Figure 1 then shows results following an analogous approach to analyze the dynamics of the sales effects between quarters *t* and *t+4*. This evidence suggests that our sales results cannot be explained by the previous alternative explanation based on the dynamics of the oil shock.

We can also use these results to provide a visual illustration of our main result. The theory in Section 1.1 suggests that the average effect of the shock over a year should not depend on the state in which the shock is initiated ($\tilde{y}_{12}(H) = \tilde{y}_{12}(L)$), in the absence of the credit multiplier effect. In terms of Figure 1, this result means that the average change in sales between quarters *t* and *t+3* should be zero. When the shock reaches quarter *t+3,* all firms will have reached their main quarters, and thus the timing of the shock should no longer matter. However, it is clear from the Figure that this average effect is negative. The average effect is also computed in Table 6, Panel A, Columns (3) and (4) and is equal to *-1.6%.* We depict this average effect in Panel B of Figure 1, together with the counterfactual predicted by the model (0%). Under our identification assumptions, this average response of -1.6% is the signature of the credit multiplier.

We also check if our results are mostly important when seasonality patterns are more significant and report these results in the Internet Appendix. We use historical data to define firms with high and low seasonality in an analogous way to the construction of *Main Quarter*. We use the gap between *Cash Flow* in the main quarter and the other quarters to measure this degree of seasonality. We then show that our results are driven by firms above the median in terms of seasonality, a subgroup of firms where the main quarter is significantly more important in predicting firm profitability.

3.6. Additional Implications of the Working Capital Channel

We analyze additional implications of the working capital channel suggested by our previous results. We first analyze changes in firms' short-term operating assets and accounts payable. As firms are more limited in their ability to purchase inputs ahead of sales, we should expect them to accumulate less of these assets (see Sections 2.4 and 2.5). If these drops in short-term operating assets are driven by the working capital channel they should be matched with less external financing and drops in firms' accounts receivables. Therefore, the previous sales effects should be matched with drops in firms' accumulation of both these assets and liabilities.

One challenge in testing these predictions is that we only observe the stock of these assets and liabilities, and cannot observe new receivables from customers, new borrowing from suppliers, or new additions to inventories. Changes in these stocks will capture also payments by customers, payments to suppliers, and the sale of existing inventories. Another challenge is that the cost of payables and inventories might change if financing from suppliers becomes more expensive after drops in the net worth of constrained firms. These higher financing costs from suppliers are likely to affect firms' operating liabilities and costs through input prices. In other words, increases in input prices might offset drops in the real amount of inputs that firms use or finance from suppliers. These price increases might also offset drops in the real amount of inventories purchased by firms.[29]

[29] This offsetting effect due to a price increase would be limited in the framework in Section 1 where the firm faces a binding constraint on the amount that it can borrow. This constraint limits the total amount that the firm can spend

We examine the previous implications for short-term operating assets and accounts receivable with these considerations in mind. We estimate the same specification used in our sales results with these outcomes. We analyze changes in the average value of these assets or liabilities over the year after the shock (relative to the previous year). We also examine their shorter-term response using the first two quarters after the shock as the level of assets and liabilities might change slowly as firms adjust their decisions.

Panels A and B of Table 10 show these results. The previous sales effects are associated with drops in both short-term operating assets (accounts receivables and inventories) and accounts payable. As in the context of the sales results, all these average effects are only present among top supplier financing firms and are associated with shorter-term responses. We find no average effects for firms in the bottom supplier financing group. These patterns further support the idea that the drop in sales we document is matched with reductions in the upfront financing of inputs by firms.

Additionally, we also examine if our sales results are matched with analogous changes in operating costs. If firms' sales drop because they are more limited in their ability to finance inputs, these sales effects should be matched with a reduced use of inputs by firms. As before, an important challenge in testing this prediction is the fact that input prices can also be affected, and we do not observe the real amount of inputs being used by the firm. We mitigate this issue by also looking at inputs that are not sold by suppliers (selling and general administrative expenses), where we should expect this price effect to be limited, in addition to examining changes in the costs of goods sold. These other inputs should be directly affected by the working capital multiplier if firms also need to finance them prior to production. These inputs might also be indirectly affected by changes in other inputs if these different inputs are complements in production.

Table 10 also reports these cost results (Panels B and C). This analysis shows that the previously analyzed drops in sales are matched with reductions in the use of inputs by firms. These effects are also only important for firms in the top supplier financing group and are not

---

on variable inputs. More broadly, one can imagine a setting where firms are saving some of their borrowing capacity for hedging purposes. In this context, firms could increase the amount spent in inputs to partially offset increases in input prices and borrowing costs from lenders. Intuitively, both firms' sales and the use of real inputs would drop in this scenario (under imperfect hedging), but total input costs could drop by significantly less or even increase.

present among firms with limited financing from suppliers. Overall, this analysis looking at additional margins supports the additional implications of the working capital channel suggested by our sales results.

3.7. Alternative Explanations Based on Adjustment Costs and Longer-Term Investment

We address in greater detail the potential role of alternative explanations for our results based on adjustment costs or the response of longer-term investment. A first possibility is that, in the presence of adjustment costs, unconstrained firms adjust faster when the shock is initiated in the main quarter. This could rationalize a stronger drop in sales throughout the cycle when the shock hits the firm in the main quarter. However, we note that the link between A_t and the first-best input response to shocks is unclear in the framework of Section 1. This point illustrates that there is not a clear connection between the costs and benefits from adjusting inputs and the main quarter for unconstrained firms.

Another possibility is that shocks initiated in the main quarter can have a stronger immediate impact on the funding of longer-term investments. While the framework in Section 1 illustrates how financing constraints naturally lead to such differential response for short-term investments in working capital, there is an important contrast with longer-term investments. The short-term investments associated with the production process generate immediate cash flows. This is the key reason why the return on these investments and, consequently, their funding depend on short-term profitability conditions within a cycle. In contrast, the returns considered by investors when financing longer-term assets should be evaluated over longer horizons. Therefore, cyclical fluctuations in firms' profitability within a cycle are less likely to affect their ability to finance long-term investments.

We argue that is unlikely that these explanations would only be relevant among firms potentially exposed to the working capital channel. Recall from Section 3.4 that our results are not present in a range of falsification tests with firms unlikely to be exposed to the working capital channel.

As a final step to address these alternative explanations, we directly examine their predictions. More specifically, we test if shocks initiated in the main quarter are associated with a stronger immediate response of capital expenditures, R&D spending, and the sales of capital. If the previous explanation based on adjustment costs drives the results, we should expect firms to immediately adjust their capital stock faster when the shock hits in the main quarter. This should translate into greater immediate declines in capital expenditures or greater immediate increases in capital sales. Similarly, if the previous explanation based on the funding of longer-term investments drives our results, our results should be matched with immediate drops on longer-term investments such as capital expenditures or R&D spending.[30] Table 11 reports these results and show that our previous sales results are not associated with immediate drops in capital expenditures or R&D spending, or immediate increases in the sales of net PPE. This provides additional evidence against the view that these alternative interpretations can explain our results.

3.8. Implied Magnitudes for Multiplier

As a final step in our analysis, we consider the implications of our results for the magnitude of the firm-level credit multiplier under the framework in Section 1. We describe here our main findings and provide greater detail in Appendix A. When the working capital channel is present, drops in the output of constrained firm in a given period translate into additional constraints in the production capacity of the firm in the next period. In the context of the framework in Section 1, the magnitude of this multiplier can be measured as the additional drop in the output of a constrained firm in period $t+1$ induced by a given drop in the output of this constrained firm in period t. This elasticity will capture how firms' balance sheets propagate and amplify a given reduction in sales over time.

A simple lower bound for this multiplier can be obtained by combining the incremental annual drop in sales when firms are hit in their main quarter, relative to when they are hit outside of their main quarter (Column (4) of Panel A of Table 6, which gives - 1.6%), with the immediate magnitude of the shock on firms hit inside their main quarter. We estimate this last magnitude by adding the additional drop in sales in the first semester when firms are hit in their main quarter (Column (2) of Table 9, which gives – 2.0%), and the magnitude of the sales shock during the first semester on firms hit outside their main quarter (which we estimate at -0.9%). We estimate this last effect in the sample of firm-quarters outside the main quarter using a

[30] If the shock has stronger long-term consequences for sales when it hits firms during the main quarter, this could potentially feedback into lower incentives for investment today. But this effect on sales has to be very strong and persistent to generate such feedback. This sales effect could be important enough to generate significant reductions in output over several quarters but not large enough over long horizons to induce such feedback on long-term investment. Recall that our motivation for analyzing the working capital channel is its potential role in driving economic fluctuations.

specification analogous to Equation (2) without the main-quarter variable and interactions. These results imply that a drop of 2.9% in the sales of a constrained firm in a given semester leads to an additional drop of at least 1.6% in sales over the next semester. This calculation implies a lower bound on the credit multiplier equal to 1.55 = 1 + (1.6/2.9). Recall that, under our identification strategy, the average effect over the entire year captures the additional propagation of the shock when the shock starts in the main quarter. The previous estimate for the multiplier scales this average incremental effect by the drop in the sales of constrained firms in the first semester.[31] This approach provides a lower bound for the multiplier because it attributes only the additional propagation effect when firms are hit in the main quarter to the multiplier. The total size of the multiplier is larger because financial amplification may also occur when constrained firms are hit by shocks outside of their main quarter.

While this effect is concentrated in a small subset of firms in our data of listed firms, this subset resembles a large number of private firms outside our data in terms of smaller size and high reliance on accounts payables. For example, suppose that firms exposed to this multiplier effect represent between 20%-40% of aggregate GDP during a recession.[32] The previous lower bound for the multiplier would then imply that, in the absence of general equilibrium considerations, a shock initially reducing aggregate GDP by 1.0% would translate into an additional drop in the GDP over the subsequent two years between 0.12% and 0.28% through this mechanism.[33]

4. Conclusion

We provide new micro-level evidence that frictions in the financing of working capital lead firms to amplify and propagate the effect of economic shocks over time. We propose a new approach to empirically identify this firm-level credit multiplier that builds on the existence of predictable differences in firm profitability due to seasonality. We detect the importance of this

[31] An alternative approach is to scale the annual sales effects by the first-semester sales effects but this leads to a biased estimate in the framework of Section 1 (see Appendix A).

[32] Our results imply that one third of the firms outside the largest firms in our data are exposed to this effect during a typical year. These numbers are plausible if we imagine that a comparable share also applies to private firms and consider that this share is likely to increase during a recession.

[33] If the previous multiplier is given by $M = 1 + \delta$, the additional effect of an initial output drop of 1 over the next two years (four semesters) is given by $\delta + \delta^2 + \delta^3 + \delta^4$. We use this expression and an aggregate value for δ, which is estimated as the product of 0.55 (firm-level estimate) and the share of total output exposed to the multiplier (between 0.2 and 0.4) This simple aggregate multiplier abstracts away from general equilibrium considerations.

working capital channel by comparing how a same firm responds to permanent shocks differently when these shocks are initiated in the period in which they are most profitable (their "main quarter"). This hypothesis allows us to identify the multiplier by measuring how the same firm responds to recurring shocks when the shock hits the firm inside versus outside its main quarter. We illustrate theoretically why our test should isolate a working capital multiplier, implement our test using oil price shocks, and provide extensive evidence supporting this identification hypothesis. While our test examines the effect of a permanent shock, our identification strategy is designed to isolate how temporary differences in firms' balance sheets are propagated and amplified over time (credit multiplier).

To the best of our knowledge, our identification strategy is new to the literature and could be applied in other settings. An important advantage of our seasonality-based identification strategy is that it can be applied to study the effect of a broad range of recurring economic shocks.

Our test detects a significant working capital multiplier that is only present in a specific subsample of listed firms that is potentially exposed to this credit multiplier. While this group of firms represents a narrow subset of our data, it is representative of a broader range of private firms outside our sample that are smaller in size and rely on financing from suppliers. Thus, we believe that this working capital channel has potentially important macroeconomic implications for the real effects of financial markets and monetary policy. In the presence of this channel, financial conditions or interest rates not only matter for aggregate demand through investment or consumption but can also directly affect firms' production decisions. In this way, these conditions can have a stronger immediate effect on real economic activity. Our analysis complements previous analyzes of these broader effects by proposing and implementing a test for detecting this working capital channel at the firm level.

Most micro-level research in corporate finance on the causes and consequences of financing frictions focuses on firms' need to finance their long-term investment. Our results highlight the importance of also considering firms' need to finance their working capital. One interesting direction for future research is incorporating these working capital considerations into analyses of firms' financial and hedging policies. Another interesting direction for future research is to understand in greater detail the contracting problems associated with this alternative financing need and the specific lending arrangements that might emerge in response to these problems. For example, if firms' demand for working capital financing is a consequence of a need to extend credit to their customers, screening and monitoring the credit quality of these customers can play a central role in addressing this financing problem.

References

Almeida, Heitor, and Murillo Campello. 2007. "Financial Constraints, Asset Tangibility, and Corporate Investment." *Review of Financial Studies,* 20(5), 1429-1460.

Almeida, Heitor, Murillo Campello, Bruno Laranjeira, and Scott Weisbenner. 2012. "Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis." *Critical Finance Review*, 1(1), 3-58.

Amiti, Mary, and David E. Weinstein. 2011. "Exports and Financial Shocks." *Quarterly Journal of Economics*, 126(4), 1841-1877.

Barrot, Jean-Noel. 2016. "Trade Credit and Industry Dynamics: Evidence from Trucking Firms." *Journal of Finance*, 71(5), 1975-2016.

Barth, Marvin J., and Valerie A. Ramey. 2001. "The Cost Channel of Monetary Transmission." *NBER Macroeconomics Annual,* 16, 199-240.

Bergman, Nittai, Rajkamal Iyer, and Richard T. Thakor. 2017. "The Effect of Cash Injections: Evidence from the 1980s Farm Debt Crisis." Working Paper, NBER

Bernanke, Ben, and Mark Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review,* 79(1), 14-31.

Carvalho, Daniel. 2015. "Financing Constraints and the Amplification of Aggregate Downturns." *Review of Financial Studies*, 28(9), 2463-2501.

Chaney, Thomas, David Sraer, and David Thesmar. 2012. "The Collateral Channel: How Real Estate Shocks Affect Corporate Investment." *American Economic Review*, 102(6), 2381-2409.

Chang, Tom Y., Samuel M. Hartzmark, David H. Solomon, Eugene F. Soltes. 2017. "Being Surprised by the Unsurprising: Earnings Seasonality and Stock Returns." *Review of Financial Studies*, 30(1), 281-323.

Christiano, Larry J., Martin Eichenbaum, and Charles L. Evans. 2005. "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy." *Journal of Political Economy,* 113(1), 1-45.

Cunat, Vincente. 2007. Trade Credit: Suppliers as Debt Collectors and Insurance Providers, *Review of Financial Studies*, 20(2), 491-527.

Duchin, Ran, Oguzhan Ozbas, and Berk A. Sensoy. 2010. "Costly External Finance, Corporate Investment, and the Subprime Mortgage Credit Crisis." *Journal of Financial Economics*, 97(3), 418-435.

Farre-Mensa, Joan and Alexander Ljungqvist. 2016. Do Measures of Financial Constraints Measure Financial Constraints? *Review of Financial Studies*, 29(2), 271-308.

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Petersen. 1988. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity,* 19(1), 1141-195.

Froot, Kenneth, David Scharfstein, and Jeremy Stein. 1990. "Risk Management: Coordinating Corporate Investment and Financing Policies." *Journal of Finance*, 48(5), 1629-1658.

Gan, Jie. 2007. "The Real Effects of Asset Market Bubbles: Loan- and Firm-Level Evidence of a Lending Channel." *Review of Financial Studies*, 20(6), 1941-1973.

Giannetti, Mariassunta, Mike Burkart, and Tore Ellingsen. 2011. "What You Sell is What You Lend? Explaining Trade Credit Contracts." *Review of Financial Studies*, 24(4), 1261-1298.

Giroud, Xavier, and Holger Mueller, 2017, "Firm Leverage, Consumer Demand, and Employment Losses During the Great Recession." *Quarterly Journal of Economics*, 132(1), 271-316.

Holmstrom, Bengt and Jean Tirole, 1998. Private and Public Supply of Liquidity. *Journal of Political Economy*, 106(1), 1-40.

Huber, Kilian. 2018. "Disentangling the Effects of a Banking Crisis: Evidence from German Firms and Counties." *American Economic Review,* 108(3), 868-98.

Jermann, Urban, and Vincenzo Quadrini. 2012. "Macroeconomic Effects of Financial Shocks." *American Economic Review*, 102(1), 238-71.

Klapper, Leora, Luc Laeven, and Raghuram G. Rajan. 2012. "Trade Credit Contracts." *Review of Financial Studies*, 25(3), 838-867.

Kiyotaki, Nobuhiro, and John Moore. 1997. "Credit Cycles." *Journal of Political Economy*, 105(2), 211-248.

Lemmon, Michael, and Michael R. Roberts. 2010. "The Response of Corporate Financing and Investment to Changes in the Supply of Credit." *Journal of Financial and Quantitative Analysis,* 45(3), 555-587.

Mian, Atif, and Amir Sufi. 2014. "What Explains the 2007-2009 Drop in Employment?", *Econometrica*, 82(6), 2197-2223.

Mendoza, Enrique G. 2010. "Sudden Stops, Financial Crises, and Leverage." *American Economic Review*, 100(5), 1941-66.

Mendoza, Enrique G., and Vivian Z. Yue. 2012. "A General Equilibrium Model of Sovereign Default and Business Cycles." *Quarterly Journal of Economics*, 127(2), 889-946.

Murfin, Justin, and Ryan Pratt. 2017. "Who Finances Durable Goods and Why It Matters: Captive Finance and the Coase Conjecture." Working Paper, Yale SOM.

Ng, Chee K., Janet K. Smith, and Richard L. Smith. 1999. "Evidence on the Determinants of Credit Terms Used in Interfirm Trade." *Journal of Finance*, 54(3), 1109-29.

Paravisini, Daniel, Veronica Rappoport, Philipp Schnabl, and Daniel Wolfenzon. 2015. "Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export Data." *Review of Economic Studies*, 82(1), 333-359.

Petersen Mitchell. A., and Raghuram G. Rajan. 1997. "Trade Credit: Theories and Evidence." *Review of Financial Studies*, 10(3), 661-691.

Rampini, Adriano A., Amir Sufi, and S. Viswanathan, 2014, Dynamic risk management, *Journal of Financial Economics*, 111(2), 271-296

Rauh, Josh. 2006. "Investment and Financing Constraints: Evidence from the Funding of Corporate Pension Plans." *Journal of Finance,* 61(1), 33-71.

Stulz, Rene. 1996. "Rethinking Risk Management". *Journal of Applied Corporate Finance*, 9(3), 8-25.

Tirole, Jean. 2006. *The Theory of Corporate Finance*. Princeton University Press, Princeton, NJ.

Wilner, Benjamim S. 2000. "The Exploitation of Relationships in Financial Distress: The Case of Trade Credit." *Journal of Finance*, 55(1), 153-78.

Wooldridge, Jeffrey. 2002. *Econometric Analysis of Cross-Section and Panel Data*. MIT Press, Cambridge, MA.

Appendix A – A Model of the Working Capital Channel: Results

We provide more details on the results from the model discussed in Section 1. We first consider the case of a constrained steady state, then analyze the unconstrained steady state, and finally discuss the identification and magnitude of the credit multiplier.

<u>Analysis of Constrained Steady State</u>

We first analyze the existence and properties of this steady state and then consider the effects of price shocks around this steady state. We start by deriving the limit on how much input a firm with low net worth can use (Equation (1)). If the firm decides to produce in period *t*, it faces the following budget constraint: $pm_t = w_t + l_t$, where l_t is the amount borrowed by the firm at the start of period *t*. The firm can borrow at most $\theta \times y_t$ and the combination of these two conditions leads to Equation (1). If this limit is binding (i.e. firm is choosing m_t^*), the firm has to repay $\theta \times y_t$ at the end of period, in addition to paying out at least a share γ of the income generated during that period. Therefore, under these conditions, the firm's net worth in period *t+1* can be determined as $w_{t+1} = (1-\gamma)(1-\theta)y(m_t^*)$. Equation (1) and this last condition determine the dynamics of a firm facing a binding working capital constraint.

Suppose a firm is in a steady state where the working capital constraint is binding in both states H and L (constrained steady state). This steady state is uniquely characterized by the input choices in each state (m_H^*, m_L^*). These choices are determined by the (necessary) condition:

$$m_S^* = \frac{(1-\gamma)(1-\theta)b_K(m_K^*)m_K^*}{p - \theta b_S(m_S^*)} \tag{A.1}$$

where $(S,K) \in \{(H,L),(L,H)\}$. This condition captures the two possible transitions from one state to the other implied by the previous dynamics. Decisions in each state imply a certain net worth, which is carried to the next state and determines the next input limit. Given a value for m_K^*, we define $\widetilde{m}_S(m_K^*)$ as the unique solution for m_S^* in Equation (A.1). This solution exists and its unique because $m_S^*(p - \theta b_S(m_S^*))$ is monotonic in m_S^* and its range covers the interval $[0,\infty)$. If a constrained steady state exists, it will be determined as the unique solution of $\widetilde{m}_H(m_L^*) = m_H^*$ and $\widetilde{m}_L(m_H^*) = m_L^*$. These two response functions will always intercept at a unique point because they satisfy the following conditions: $\widetilde{m}_S^{'}(m) > 0$, $\widetilde{m}_S^{''}(m) < 0$, $\lim_{m\to\infty} \widetilde{m}_S^{'}(m) < 1$, and $\lim_{m\to 0} \widetilde{m}_S(m) > 0$. One can check these properties using the implicit differentiation of $\widetilde{m}_S(m)$ in Equation (A.1) combined with the properties of the revenue function.

This unique solution (m_H^*, m_L^*) for Equation (A.1) will only be a steady state if it is optimal for firms to reach the binding limit on inputs. In other words, we must have that $y_S^{'}(m_S^*) > p$ for $S \in \{H,L\}$. Since the revenue function is concave, this condition will imply that is optimal for firms to expand as much as possible in the constrained regions. Note that $y_S^{'}(m_S^*) = \varepsilon \times b_S(m_S^*)$ and denote $b_S^* \equiv b_S(m_S^*)$, what allows us to write the last condition as $\frac{b_S^*}{p} > \frac{1}{\varepsilon}$. We have that $b_H^* > b_L^*$ in any solution (m_H^*, m_L^*) for Equation (A.1), so we only need to check this condition in the low state. This last result can be shown as follows. Denote $y_S^* \equiv b_S^* m_S^* = A_S(m_S^*)^{\varepsilon}$. If $m_H^* \geq m_L^*$, then it must be the case that $y_H^* > y_L^*$ (since $A_H > A_L$). If $b_H^* \leq b_L^*$, then Equation (A.1) would imply that $m_H^* < m_L^*$, since firms start the high state with lower net worth and have a lower multiplier in the high state. Alternatively, if $m_H^* < m_L^*$, the fact that $b_S^* = \frac{A_S}{(m_S^*)^{1-\varepsilon}}$ and $A_H > A_L$ implies that $b_H^* > b_L^*$. As in the previous case, it also must be the case that $b_H^* m_H^* > b_L^* m_L^*$. If the opposite holds, Equation (A.1) would imply that $m_H^* > m_L^*$. Therefore, in any solution of Equation (A.1) we also have that $y_H^* > y_L^*$.

One way to ensure that the previous condition holds in the low state is to find an upper bound for m_L^*. Let $\overline{m}_L$ be an upper bound for m_L^* and $\widetilde{b}_L = \frac{A_L}{(\overline{m}_L)^{1-\varepsilon}}$. The condition $\frac{\widetilde{b}_L}{p} > \frac{1}{\varepsilon}$ will imply that $\frac{b_L^*}{p} > \frac{1}{\varepsilon}$. We use an intuitive upper bound $\overline{m}_L = m^*$ to derive a sufficient condition for the existence of this steady state. More specifically, we set m^* as the solution of $\widetilde{m}_H(m^*) = m^*$, the unique solution of $\widetilde{m}_H(m_L^*) = m_H^*$ and $\widetilde{m}_L(m_H^*) = m_L^*$ that would emerge if we changed the value of A_L to match the initial value for A_H. As we move from the initial intersection of the response functions to the new intersection, the only change is an increase in the value of A_L. This leads to an increase in $\widetilde{m}_L(m)$ for any given m(from Equation (A.1)). Therefore, the value for m^* must be larger than the initial value for m_L^*.

The solution for m^* implies that $\widetilde{b}_L = \frac{A_L}{(m^*)^{1-\varepsilon}} = \left(\frac{A_L}{A_H}\right)\left(\frac{p}{1-\gamma(1-\theta)}\right)$ and $\frac{\widetilde{b}_L}{p} > \frac{1}{\varepsilon}$ will hold only if $\gamma(1-\theta) > 1-(A_L / A_H)\varepsilon$. This last condition (described in Section 1) is therefore a sufficient condition for the existence of a (unique) constrained steady state. This condition is intuitive and will be satisfied only if the payout ratio γ is sufficiently high and firms' ability to pledge their income θ is sufficiently limited.

We then analyze firms' response to input price shocks around this steady state (exercise described in Section 1). Recall that we measure firms' response to the shock in period *t* as $\widetilde{y}_t(s_1) \equiv \frac{\partial y_t(s_1)}{\partial \widetilde{p}} \times \frac{p}{y_t^*(s_1)}$, where $y_t(s)$ denotes the actual value for the firm's revenue in period *t*, $\widetilde{p}$ is the new price, $y_t^*(s_1)$ is the value for $y_t(s_1)$ at the original price (no shock), and s_1 is the original state at the time of the shock (*t=1*). We can define the effect of the shock on firms' input choices and net worth in an analogous way and we denote these responses as $\widetilde{m}_t(s_1)$ and $\widetilde{w}_t(s_1)$, respectively. We note that $\widetilde{y}_t(s_1) = \varepsilon \times \widetilde{m}_t(s_1)$ (constant factor elasticity in Cobb-Douglas revenue function) and focus on the analysis of $\widetilde{m}_t(s_1)$.

The central points in this analysis are the following. There are both direct and indirect effects from the marginal change in input price. The direct effect in each period is captured by the effect of marginal input price changes in Equation (1) (conditional on the net worth). We can write this equation as:

$$m_t^* = \frac{1}{p-\theta b_t(m_t^*)} \times w_t. \tag{A.2}$$

An increase in the input price affects firms funding capacity m_t^* by increasing the minimum down payment $p-\theta b_t(m_t^*)$. This direct effect is present in both periods *t=1* and *t=2*. As firms' input decisions change in response to this direct effect, their net worth changes, and this feedbacks into their decisions. This indirect effect will be captured in Equation (A.2) by endogenous changes in w_t. This endogenous response of firms' net worth will not be relevant in *t=1* because the firm's initial net worth at *t=1* is determined prior to the shock. On the other hand, the direct effect in *t=1* will translate into a change in net worth and an indirect effect at *t=2*. More formally, we can solve for $\widetilde{m}_1(s_1)$ by differentiating both sides of Equation (A.2) with respect to *p* (the net worth is fixed). The previous condition determining the evolution of the net worth then implies that $\widetilde{w}_2(s_1) = \widetilde{y}_1(s_1) = \varepsilon \times \widetilde{m}_1(s_1)$. Finally, we can solve for $\widetilde{m}_2(s_1)$ by also differentiating both sides of Equation (A.2) with respect to p and using the previous expression for $\widetilde{w}_2(s_1)$.

Denote $b_t(s_1)$ as the value of $b_t(m_t^*)$ in the original steady state trajectory ($\widetilde{p} = p$). This average profitability depends on s_1 because this initial state determines the state in period t. As in Section 1, denote the average effect of the shock as $\widetilde{m}_{12}(s_1) \equiv (1/2)(\widetilde{m}_1(s_1) + \widetilde{m}_2(s_1))$. The previous steps lead to $\widetilde{m}_1(s_1) = -\left(\dfrac{p}{p - \theta\varepsilon b_1(s_1)}\right)$. This captures the previous direct effect of the input price shock. A one dollar increase in the price requires an additional one dollar in internal funds per unit of input, and the percentage increase in these required internal funds is larger when firms initially have more leverage or use less internal funds, i.e. when the minimum down payment is initially smaller. This expression implies that $\widetilde{y}_1(H) < \widetilde{y}_1(L) < 0$.

It is natural to expect the average direct effect over the cycle (*t=1* and *t=2*) to be given in an analogous way by $D \equiv -(0.5)\left(\dfrac{p}{p - \theta\varepsilon b_1(s_1)}\right) - (0.5)\left(\dfrac{p}{p - \theta\varepsilon b_2(s_1)}\right)$. Note that this term does not depend on s_1 because the average captures all states. Consistent with this intuition, the previous steps lead to $\widetilde{m}_{12}(s_1) = D + M(s_1)$, where $M(s_1) < 0$ is the previous credit-multiplier effect in *t=2* due to the endogenous change in net worth at *t=1* (indirect effect of price shock). We have that $M(s_1) = -C \times \left(\dfrac{p}{p - \theta b_1(s_1)}\right)$, where $0 < C < 1$ is a term that does not depend on s_1. This indirect effect depends on the firms' net worth multiplier in the first period because this determines the importance of the initial direct effect of the price shock. When the initial (*t=1*) direct effect is stronger, there is larger drop in net worth in the second period and a larger multiplier effect over time. Because firms' profitability in the steady state is stronger in the high state, we have that $M(H) < M(L) < 0$ and $\widetilde{y}_{12}(H) < \widetilde{y}_{12}(L) < 0$. This implies that $\widetilde{y}_{12}(s_1) = \varepsilon \times \widetilde{m}_{12}(s_1) = D_y + ME(s_1)$, where $ME(s_1) = \varepsilon \times M(s_1)$ and $D_y = \varepsilon \times D$. The difference $\Delta\widetilde{y}_{12} = \widetilde{y}_{12}(H) - \widetilde{y}_{12}(L) = ME(H) - ME(L)$ isolates the differential importance of the credit-multiplier effect in the case where the shock is initiated in the high state. This last result is the key point we use to motivate our identification of the credit-multiplier effect on firm sales. We summarize these results in the proposition below.

<u>PROPOSITION A.1</u>: *A constrained steady state exists if* $\gamma(1-\theta) > 1 - (A_L / A_H)\varepsilon$. *This constrained steady state is always unique. If the firm is in this steady state, we have that* $\widetilde{y}_1(H) < \widetilde{y}_1(L) < 0$, $\widetilde{y}_{12}(H) < \widetilde{y}_{12}(L) < 0$, *and* $\Delta\widetilde{y}_{12} = \widetilde{y}_{12}(H) - \widetilde{y}_{12}(L) = ME(H) - ME(L)$.

Proof. See the text above.

<u>Analysis of Unconstrained Steady State</u>

We follow the previous analysis and first analyze the existence and properties of this steady state. We then examine the effects of price shocks around this steady state and also consider a version of the model where there is no timing gap between inputs and sales. In an unconstrained steady state, firms' decisions (m_H^*, m_L^*) are given by the first-best decisions $y_S^{'}(m_S^*) = p$ for $S = H, L$. A sufficient condition for the existence of this steady state is that:

$$\frac{(1-\gamma)(1-\theta)b_K(m_K^*)m_K^*}{p - \theta b_S(m_S^*)} > m_S^*, \tag{A.3}$$

where $(S,K) \in \{(H,L),(L,H)\}$ and (m_H^*, m_L^*) are the previous first-best decisions. If Equation (A.3) is satisfied, firms in the first best in period *t* always manage to have enough net worth at the start of period *t+1* to continue in the first best. Firms in this situation always have more net worth than the minimum net worth required (with the minimum down payment) to finance the first best decision. In other words, firms can use internal resources to finance inputs upfront and continue outside the binding credit constraint as they transition between the two states.

We consider parameter values where Equation (A.3) is satisfied. We start by noticing that $y_S^{'}(m_S^*) = \varepsilon \times b_S(m_S^*)$. This implies that $y_S(m_S^*) = \left(\frac{p}{\varepsilon}\right) m_S^*$ and $y_H(m_H^*) / y_L(m_L^*) = m_H^* / m_L^* > 1$. We first consider the transition from a high into a low state ($(S,K) = (L,H)$). Since $y_H(m_H^*) / y_L(m_L^*) > 1$, Equation (A.3) is satisfied if $(1-\gamma)(1-\theta) y_L(m_L^*) > (p - \theta b_L(m_L^*)) m_L^*$, which holds if $\gamma(1-\theta) < 1-\varepsilon$. This last step uses the fact that $b_S(m_S^*) = \left(\frac{p}{\varepsilon}\right)$. We label this last condition as (L). We then examine the transition from a low into a high state $(S,K) = (H,L)$. Equation (A.3) is now satisfied if $(1-\gamma)(1-\theta) y_H(m_H^*)(1-\rho) > (p - \theta b_H(m_H^*)) m_H^*$, where $(1-\rho) = y_L(m_L^*) / y_H(m_H^*) = m_L^* / m_H^*$. The expression $b_S(m_S^*) = \left(\frac{p}{\varepsilon}\right)$ allows one to determine (m_H^*, m_L^*) and write $\rho = 1 - \left(\frac{A_L}{A_H}\right)^{\frac{1}{1-\varepsilon}}$, as well as express Equation (A.3) in this context as: $\gamma(1-\theta) < 1 - \varepsilon - \rho(1-\gamma)(1-\theta)$. We label this last condition as (H) and note that, if (H) holds, then (L) also holds. Therefore, this unconstrained steady state exists if $(\gamma(1-\rho)+\rho)(1-\theta) < 1-\varepsilon$, where $0 < \rho(A_L, A_H) < 1$.

We now analyze firms' response to input price shocks around an unconstrained steady state. Note that the firm remains unconstrained (in all states) in a neighborhood of this steady state. This allows us to determine firms' decisions $m_t(s)$ in response to marginal price shocks using the previous first-best conditions $y_S^{'}(m_t(s)) = \tilde{p}$. In this context, $\tilde{m}_{12}(s_1)$ will be a simple average of direct price effects across the two states. Changes in the price will only affect the factor demand directly through this expression as firms' net worth does not affect decisions. Therefore, the average effect across the two states will be given by an average of the direct effects and will not depend on the timing of the shock (s_1).This implies that $\tilde{y}_{12}(H) = \tilde{y}_{12}(L)$. The effect $\tilde{m}_1(s_1)$ will depend on the second derivative of the revenue function. In general, the interaction of $\tilde{m}_1(s_1)$ with s_1 will depend on third-order terms of this revenue function and will have an unclear sign. In our specific example with a Cobb-Douglas revenue function, we can write that

$m_t(s) = \left(\frac{A_S \varepsilon}{\widetilde{p}}\right)^{\frac{1}{1-\varepsilon}}$ and this leads to $\widetilde{m}_1(H) = \widetilde{m}_1(L) = -\left(\frac{1}{1-\varepsilon}\right)$ and $\widetilde{y}_1(H) = \widetilde{y}_1(L)$. Notice that these results would remain the same if we analyzed a version of the model where there is no timing gap between the purchase of inputs and revenue collection. In this context, the firm's input decisions will also be given by the first-best input choices as there is no need for the financing of production. Therefore, all steps in the last analysis would remain unchanged. We summarize these results in the next proposition.

PROPOSITION A.2: *An unconstrained steady state exists if* $(\gamma(1-\rho)+\rho)(1-\theta) < 1-\varepsilon$*, where* $0 < \rho(A_L, A_H) < 1$. *If the firm is in an unconstrained steady state, we have that* $\widetilde{y}_1(H) = \widetilde{y}_1(L)$ *and* $\widetilde{y}_{12}(H) = \widetilde{y}_{12}(L)$. *These last results will also hold if the firm is in the steady state of the version of the model without the timing gap in production.*

Proof. See the text above.

Equation (A.3) implies that a firm initially in the first best can build net worth over time until there is no need to raise external funds. Since there is an arbitrarily small cost of using external funds, the firm will prefer to follow this strategy. In contrast with the constrained steady state where the firm keeps borrowing to the limit to finance inputs, the firm in this unconstrained steady state will finance inputs using only internal funds.

Analysis of Credit Multiplier

In the constrained case, $ME(s_1)$ is the credit-multiplier effect at *t=2*. We can express this effect as $ME(s_1) = CM(s_1) \times \widetilde{y}_1(s_1)$, where $0 < CM(s_1) < 1$ is a credit multiplier on firms' sales. This multiplier describes how a 1.0% drop in the production capacity of a constrained firm in period *t* reduces its production capacity (%) in *t+1* through the working capital channel. A drop in production capacity in *t* reduces firms' net worth w_{t+1} and this lowers its financing capacity at *t+1* (m^*_{t+1}). As discussed above, we can isolate the importance of the credit-multiplier effect by examining the difference $\Delta\widetilde{y}_{12} = ME(H) - ME(L) = \Delta ME$. This provides a lower bound for the absolute value of $ME(H)$. Since $CM(H) = ME(H)/\widetilde{y}_1(H)$, a simple lower bound for $CM(H)$ is $\beta = \Delta\widetilde{y}_{12}/\widetilde{y}_1(H) = \Delta ME/\widetilde{y}_1(H)$. Intuitively, this lower bound will be closer to $CM(H)$ when $\widetilde{y}_1(H) - \widetilde{y}_1(L)$ is large in absolute terms relative to $\widetilde{y}_1(L)$. If this is the case, ΔME will also be closer in absolute terms to $ME(H)$.

An alternative approach to estimate the multiplier would be to use the ratio $\beta = \Delta\widetilde{y}_{12}/\Delta\widetilde{y}_1$. This approach would scale the incremental credit-multiplier effect by the incremental value of the initial drop in sales. While intuitive, this approach leads one to overestimate the multiplier because $CM(H) > CM(L)$ and $\Delta ME = CM(H)\tilde{y}_1(H) - CM(L)\tilde{y}_1(L)$ incorporates both this difference and the effect of $\Delta\tilde{y}_1$.

We note that a high value for this multiplier does not imply that an equally large share of incremental cash flows in a given period is being used to fund production in the next period. For example, consider the unique constrained steady state that emerges in the case where $\{A_H, A_L, p, \varepsilon, \theta, \gamma\} = \{6, 5, 1, 0.85, 0.2, 0.5\}$. We have that $CM(H) = 0.80$ while a constrained firm uses 50% of increases in current cash flows for other purposes different than funding production in the next period. If a firm is saving a constant share of its current cash flows to fund future production, even if this share is low, a 1.0% increase in cash flows today will translate into 1% more funds tomorrow that can be combined with external funds. Therefore, the multiplier (elasticity) can be high even if the share of cash flows used to fund future production is low.

Appendix B – Variable Definitions

Main Quarter is an indicator that equals one in the quarter of a year when a firm is historically with the highest *Cash Flow* based on the previous five calendar years.

Cash Flow is the ratio of operating income before depreciation (*oidbpq*) to lagged total assets (*atq*).

Oil Price Growth is the log difference between oil prices in quarter *t* and *t-1*.

Industry Oil Beta is the average industry (SIC-3-digit) oil beta.

Oil Shock = Oil Price Growth(-Industry Oil Beta).*

Log of Sales is log of (*saleq* + 1).

Log of Age is log of (number of years + 1) since a firm first appears in Compustat annual tape.

Q is the ratio of market capitalization (*prccq* * *cshprq*) plus total outstanding debt (*dlcq* + *dlttq*) plus total preferred stock (*pstkq*) minus deferred taxes and investment tax credit (*txditcq*) to total assets (*atq*).

Cash is the ratio of cash and short-term investments (*cheq*) to lagged total assets (*atq*).

Book Leverage is the ratio of total outstanding debt (*dlcq* + *dlttq*) to lagged total assets (*atq*).

Short-Term Debt/Assets is the ratio of current liabilities minus long-term debt due in one year (*dlcq-dd1q*) to total assets (*atq*).

Short-Term Debt/Sales is the ratio of current liabilities minus long-term debt due in one year (*dlcq-dd1q*) to annualized sales (*saleq*4*).

Investment is the quarterly capital expenditure (*capex*) divided by lagged net property, plant and equipment (*ppentq*).

Supplier Financing is the ratio of accounts payable (*apq*) to annualized sales (*saleq**4).

Payables/Assets is the ratio of accounts payable (*apq*) to total assets (*atq*).

Receivables/Sales is the ratio of receivables (*rectq*) to annualized sales (*saleq**4).

Receivables/Assets is the ratio of receivables (*rectq*) to total assets (*atq*).

Inventories/Sales is the ratio of inventory (*invtq*) to annualized sales (*saleq**4).

Inventories/Assets is the ratio of inventory (*invtq*) to total assets (*atq*).

Profit Margin is the ratio of operating income before depreciation *(oibdp)* to sales *(saleq)*.

Log of Cogs is log of *(cogsq + 1)*.

Log of SG&A is log of (*xsgaq* + 1).

R&D/Assets is the ratio of research and development expense (*xrdq*) to total assets (*atq*).

Sales of PPE is sale of property, plant, and equipment *(sppe)*.

LogAP is the log of payables, log of *(apq +1)*.

LogARInvt is the log of the sum of receivables and inventory, log of (*rectq* + *invtq* + 1).

MedianAP in Table 2 is the median of the ratio of payables (*apq*) to annualized sales (*saleq**4).

MedianAR in Table 2 is the median of the ratio of receivables (*rectq*) to annualized sales (*saleq**4).

MedianInvt in Table 2 is the median of the ratio of inventory (*invtq*) to annualized sales (*saleq**4)

For every variable *X*, *△Log X (t,t+k)* is the average of *Log(X)* between quarters *t* and *t+k* minus the average value of this variable between quarters *t-1* and *t-4*. *△Log X (t)* is the log of *X* in quarter *t* minus the average for this variable between quarters *t-1* and *t-4*.

Table 1: Summary Statistics

This table presents summary statistics on the main samples used in the analysis. Panel A reports summary statistics for the overall sample, which includes firms with nonpositive industry (3-digit SIC code) oil beta that are outside the top size tercile. This size tercile is constructed using the one-quarter lag of total (book) assets and all firms (sorted by calendar year). The samples in Panels B, C, D, and E represent different subsamples of this initial sample. The samples in Panels B and C are constructed as the top and bottom terciles of the average value of *Supplier Financing* in the previous four quarters (sorted by year). *Supplier Financing* is the ratio of payables to sales (annualized). The samples in Panels D and E are constructed in an analogous way using the average value of *Short-term Debt/Sales* in the previous four quarters. See Appendix B for variable definitions.

Panel A: All Negative Beta Firms

	Nobs	Mean	Median	SD	P10	P90
Log of Sales	38,514	3.43	3.56	1.55	1.20	5.36
Log of Age	38,457	2.80	2.77	0.51	2.20	3.50
Q	38,161	1.69	1.09	2.30	0.55	3.20
Cash Flow	37,022	0.01	0.03	0.07	-0.04	0.07
Profit Margin	35,651	0.06	0.09	0.27	-0.11	0.25
Cash	37,907	0.18	0.10	0.21	0.01	0.51
Book Leverage	38,284	0.23	0.16	0.32	0.00	0.52
Short-Term Debt/Assets	38,290	0.06	0.01	0.16	0.00	0.16
Short-Term Debt/Sales	38,256	0.07	0.01	0.30	0.00	0.13
Supplier Financing (= Payables/Sales)	38,047	0.13	0.06	0.54	0.02	0.17
Payables/Assets	38,276	0.10	0.07	0.10	0.02	0.22
Receivables/Sales	37,814	0.17	0.15	0.14	0.04	0.27
Receivables/Assets	37,610	0.18	0.16	0.13	0.03	0.35
Inventories/Sales	37,603	0.13	0.09	0.15	0.00	0.30
Inventories/Assets	37,183	0.15	0.11	0.16	0.00	0.39
Investment	35,919	0.07	0.05	0.09	0.01	0.16
R&D/Assets	34,097	0.29	0.00	1.02	0.00	0.70
Sales of PPE	28,467	0.00	0.00	0.01	0.00	0.01

Panel B: Top 33% Supplier Financing

	Nobs	Mean	Median	SD	P10	P90
Log of Sales	12,589	2.99	3.05	1.68	0.59	5.21
Log of Age	12,570	2.73	2.67	0.50	2.08	3.43
Q	12,451	1.91	1.02	3.18	0.51	3.90
Cash Flow	12,017	-0.01	0.02	0.10	-0.12	0.06
Profit Margin	10,876	-0.04	0.06	0.38	-0.40	0.22
Cash	12,245	0.20	0.09	0.24	0.01	0.61
Book Leverage	12,515	0.27	0.18	0.43	0.00	0.57
Short-Term Debt/Assets	12,511	0.08	0.01	0.22	0.00	0.21
Short-Term Debt/Sales	12,494	0.11	0.01	0.42	0.00	0.21
Supplier Financing (= Payables/Sales)	12,532	0.27	0.13	0.83	0.07	0.35
Payables/Assets	12,562	0.16	0.13	0.14	0.04	0.32
Receivables/Sales	12,278	0.19	0.17	0.18	0.03	0.32
Receivables/Assets	12,214	0.18	0.16	0.13	0.02	0.37
Inventories/Sales	12,188	0.16	0.11	0.19	0.00	0.37
Inventories/Assets	11,964	0.16	0.11	0.17	0.00	0.42
Investment	11,635	0.07	0.04	0.09	0.00	0.16
R&D/Assets	10,993	0.42	0.00	1.37	0.00	1.07
Sales of PPE	9,395	0.00	0.00	0.01	0.00	0.01

Panel C: Bottom 33% Supplier Financing

	Nobs	Mean	Median	SD	P10	P90
Log of Sales	12,692	3.68	3.80	1.38	1.76	5.40
Log of Age	12,667	2.80	2.77	0.48	2.20	3.47
Q	12,607	1.66	1.21	1.49	0.60	3.16
Cash Flow	12,285	0.03	0.04	0.04	-0.00	0.07
Profit Margin	12,269	0.12	0.12	0.18	-0.01	0.30
Cash	12,644	0.19	0.12	0.20	0.01	0.49
Book Leverage	12,630	0.19	0.11	0.25	0.00	0.51
Short-Term Debt/Assets	12,635	0.03	0.00	0.09	0.00	0.09
Short-Term Debt/Sales	12,636	0.04	0.00	0.18	0.00	0.08
Supplier Financing (= Payables/Sales)	12,619	0.03	0.03	0.02	0.01	0.05
Payables/Assets	12,659	0.04	0.04	0.04	0.01	0.09
Receivables/Sales	12,561	0.15	0.14	0.10	0.04	0.25
Receivables/Assets	12,519	0.17	0.15	0.12	0.04	0.33
Inventories/Sales	12,477	0.09	0.04	0.12	0.00	0.24
Inventories/Assets	12,420	0.11	0.05	0.14	0.00	0.33
Investment	11,941	0.08	0.05	0.09	0.01	0.17
R&D/Assets	11,345	0.23	0.00	0.66	0.00	0.64
Sales of PPE	9,277	0.00	0.00	0.01	0.00	0.01

Panel D: Top 33% Short-Term Debt/Sales

	Nobs	Mean	Median	SD	P10	P90
Log of Sales	16,617	3.42	3.55	1.63	1.12	5.47
Log of Age	16,599	2.83	2.83	0.52	2.20	3.56
Q	16,472	1.70	1.03	2.60	0.54	3.23
Cash Flow	15,949	0.01	0.03	0.08	-0.06	0.06
Profit Margin	14,963	0.04	0.09	0.31	-0.16	0.27
Cash	16,176	0.14	0.06	0.20	0.01	0.42
Book Leverage	16,546	0.31	0.25	0.35	0.00	0.60
Short-Term Debt/Assets	16,550	0.10	0.05	0.19	0.00	0.27
Short-Term Debt/Sales	16,499	0.12	0.04	0.40	0.00	0.23
Supplier Financing (= Payables/Sales)	16,407	0.17	0.07	0.70	0.02	0.19
Payables/Assets	16,502	0.11	0.08	0.12	0.02	0.24
Receivables/Sales	16,325	0.17	0.15	0.15	0.04	0.28
Receivables/Assets	16,177	0.19	0.17	0.13	0.03	0.37
Inventories/Sales	16,185	0.14	0.10	0.17	0.00	0.32
Inventories/Assets	15,991	0.16	0.11	0.17	0.00	0.41
Investment	15,592	0.07	0.04	0.08	0.01	0.15
R&D/Assets	14,934	0.33	0.00	1.28	0.00	0.70
Sales of PPE	12,244	0.00	0.00	0.01	0.00	0.01

Panel E: Bottom 33% Short-Term Debt/Sales

	Nobs	Mean	Median	SD	P10	P90
Log of Sales	14,696	3.37	3.51	1.58	1.06	5.32
Log of Age	14,662	2.79	2.77	0.50	2.20	3.50
Q	14,576	2.05	1.37	2.41	0.61	3.97
Cash Flow	14,251	0.01	0.03	0.08	-0.05	0.07
Profit Margin	13,711	0.06	0.10	0.29	-0.12	0.27
Cash	14,618	0.28	0.22	0.24	0.02	0.66
Book Leverage	14,621	0.12	0.01	0.21	0.00	0.39
Short-Term Debt/Assets	14,628	0.00	0.00	0.03	0.00	0.01
Short-Term Debt/Sales	14,625	0.01	0.00	0.08	0.00	0.01
Supplier Financing (= Payables/Sales)	14,436	0.14	0.05	0.64	0.02	0.17
Payables/Assets	14,584	0.08	0.05	0.09	0.01	0.19
Receivables/Sales	14,449	0.17	0.15	0.15	0.03	0.27
Receivables/Assets	14,436	0.16	0.14	0.12	0.02	0.33
Inventories/Sales	14,401	0.11	0.07	0.15	0.00	0.27
Inventories/Assets	14,282	0.12	0.07	0.14	0.00	0.32
Investment	13,824	0.09	0.06	0.10	0.01	0.19
R&D/Assets	13,242	0.48	0.00	1.40	0.00	1.22
Sales of PPE	11,482	0.00	0.00	0.01	0.00	0.00

Table 2

Industries with Top Supplier Financing Firms

This table describes industries with the highest concentration of top supplier financing firms. Industries are defined as Fama-French industries (48 industries) in Panel A and 4-digit SIC codes in Panels B and C. For each industry (broader or narrower), *TSF Share* is the share of firms in the industry in the top tercile of supplier financing (see Table 1), *NBeta Share* is the share of firms with an industry oil beta more negative than the median beta, and *TSF and NBeta Share* is the share of firms in both of the previous groups (top supplier financing and low beta). These shares are computed using all firms in the industry in the overall sample in Panel A of Table 1. Panel A lists all (broad) industries above the average in terms of *TSF Share*. Panels B and C list the top 15 (narrow) industries in terms of *TSF Share* and *TSF and NBeta Share*, respectively. We require industries to have at least 100 observations in the sample in Panel A of Table 1. *Median AR Ratio* is the median ratio of receivables to sales (annualized) in the industry. *Median Invt Ratio* is the median ratio of inventories to sales (annualized) in the industry.

Panel A: Broader Industry Definitions (Fama-French Industries) based on Top Sup Fin Share

Fama-French Industries	TSF Share	NBeta Share	TSF and NBeta Share	Median AR Ratio	Median Invt Ratio
Steel Works Etc	0.348	0.759	0.297	0.134	0.145
Electronic Equipment	0.352	0.361	0.160	0.179	0.194
Recreation	0.368	0.828	0.317	0.179	0.200
Wholesale	0.368	0.388	0.125	0.133	0.109
Retail	0.371	0.755	0.315	0.022	0.167
Communication	0.372	0.344	0.163	0.161	0.000
Machinery	0.380	0.474	0.180	0.195	0.214
Rubber and Plastic Products	0.413	0.812	0.310	0.148	0.128
Electrical Equipment	0.415	0.650	0.291	0.171	0.194
Non-Metallic and Industrial Metal Mining	0.420	0.644	0.266	0.152	0.097
Coal	0.429	0.646	0.281	0.116	0.051
Shipbuilding, Railroad Equipment	0.435	0.489	0.160	0.107	0.099
Chemicals	0.471	0.490	0.241	0.158	0.140
Construction	0.514	0.618	0.319	0.147	0.100
Defense	0.517	0.955	0.517	0.149	0.124
Precious Metals	0.520	1.000	0.520	0.142	0.162
Pharmaceutical Products	0.542	0.155	0.084	0.141	0.075
Aircraft	0.638	0.037	0.037	0.150	0.240

Panel B: Narrower Industry Definitions (4-Digit SIC codes) based on Top Sup Fin Share

SIC Code	SIC Industy	Fama-French Industry	TSF Share	NBeta Share	TSF and NBeta Share	Median AR Ratio	Median Invt Ratio
3330	Primary Smelting and Refining of Nonferrous Metals	Steel Works Etc	0.558	1.000	0.558	0.106	0.142
3571	Electronic Computers	Computers	0.563	0.335	0.156	0.234	0.147
1600	Heavy Construction other than Building Construction	Construction	0.587	0.964	0.550	0.185	0.039
4841	Cable and other Pay Television Services	Communication	0.602	0.352	0.259	0.142	0.000
5700	Home Furniture, Furnishings, and Equipment Stores	Retail	0.607	0.959	0.573	0.020	0.274
3080	Miscellaneous Plastics Products	Rubber and Plastic Products	0.628	0.806	0.497	0.155	0.151
2836	Biological Products, except Diagnostic Substances	Pharmaceutical Products	0.699	0.154	0.107	0.157	0.000
3728	Aircraft Parts and Auxiliary Equipment	Aircraft	0.730	0.029	0.029	0.145	0.239
7311	Advertising Agencies	Business Services	0.766	0.430	0.402	0.329	0.035
4011	Railroads, Line-Haul Operating	Transportation	0.804	0.039	0.039	0.140	0.030
5940	Miscellaneous Shopping Goods Stores	Retail	0.807	0.868	0.700	0.013	0.310
3612	Power, Distribution, and Specialty Transformers	Electrical Equipment	0.895	0.549	0.444	0.190	0.141
5735	Record and Prerecorded Tape Stores	Retail	0.928	0.928	0.856	0.003	0.222
1540	General Building Contractors-Nonresidential	Construction	0.958	0.685	0.657	0.225	0.002
5944	Jewelry Stores	Retail	0.964	0.857	0.830	0.184	0.416

Panel C: Narrower Industry Definitions (4-Digit SIC codes) based on Top Sup Fin and Neg Beta Share

SIC Code	SIC Industy	Fama-French Industry	TSF Share	NBeta Share	TSF and NBeta Share	Median AR Ratio	Median Invt Ratio
5331	Retail-Variety Stores	Retail	0.445	0.834	0.414	0.009	0.236
3690	Miscellaneous Electrical Machinery, Equipment & Supplies	Electrical Equipment	0.511	0.764	0.424	0.188	0.243
3651	Household Audio & Video Equipment	Recreation	0.470	0.961	0.440	0.177	0.200
7948	Services-Racing, Including Track Operation	Entertainment	0.495	0.926	0.442	0.031	0.000
3612	Power, Distribution, and Specialty Transformers	Electrical Equipment	0.895	0.549	0.444	0.190	0.141
1040	Gold and Silver Ores	Precious Metals	0.455	1.000	0.455	0.102	0.159
3080	Miscellaneous Plastics Products	Rubber and Plastic Products	0.628	0.806	0.497	0.155	0.151
3480	Ordnance & Accessories (No Vehicles/Guided Missiles)	Defense	0.523	1.000	0.523	0.141	0.170
1600	Heavy Construction other than Building Construction	Construction	0.587	0.964	0.550	0.185	0.039
3330	Primary Smelting & Refining of Nonferrous Metals	Steel Works Etc	0.558	1.000	0.558	0.106	0.142
5700	Home Furniture, Furnishings, and Equipment Stores	Retail	0.607	0.959	0.573	0.020	0.274
1540	General Building Contractors-Nonresidential	Construction	0.958	0.685	0.657	0.225	0.002
5940	Miscellaneous Shopping Goods Stores	Retail	0.807	0.868	0.700	0.013	0.310
5944	Jewelry Stores	Retail	0.964	0.857	0.830	0.184	0.416
5735	Record and Prerecorded Tape Stores	Retail	0.928	0.928	0.856	0.003	0.222

Table 3
Distributions of Oil Shocks and Main Quarters

This table shows the distribution of oil price shocks and main quarters used in the analysis. Panel A reports the distribution of quartely oil price growth (oil price shocks) during the sample period separately for each quarter. Oil price growth is the difference between the log of the average (deflated) oil price in the current and previous quarters. Panel B reports the distributions of main quarters in different samples of firms in Table 1. In each sample, the shares of firms with the main quarter equal to Q1, Q2, Q3, and Q4 are listed.

Panel A: Oil Price Growth Distribution in Each Quarter

1st Quarter				
Mean	Median	SD	P25	P75
-0.0074	0.0033	0.1365	-0.0860	0.0766
2nd Quarter				
Mean	Median	SD	P25	P75
-0.0042	0.0109	0.1478	-0.0703	0.0826
3rd Quarter				
Mean	Median	SD	P25	P75
-0.0095	0.0132	0.1476	-0.0898	0.0826
4th Quarter				
Mean	Median	SD	P25	P75
-0.0042	0.0109	0.1415	-0.0777	0.0826

Panel B: Distribution of Main Quarters

Share of Firms with Main Quarter in Each Quarter			
	All Firms	Top 33% Sup Fin	Bottom 33% Sup Fin
Main Quarter = Q1	20.66	23.43	17.74
Main Quarter = Q2	24.02	24.36	24.43
Main Quarter = Q3	24.00	24.15	23.39
Main Quarter = Q4	31.32	28.05	34.44

Table 4

How Important is the Predictable Seasonality in Firm Profitability?

This table analyzes the importance of predictable seasonality in firms' profitability. The results are based on linear regressions predicting different outcomes using *Main Quarter,* industry-quarter fixed effects (3-digit SIC code), and firm-type fixed effects. *Main Quarter* is an indicator that equals one if the firm is currently in its main quarter in terms of profitability (Q1, Q2, Q3, or Q4). For each quarter *t* , this variable is constructed using only historical data on *Cash Flow* in the previous five calendar years (see Section 2 for details). Firm type fixed effects include four indicators for firms with their main quarter in each of the possible four quarters (Q1 firms, Q2 firms, Q3 firms, and Q4 firms). *Cash Flow* is a measure of firms' operating income over assets. *Profit Margin* is a measure of firms' operating income over sales. For each variable *X,* *∆Log X(t)* is the difference between the value of log of *X* in quarter *t* and its average value between quarters *t-1* and *t-4* . *AR* , *Invt* , *AP* , and *STD* denote the firms' outstanding value of receivables, inventories, payables, and short-term debt, respectively. The results are separately estimated in the samples listed in Table 1. In all results where *Cash Flow* or *Profit Margin* is the outcome variable, the reported coefficient of *Main Quarter* is scaled to capture its magnitude. The estimated coefficient is divided by the mean of the outcome variable in the overall sample (see Table 1). Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: All Negative Beta Firms

	Cash Flow	Profit Margin	∆ Log Sale(t)	∆ Log AR+Invt(t)	∆ Log AP(t)	∆ Log STD(t)
	(1)	(2)	(3)	(4)	(5)	(6)
Main Quarter	0.829***	0.317***	0.049***	0.019***	0.016***	0.002
	(10.083)	(7.156)	(6.074)	(3.926)	(3.387)	(0.284)
Observations	42,130	41,249	42,130	42,130	42,130	43,315
R-Squared	0.010	0.011	0.01	0.00	0.00	0.000
Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Top 33% Supplier Financing Firms

	Cash Flow	Profit Margin	∆ Log Sale(t)	∆ Log AR+Invt(t)	∆ Log AP(t)	∆ Log STD(t)
	(1)	(2)	(3)	(4)	(5)	(6)
Main Quarter	0.926***	0.386***	0.042***	0.015**	0.021***	0.012
	(6.850)	(5.203)	(3.300)	(2.531)	(2.662)	(1.144)
Observations	13,385	12,777	13,385	13,385	13,385	13984
R-Squared	0.021	0.006	0.008	0.008	0.008	0.000
Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel C: Bottom 33% Supplier Financing Firms

	Cash Flow	Profit Margin	∆ Log Sale(t)	∆ Log AR+Invt(t)	∆ Log AP(t)	∆ Log STD(t)
	(1)	(2)	(3)	(4)	(5)	(6)
Main Quarter	0.744***	0.306***	0.050***	0.018**	0.018***	-0.006
	(7.033)	(6.007)	(5.644)	(2.534)	(3.215)	(-0.543)
Observations	13,186	13,750	14,243	13,699	14,228	13,516
R-Squared	0.007	0.003	0.015	0.004	0.001	0.000
Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5
The Effect of Oil Price Shocks on Firms' Cash Flows

This table reports evidence that the oil price shocks used in the analysis (constructed at the industry level) have significant and persistent effects on firms' performace. The results are based on linear regresssions predicting different cash flow outcome variables with *Oil Shock* and controls. *Oil Shock = Oil Price Growth × Oil Exposure*, where *Oil Price Growth* is the difference between the log of the average (deflated) oil price in the current and previous quarters. *Oil Exposure* is the absolute value of the estimated industry oil beta (see Section 2). Recall that only firms with negative values for this beta are included. The controls include quarter fixed effects, *Oil Exposure,* and the average value of *Q* between quarters *t-1* and *t-4.* *△Cash Flow(t)* is *Cash Flow* in quarter *t* minus the average value of this variable between quarters *t-1* and *t-4* . *△Cash Flow(t,t+3)* is the average value of *Cash Flow* between quarters *t* and *t+3* minus the average value of this variable between quarters *t-1* and *t-4* . The estimated coefficient of *Oil Shock* is scaled to better capture its magnitude. This coefficient is first multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). This coefficient is then divided by the mean of *Cash Flow* in the overall sample. The results are separateky estimated in the samples described in Table 1. Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: All Negative Beta Firms		
	△Cash Flow(t)	△Cash Flow(t,t+3)
	(1)	(2)
Oil Shock	-0.139***	-0.090***
	(-11.135)	(-7.871)
Observations	36,717	32,835
R-Squared	0.004	0.004
Quarter FE	Yes	Yes
Panel B: Top 33% Supplier Financing Firms		
	△Cash Flow(t)	△Cash Flow(t,t+3)
	(1)	(2)
Oil Shock	-0.177***	-0.092***
	(-6.364)	(-3.600)
Observations	11,485	10,080
R-Squared	0.004	0.004
Quarter FE	Yes	Yes
Panel C: Bottom 33% Supplier Financing Firms		
	△Cash Flow(t)	△Cash Flow(t,t+3)
	(1)	(2)
Oil Shock	-0.093***	-0.073***
	(-7.622)	(-7.063)
Observations	11,851	10,788
R-Squared	0.005	0.006
Quarter FE	Yes	Yes

Table 6

Oil Price Shocks, Seasonality, and Firm Sales

This table reports results analyzing the differential effect of oil price shocks on the sales of firms that are hit by the shock in their main quarter. The results are based on the estimation of Equation (2) in the paper with different outcome variables. *ΔLog Sale (t)* is the log of sales in quarter *t* minus the average value of this variable between quarters *t-1* and *t-4*, and captures the immediate response to the shock. *ΔLog Sale (t,t+3)* is the average value of the log of sales between quarters *t* and *t+3* minus the average for this variable between quarters *t-1* and *t-4*. This last variable captures the average effect of the shock over the entire cycle (year). The controls include *Average_Q*, *Main Quarter*, and oil control variables (*Oil Price Growth* and *Oil Exposure*), as well as the interactions between each of these oil controls and *Main Quarter*. *Average_Q* is the average value of *Q* between quarters t-1 and t-4. Firm type fixed effects (interacted with shocks) include four indicators for firms with their main quarter in each of the possible four quarters (Q1 firms, Q2 firms, Q3 firms, and Q4 firms). This last set of controls also includes the interaction of each of the firm-type fixed effects with the two oil control variables and *OilShock*. The estimated coefficient of *Oil Shock* × *MQuarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). The results are estimated in the different samples described in Table 1. Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Top 33% Supplier Financing

	Δ Log Sale(t)	Δ Log Sale(t)	Δ Log Sale(t,t+3)	Δ Log Sale(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.019**	-0.020***	-0.017***	-0.016**
	(-2.393)	(-2.700)	(-2.919)	(-2.350)
Observations	12,378	12,378	11,755	11,755
R-Squared	0.007	0.009	0.006	0.010
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel B: Top 33% Short-Term Debt Financing

	Δ Log Sale(t)	Δ Log Sale(t)	Δ Log Sale(t,t+3)	Δ Log Sale(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.002	-0.003	-0.002	-0.002
	(-0.254)	(-0.380)	(-0.348)	(-0.339)
Observations	16,181	16,181	15,209	15,209
R-Squared	0.012	0.013	0.009	0.011
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel C: Falsification Test - Bottom 33% Supplier Financing				
	Δ Log Sale(t)	Δ Log Sale(t)	Δ Log Sale(t,t+3)	Δ Log Sale(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	0.002	0.003	0.001	0.002
	(0.458)	(0.434)	(0.107)	(0.298)
Observations	12,483	12,483	11,987	11,987
R-Squared	0.037	0.039	0.041	0.043
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Panel D: Falsification Test - Bottom 33% Short-Term Debt Financing				
	Δ Log Sale(t)	Δ Log Sale(t)	Δ Log Sale(t,t+3)	Δ Log Sale(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.003	-0.005	-0.000	-0.000
	(-0.590)	(-1.063)	(-0.111)	(-0.084)
Observations	14,627	14,627	13,868	13,868
R-Squared	0.019	0.020	0.022	0.024
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Table 7

Sales Effects with Alternative Cutoffs

This table reports results estimating the effects in Table 6 in different subsamples, constructed with alternative cuttoffs for the importance of supplier financing. The results are estimated using the same specifications as in Panel A of Table 6. The different subsamples are constructed in an analogous way to the ones in Table 1 using the different cutoffs for *Supplier Financing*. As in the samples in Table 1, the largest firms are dropped before the subgroups are constructed. In the subsamples using the 25% and 40% cutoffs for supplier financing, we define the largest firms in an analogous way to Table 1 using the 25% and 40% cutoffs for total assets, respectively. The estimated coefficient of *Oil Shock × Main Quarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Firms in the Top and Bottom 25% of Supplier Financing

	Top 25% Supplier Fin				Bottom 25% Supplier Fin			
	Δ Log Sale(t)		Δ Log Sale(t,t+3)		Δ Log Sale(t)		Δ Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OilShock × MQuarter	-0.019**	-0.022***	-0.017***	-0.018**	0.003	0.004	0.004	0.005
	(-2.418)	(-2.920)	(-2.762)	(-2.472)	(0.504)	(0.632)	(0.644)	(0.816)
Observations	10,235	10,235	9,725	9,725	10,772	10,772	10,362	10,362
R-Squared	0.007	0.010	0.006	0.010	0.039	0.042	0.044	0.048
Firm Type FE × Shock	No	Yes	No	Yes	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Firms in the Top and Bottom 40% of Supplier Financing

	Top 40% Supplier Fin				Bottom 40% Supplier Fin			
	Δ Log Sale(t)		Δ Log Sale(t,t+3)		Δ Log Sale(t)		Δ Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OilShock × MQuarter	-0.020**	-0.022***	-0.016***	-0.016**	0.004	0.006	0.000	0.003
	(-2.348)	(-2.852)	(-2.749)	(-2.345)	(1.033)	(1.206)	(0.080)	(0.765)
Observations	13,179	13,179	12,508	12,508	13,716	13,716	13,151	13,151
R-Squared	0.007	0.009	0.006	0.009	0.035	0.036	0.034	0.036
Firm Type FE × Shock	No	Yes	No	Yes	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8

Additional Falsification Tests

This table reports results estimating the effects in Table 6 using different samples of firms that are unlikely to be exposed to financing constraints in their ability to fund their working capital. The results are estimated using the same specifications as in Panel A of Table 6. The samples in Panels A to C are constructed using the top terciles for *Total Assets* , *Cash* , and *Payout* in quarter *t-1* . These cutoffs are determined based on the distribution of all firms (positive or negative beta). Panel D includes firms with a long-term bond rating in quarter *t-1* . Note that the largest firms (top asset tercile) are excluded from the samples described in Table 1 and used in the previous results. The estimated coefficient of *Oil Shock* × *Main Quarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Top 33% of Total Assets				
	∆ Log Sale(t)		∆ Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × *MQuarter*	0.003	0.005	0.004	0.007*
	(0.594)	(1.195)	(0.963)	(1.802)
Observations	16490	16490	15995	15995
Firm Type FE × Shock	No	Yes	No	Yes
R-Squared	0.037	0.039	0.027	0.030
Industry-Quarter FE	Yes	Yes	Yes	Yes
Panel B: Top 33% of Cash				
	∆ Log Sale(t)		∆ Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × *MQuarter*	0.000	-0.001	-0.004	-0.002
	(0.022)	(-0.239)	(-1.001)	(-0.612)
Observations	18,954	18,954	18,051	18,051
R-Squared	0.013	0.014	0.019	0.020
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Panel C: Top 33% of Payout				
	∆ Log Sale(t)		∆ Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × *MQuarter*	-0.003	-0.000	-0.004	0.001
	(-0.676)	(-0.038)	(-0.847)	(0.227)
Observations	15,996	15,996	15,506	15,506
R-Squared	0.036	0.037	0.030	0.032
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Panel D: Rated Firms				
	∆ Log Sale(t)		∆ Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × *MQuarter*	-0.002	-0.001	0.002	0.003
	(-0.286)	(-0.105)	(0.359)	(0.701)
Observations	12,417	12,417	11,990	11,990
R-Squared	0.033	0.035	0.027	0.031
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Table 9
Sales Effects Over Different Horizons

This table reports results estimating the effects in Table 6 with changes in sales over different horizons. The results are estimated using the same specifications and samples as in Panels A and C of Table 6 with different outcome variables. *∆Log Sale (t,t+1)* is the average of the log of sales between quarters *t* and *t+1* minus the average value of this variable between quarters *t-1* and *t-4*. *∆Log Sale (t+4)* is the log of sales in quarter *t+4* minus the average for this variable between quarters *t-1* and *t-4*. The estimated coefficient of *Oil Shock* × *Main Quarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Top 33% Supplier Financing				**Bottom 33% Supplier Financing**			
	∆ Log Sale(t, t+1)		∆ Log Sale(t+4)		∆ Log Sale(t, t+1)		∆ Log Sale(t+4)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OilShock × *MQuarter*	-0.018***	-0.020***	-0.023***	-0.018**	0.001	0.002	-0.001	0.004
	(-2.829)	(-3.118)	(-2.807)	(-2.359)	(0.229)	(0.351)	(-0.102)	(0.388)
Observations	12,276	12,276	11,420	11,420	12,407	12,407	11,658	11,658
R-Squared	0.005	0.008	0.007	0.009	0.033	0.036	0.041	0.044
Firm Type FE × Shock	No	Yes	No	Yes	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10

What Happens to Short-Term Operating Assets, Supplier Financing, and Operating Costs?

This table reports results estimating the effects in Table 6 with additional outcomes. The results are estimated using the same specifications and samples as in Panels A and C of Table 6 with different outcome variables. For every variable *X*, *ΔLog X (t,t+k)* is the average of the log of *X* between quarters *t* and *t+k* minus the average value of this variable between quarters *t-1* and *t-4*. *ΔLog X (t)* is the log of *X* in quarter *t* minus the average for this variable between quarters *t-1* and *t-4*. *AR + Invt* captures short-term operating assets (sum of inventories and receivables). *AP* is the firms' outstanding payables. *Cogs* and *SG&A* measure operating expenses and denote the costs of goods sold and selling & general admnistrative expenses, respectively. The estimated coefficient of *Oil Shock × Main Quarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Effects on Short-Term Operating Assets and Payables - Top 33% Supplier Financing				
	Δ Log AR+Invt(t,t+1)	Δ Log AR+Invt(t,t+3)	Δ Log AP(t,t+1)	Δ Log AP(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.019**	-0.017***	-0.016**	-0.018***
	(-2.571)	(-2.674)	(-2.061)	(-2.653)
Observations	12,319	11,799	12,928	12,440
R-Squared	0.010	0.012	0.004	0.006
Firm Type FE × Shock	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Panel B: Effects on Short-Term Operating Assets and Payables - Bottom 33% Supplier Financing				
	Δ Log AR+Invt(t,t+1)	Δ Log AR+Invt(t,t+3)	Δ Log AP(t,t+1)	Δ Log AP(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	0.011*	0.004	-0.004	-0.000
	(1.656)	(0.541)	(0.382)	(-0.001)
Observations	12,512	12,040	12,973	12,513
R-Squared	0.034	0.046	0.009	0.015
Firm Type FE × Shock	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel C: Effects on Operating Costs - Top 33% Supplier Financing

	ΔLog Cogs(t)	ΔLog Cogs(t,t+1)	ΔLog Cogs(t,t+3)	ΔLog SG&A(t)	ΔLog SG&A(t,t+1)	ΔLog SG&A(t,t+3)
	(1)	(2)	(3)	(4)	(5)	(6)
OilShock × *MQuarter*	-0.006	-0.017**	-0.017**	-0.009**	-0.009**	-0.009**
	(-0.391)	(-2.439)	(-2.439)	(-2.245)	(-2.008)	(-2.343)
Observations	12,146	11,409	11,409	10,079	9,966	9,504
R-Squared	0.004	0.001	0.001	0.003	0.004	0.004
Firm Type FE × Shock	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel D: Effects on Operating Costs - Bottom 33% Supplier Financing

	ΔLog Cogs(t)	ΔLog Cogs(t,t+1)	ΔLog Cogs(t,t+3)	ΔLog SG&A(t)	ΔLog SG&A(t,t+1)	ΔLog SG&A(t,t+3)
	(1)	(2)	(3)	(4)	(5)	(6)
OilShock × *MQuarter*	-0.001	-0.001	0.002	-0.005	-0.005	-0.003
	(-0.197)	(-0.100)	(0.247)	(-0.710)	(-1.624)	(-0.577)
Observations	12,371	12,257	11,771	11,109	11,013	10,585
R-Squared	0.016	0.016	0.023	0.032	0.041	0.056
Firm Type FE × Shock	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 11
Immediate Responses of Long-Term Investment and Asset Sales

This table reports results estimating the effects in Table 6 with long-term investment and asset sales as the outcomes. The results are estimated using the same specifications and samples as in Panels A and C of Table 6 with different outcome variables. *ΔInv (t,t+1)* is the average of *Investment* between quarters *t* and *t+1* minus the average value of this variable between quarters *t-1* and *t-4*. *ΔInv (t)* is *Investment* in quarter *t* minus the average for this variable between quarters *t-1* and *t-4*. The outcomes in Panel B and C are constructed in an analogous way using *Sale of PPE* and *R&D/Assets*. The estimated coefficient of *Oil Shock* × *Main Quarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). Standard errors are heteroskedasticity robust and clustered at the industry level (3-digit SIC code) and we report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Capital Expenditures

	Top 33% Supplier Financing		**Bottom 33% Supplier Financing**	
	ΔInv (t)	ΔInv (t,t+1)	ΔInv (t)	ΔInv (t,t+1)
	(1)	(2)	(5)	(6)
OilShock × MQuarter	-0.000	-0.002	0.002	0.002
	(-0.316)	(-1.091)	(1.218)	(1.031)
Observations	10,707	10,489	11,251	11,102
R-Squared	0.004	0.003	0.001	0.000
Firm Type FE × Shock	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel B: Sales of PPE

	Top 33% Supplier Financing		**Bottom 33% Supplier Financing**	
	ΔSales PPE (t)	ΔSales PPE (t,t+1)	ΔSales PPE (t)	ΔSales PPE (t,t+1)
	(1)	(2)	(5)	(6)
OilShock × MQuarter	0.000	0.000	-0.000	-0.000
	(1.511)	(0.098)	(-1.313)	(-0.723)
Observations	6,840	6,417	6,942	6,612
R-Squared	0.003	0.005	0.004	0.007
Firm Type FE × Shock	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel C: R&D/Assets

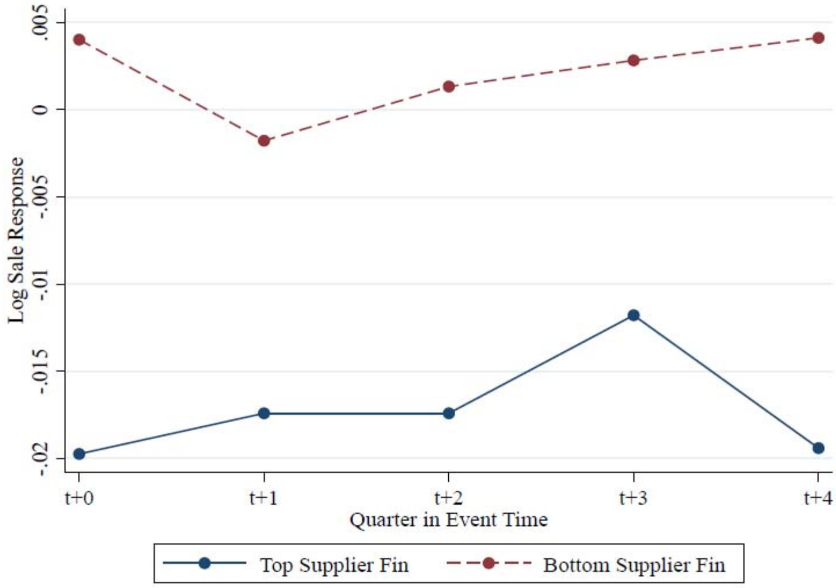
	Top 33% Supplier Financing		**Bottom 33% Supplier Financing**	
	ΔR&D (t)	ΔR&D (t,t+1)	ΔR&D (t)	ΔR&D (t,t+1)
	(1)	(2)	(5)	(6)
OilShock × MQuarter	-0.003	0.005	-0.001	-0.006
	(-0.540)	(1.067)	(-0.185)	(-1.490)
Observations	10,387	10,284	10,834	10,761
R-Squared	0.005	0.005	0.001	0.001
Firm Type FE × Shock	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Figure 1

Dynamics of Sales Effects

This figure reports results analogous to the ones in Table 6 with more detailed changes in sales over time. The results are estimated using the same specifications and samples as in Panels A and C of Table 6 (Column (2) in each panel) with different outcome variables. *ΔLog Sale (t+k)* is the log of sales in quarter *t+k* minus the average value of this variable between quarters *t-1* and *t-4*. The effect in quarter *t+k* is given by the result estimated with *ΔLog Sale (t+k)* as the outcome. The estimated coefficient of *Oil Shock* × *Main Quarter* is scaled to better capture its magnitude. This coefficient is multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (significant oil exposure in sample). Panel A separately reports the effects for the top and bottom supplier financing groups. Panel B shows the average effect between quarters *t* and *t+4* for the top supplier financing group and compares it to the counterfactual where there is no credit multiplier effect.

Panel A: Sales Effects for Top and Bottom Supplier Financing Groups



Panel B: Average Sales Response and Counterfactual