Understanding the Credit Multiplier: The Working Capital Channel

Heitor Almeida, Daniel Carvalho and Taehyun Kim*

November, 2017

We provide novel evidence on how frictions in the financing of working capital amplify and propagate the effect of economic shocks over time. We propose a test for this idea in a situation where firms must pay for inputs in advance of production, and face credit constraints and seasonal variation in profitability. Persistent input price shocks lead to stronger immediate and longer-term drops on firms' sales when firms are hit in the period in which they are most profitable (their "main quarter"). These patterns are unlikely to be present in the absence of constraints on firms' ability to finance their inputs. Our analysis implements this test with oil price shocks and suggests that the financing of working capital can be an important channel for understanding how the credit multiplier affects economic activity.

*We thank Alexandre Baptista, John Moore, Greg Udell, and seminar participants at the Edinburgh Business School, Cass Business School, George Washington University, and Indiana University (Kelley) 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 cycles in driving fluctuations in 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. For example, adverse economic shocks reduce firms' net worth, limiting their ability to borrow, and further reducing their net worth over time. 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 the significance of this credit multiplier in shaping the effect of input price shocks on firms through a working capital channel. We consider a situation where firms need to pay for inputs in advance of production, and face a credit constraint. The effects of shocks to input prices are amplified by endogenous changes in net worth. As inputs become more expensive (cheaper), firms find it harder (easier) to finance their production over time and both immediate and longer-term drops in their sales are larger.

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.[1] 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. The potential importance of these working capital effects has also been emphasized in studies of monetary policy shocks, as they lead interest rates to change supply conditions (marginal costs), in addition to aggregate demand conditions.[2] Another central motivation for this focus is the importance of accounts payable on the balance sheets of U.S. firms. For example, accounts payables represented approximately 10 percent of total assets (book value) for the average U.S. listed nonfinancial firm between 1980

[1] We discuss this literature in greater detail below.

[2] 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. See Barth and Ramey (2001) and Christiano, Eichenbaum, and Evans (2005) for the role of this working capital channel in shaping the effect of monetary policy shocks. These literatures argue that incorporating a working capital channel allows models to do a better job in matching broad empirical patterns. We focus on proposing and testing micro-level implications of these effects.

and 2016, and was significantly more important than short-term debt or total current outstanding debt in these balance sheets.[3] This source of trade credit is mostly significant among smaller firms and often seen as motivated by financing considerations (Petersen and Rajan (1997), and Murfin and Nijoroge (2014)). These trade credit arrangements are also very short term, with typical maturities between 60 and 90 days, and often seen as covering a gap between the purchase of inputs and final sales (Klapper, Laeven, and Rajan (2011)). The importance of financing inputs upfront is also consistent with the observation that in many industries firms are often paid by customers with some delay after the start of production (e.g., construction) or often need to purchase inventories prior to sales (e.g. retail).

Previous research analyzing how balance sheet conditions affect firms' real decisions has traditionally attempted to search for "pure" financial shocks constraining firms.[4] However, the central point of a credit multiplier idea is that economic shocks endogenously trigger financial problems, which then amplify and propagate the shock. Therefore, testing the importance of this idea requires analyzing how a given economic shock affects firms differently when the financial amplification mechanism is more important.[5]

Our analysis addresses this question. We propose an intuitive test for directly examining the importance of the credit multiplier and the specific role of the working capital channel in driving it. Our test considers a situation where firms face a predictable cycle in their profitability within a year (seasonality) and experience a permanent input price shock. We build on a key point that emerges in this context if firms need to finance inputs upfront and are credit constrained. Namely, the effect of this permanent shock over the entire cycle (year) should depend on the immediate effect it induces on firms' balance sheets. When the shock hits the firm during its

[3] Calculations by the authors using Compustat data (see also Table 1). This ratio is also approximately 10 percent for the aggregate balance sheet of U.S. nonfinancial corporations when calculated using flow of funds data.

[4] 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 "pure" shifts in firms' financial conditions with shocks the supply of capital by lenders (e.g., Lemmon and Roberts (2010), Duchin et al. (2011), and Almeida et al. (2012)) or shocks to the value of firms' collateral (e.g., Gan (2007), Chaney, Sraer, and Thesmar (2012)).

[5] Campello and Hackbarth (2012) study how the multiplier can amplify the effect of shocks to Tobin's Q. Carvalho (2015) analyzes the amplification of industry shocks (but not the propagation over time) with a different approach than the one in this paper. Neither paper considers the role of the working capital channel as a mechanism for this financial amplification. Estimating the importance of a credit multiplier effect using these "pure" financial shocks is challenging because of the two-way interaction between firms' financial conditions and economic decisions.

"main quarter" (the quarter when the firm is most profitable), it generates stronger immediate balance sheet effects. These balance sheet effects amplify the effects of the shock, and translate into stronger financial amplification effects on production decisions over the entire subsequent cycle. In contrast, the effect of the permanent shock over the entire cycle of an unconstrained 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 illustrate this point, consider the example of a retailer that needs to finance inventories prior to sales. Imagine that the firm faces an annual cycle in demand leading to periods of higher and lower profitability, which we label as a high and low periods, respectively. A permanent input price increase leads to a stronger immediate reduction on the net worth of the retailer when it happens in the high period, because the firm is borrowing more aggressively to finance its larger sales. When the shock hits in this specific period, it induces a weaker balance sheet over the subsequent cycle of the firm and further constrains the ability of the firm to finance its production. This mechanism leads to a stronger drop in the sales of a constrained retailer over the entire year (high and low periods) if it initially happens in the high period. In the case of an unconstrained firm, input price changes can also affect factor demand and production decisions. However, the effect of this permanent input-price change on subsequent high and low periods is unlikely to depend in this same way on the history of the shock. Therefore, the average effect of the shock over the entire subsequent cycle (high and low periods) should not be systematically stronger when the shock is initiated in a high period.

We start our analysis by formalizing this intuition with a model of working capital constraints. We adapt Kiyotaki and Moore (1997) to the previous context in which firms need to pay upfront for inputs and their profitability is subject to short-term cycles (seasonality). We show that persistent shocks to input prices have a stronger immediate impact on the sales and balance sheets of constrained firms during periods of high profitability (high periods). As in the previous example, this result is driven by the fact that firms borrow more aggressively during such periods. We also show that this initial net worth effect leads permanent shocks initiated during high periods to induce a stronger change on the sales of a constrained firm over its entire subsequent production cycle. This effect captures the importance of a credit multiplier and is not present among firms that do not face a binding constraint in their ability to finance their working capital (unconstrained firms).

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 shocks depends on predictable differences in profitability at the time of the shock (seasonality). We use historical data to identify firms' main quarter and show that firms have significantly higher (predicted) profitability firms during this quarter. Our results compare the effect of a same industry shock on firms that are outside versus inside their main quarter at the time of the shock. We analyze short- and longer-term effects of these shocks by considering firms' responses over one quarter and one year, respectively.

One potential issue with the previous approach is that these comparisons might capture differences across different types of firms in their sensitivity to shocks, as opposed to differences in the sensitivity of one type of firm within its annual cycle. For example, imagine some firms have Q4 as their main quarter (Q4-type firms) and others have Q2 as their main quarter (Q2-type firms). If shocks take place more often during Q4 or if there are more Q4-type firms, the previous result could capture the differential sensitivity of Q4-type firms to shocks. We show that firms have their main quarter spread across different quarters and that shocks have comparable distributions across these quarters. We then take advantage of the recurring shocks in our data to control for fixed differences across firm types in their sensitivity to shocks. This strategy allows us to estimate how a same firm type responds to shocks over time when the shock hits the firm inside versus outside its main quarter. In other words, 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. We believe this identification strategy is new to the literature.

As we explain above, our model predicts that the previous test should only detect a credit multiplier effect when a firm's working capital constraint is binding. This prediction allows us to implement an important falsification check on our identification strategy by analyzing the previous effects among firms that are plausibly unconstrained. While it is difficult to identify ex-ante constrained firms, our model illustrates how a strong dependence on external funds for the financing of inputs is an important necessary condition. Firms might grow out of a working capital constraint – funding inputs internally - or face no need to pay upfront for inputs (no need for input financing to begin with). In either case, the amplification effect due to the working capital channel should be absent.

We use firms' reliance on borrowing from their suppliers (accounts payable) as a proxy for this type of outside financing. As previously discussed, the idea that credit from suppliers addresses this working capital need among small/medium firms has been supported by previous empirical research on trade credit – and this also suggested by anecdotal evidence.[6] We exclude the largest firms because it has been argued that the importance of account payables among these firms is more driven by other considerations, such as ensuring the quality provided by suppliers, as opposed to financing needs (Klapper, Laeven, and Rajan (2011)). We therefore examine the importance of our results among a sample of smaller firms with high accounts payable. We note that this group represents a small subset of firms in our data of listed firms, but resembles a large number of private firms outside our data in terms of smaller size and high reliance on accounts payables. We then use small firms with more limited dependence on accounts payable and large firms as alternative groups of firms that should have a more limited need to externally finance their inputs. The working capital channel should not matter for these groups of firms.

Our 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 specific subgroup of firms that significantly rely on external funds from suppliers. It is unlikely that alternative interpretations would both generate these joint robust responses and lead them to be relevant only in this subgroup of our data. Additionally, we find 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.

We also contrast the immediate responses of sales in our analysis with the one of longer-term investment. We show that oil shocks are not associated with a significantly stronger immediate drop in long-term investment by firms hit in their main quarter. This is also suggested by our framework. Short-term differences in productivity matter for firms' ability to finance inputs because the same inputs generate more (less) cash flows in periods with high (low) profitability.

[6] Anecdotal evidence also suggests that firms borrow from other sources (different from suppliers) to finance these working capital needs. For example, firms can use lines of credit or alternative arrangements such as factoring (Udell (2004)). However, there is limited data on such targeted arrangements. The importance of accounts receivables and the fact that it is typically viewed as an expensive source of funds (Petersen and Rajan (1997)) motivate our approach to use it as proxy for firms' need for this type of outside financing.

In contrast with variable inputs, it is plausible to expect capital purchases to have a more delayed effect on firms' sales, and for firms' ability to finance their capital to fluctuate less within an annual cycle. This result provides further evidence that our sales results are driven by working capital constraints.

Overall, our analysis suggests that these results capture the amplification and propagation of oil price shocks through 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 2-3 percentage points more (over a one-year horizon) than in a benchmark case with no amplification effects.

Our paper makes two main contributions to previous 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 the literature. Second, it provides direct evidence that financing frictions can have important effects on firms through the financing of working capital. This analysis of working capital considerations distinguishes our paper from the literature that focuses on the impact of financing frictions on long-term investment. [7] We complement this literature by considering the implications of liquidity problems in the financing of inputs and the role of these problems driving the credit multiplier. 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 results suggest that these considerations can be relevant more broadly in constraining firms' sales and can induce a significant credit multiplier for frequent input price shocks among U.S. firms. Additionally, 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)).

[7] See the references previously discussed on the effects of financing frictions on firms' real decisions for an incomplete list of papers.

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 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 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.[8] 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.[9] For simplicity, the interest rate is zero and firms face no cost in their borrowing in

[8] We motivate and illustrate the empirical relevance of this assumption in Sections 2.4 and 2.5. This is intended to capture a demand by customers for delayed payments or a need to acquire or produce inventories prior to sales and reflects characteristics of product markets in which firms operate or the nature of their production process.

[9] Note that this is not a collateral constraint tied to the value of capital, which is fixed over time in the model. We could allow the borrowing constraint to also depend on a collateral value tied to firms' capital as long as it was still

addition to the previous constraint.[10] 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.

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:

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

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.

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

---

relaxed by increases in the expected income generated by the firm. For example, if firms were financing inputs leading to accounts receivables, the assumption would be that having more receivables allows them to raise more external funds. When borrowing to finance accounts receivables, firms often use receivables as collateral or sell them at discounts to lenders (Udell (2004)). This assumption would be natural in such a context.

[10] 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.

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.[11]

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.

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

[11] 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.

place at the beginning of $t=1$. We denote the new price as $\tilde{p}$ 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 $\tilde{y}_t(s_1) \equiv \frac{\partial y_t(s_1)}{\partial \tilde{p}} \times \frac{p}{y_t^*(s_1)}$. This elasticity is evaluated at the initial steady state ($\tilde{p} = p$) and captures the marginal percentage effect on sales from a given price shock, i.e. a given percentage increase in the input price.

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 need more funds to finance inputs upfront, and this increase is analogous to a drop in their net worth. A same drop in net worth leads to a greater percentage drop in sales because of this higher leverage.

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 (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.

While our model is stylized, in the absence of working capital constraints, it is unclear why the average effect of the shock over the entire cycle would be systematically related to its initial timing in the previous way. Our identification assumption for the analysis of the working capital multiplier is that this systematic relationship captures a credit multiplier. One possibility outside the previous model is that the effect of the shock on unconstrained firms could change over time (conditional on their state). For example, the investment of unconstrained firms could immediately respond to the shock and have some effect on the capital stock by the end of the cycle.[12] Even if this was the case, our identification assumption would still remain valid as long as these changes in the effect of the shock over time were not systematically related to the initial timing of the shock. While completely ruling out this possibility ex-ante is challenging, our framework suggests an important falsification test on our identification assumption. Namely, the previous patterns should not be systematically present among firms that do not depend on external funds to finance their inputs. This dependence is an important necessary condition for firms to be constrained in our framework, so firms without such dependence should not be facing a binding working capital constraint.

2. Data, Samples, Summary Statistics, and Examples

We describe the databases and samples used in the paper. 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 (2011)). 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

[12] We explicitly address this possibility in our empirical analysis.

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.[13] 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 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.[14]

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. The results motivating our test in Section 1 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

[13] 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.

[14] 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.

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 four times and, for example, can be in the four 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.

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 from Suppliers

Our framework illustrates that working capital constraints should only be relevant for firms that significantly rely on external financing to fund their inputs. We use the firms' reliance on accounts payable as a proxy for this type of outside financing among smaller firms. Accounts payable is important in firms' balance sheets (more than short-term debt). Both previous research and anecdotal evidence suggest that, among smaller firms, these trade-credit arrangements are motivated by firms' need to finance input purchases ahead of sales (Petersen and Rajan (1997), and Murfin and Nijoroge (2014)). Consistent with the view that these trade-credit arrangements cover a gap between the purchase of inputs and final sales, they typically have maturities between 60 and 90 days (Klapper, Laeven, and Rajan (2011)). There are examples of alternative financial arrangements by other lenders (different from suppliers) designed to address this same financing problem (e.g. factoring and lines of credit). But there is no systematic data on these alternative sources of funding targeted at the financing of inputs. For example, lines of credit might be motivated by other financing considerations and it is challenging to isolate when they are motivated by the need to finance input purchases. Given its magnitude relative to other sources of short-term funding (e.g. short-term debt), it is plausible to expect accounts payable to be a leading source of financing for these purposes (at least in the U.S.). Additionally, financing from suppliers is often argued to be more expensive than other sources of external funding such as bank loans (e.g., Rajan and Petersen (1995)), so firms with significant borrowing on this margin are unlikely to be able to fund their inputs internally.

We sort firms into three broad groups (top, middle, and bottom) based on their reliance on financing from suppliers. More specifically, we rank firms using *Supplier Financing*, the ratio of accounts payable to sales. We partition our overall sample into three terciles 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. This is motivated by our theoretical framework in Section 2, where the importance of outside financing of inputs can be captured by the ratio of the liabilities associated with the financing of inputs to the revenue of the firm.[15]

Our construction of these broad 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 working capital constraints to be binding. The analysis of this last group provides an important check on our identification strategy for isolating a working capital multiplier.

2.4. Summary Statistics and Characteristics of Top Supplier Financing Firms

Table 1 provides summary statistics on our overall sample and the three previous subsamples based on the importance of financing from suppliers. 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

[15] 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.

their total assets (combined). The significance of these short-term operating assets captures the importance of the timing gap between input purchase and revenues that we have in mind for these firms. As firms that are often paid by customers with some delay they accumulate accounts payable. Alternatively, firms might need to buy inventories prior to sales or hold stocks of finished goods before sales due to production delays. These last considerations would lead them to hold significant stocks of inventory. We interpret the demand for such assets as driven by product markets or firms' production processes and as capturing an important pre-condition for working capital constraints. We also note that firms facing a working capital constraint will be more limited in their ability to accumulate these assets and do not use the importance of these assets to construct the different subgroups in our analysis.

Firms with high supplier financing are smaller, younger, less profitable, but have higher Q and do not have significantly lower investment. These patterns are consistent with the view that firms with high supplier financing can rely less on internal funds to finance their inputs. 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, driven by a comparable or stronger investment demand matched with lower operating cash flows, can be interpreted as a higher value for γ. The younger age, smaller size, and lower profitability should naturally lead to lower θ. For example, these types of firms should be plausibly more exposed to greater adverse selection problems and require more monitoring by lenders.

2.5. Industries with Top Supplier Financing Firms and Examples

We motivate the timing gap between the purchase of inputs and cash from sales as originating from a demand by customers for delayed payments and a need to acquire or invest in inventories prior to sales. It is natural to think about this financing need as a consequence of both the product market conditions faced by firms and their production process. We illustrate these ideas in the context of the industries with the highest concentration of top supplier financing firms and examples. Table 2 lists these industries. For each industry, *TSF Share* is the share of firms in the industry in the top supplier financing group (see Table 1). Since our results capture the effects of oil shocks, we also describe the share of firms in each industry with significant exposure to these shocks. *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). We describe the importance of both these shares and short-term operating assets associated with the previous timing gap (accounts receivable and inventories) in these industries. We consider both broader and narrower industry definitions. Panel A lists the broader industries (48 Fama-French industries) above the average in terms of *TSF Share*. Panels C and B list the top 15 narrower industries (4-digit SIC codes) in terms of *TSF Share* and *TSF and NBeta Share*.

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. Moreover, suppliers of the durable goods sold in these industries typically play an important role in financing them (e.g., Murfin and Pratt (2017)). Both of these considerations lead to a timing gap between input purchases and revenue collection and the latter consideration will be captured in the accounts receivables of these industries.[16] This delay in the production process can also motivate firms to stock finished goods (inventories) in anticipation of future demand. This allows firms to deliver orders in a faster way but also requires them to cover costs prior to collecting the cash from customers. Both accounts receivables and inventories are typically important in these industries.

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 some retailers might extend credit to their customers (e.g. Jewerly Stores), accounts payable are typically limited when compared to inventories in these retail industries. In contrast, accounts receivables are more important in the construction industries. Intuitively, there is also a delay between the execution of construction work and payments from customers. This delay is captured by the accounts receivable of construction companies.

[16] Firms in these industries would typically recognize their revenues at the time of delivery of goods and accounts receivables would capture payments by customers not made at that point (see Section 3.1). Barrot (2016) illustrates how product market considerations might lead firms to lend to their customers even if this significantly exposes them to liquidity problems.

This discussion also helps to illustrate why firms might face challenges in financing their inputs prior to production. When customers pay firms with delay, lenders need to track the credit quality of the firms' customers. Firms' decisions to accumulate inventories are also associated with risks due to future demand conditions. The importance of these considerations and the associated risks affecting firms are consistent with anecdotal evidence in these industries. For example, Dycom Industries Inc (DY) is a provider of construction, maintenance, and installation services for telecommunication companies. Their 2017 10-K discusses the importance of tracking the credit quality of their customers and the associated liquidity problems: "We have significant amounts of accounts receivable … which could become uncollectible. We extend credit to customers as a result of performing work under contract prior to billing for that work. We periodically access the credit quality of our customers and regularly monitor the timeliness of their payments … The failure and delay of payment by our customers could reduce our expected cash flows and adversely affect our liquidity and profitability." Another example is Zales Corp (ZLC), a company that specializes in jewelry retailing in the U.S. with an emphasis on diamond products. Their 2013 10-K emphasizes the need to acquire inventories upfront and the associated liquidity risks: "Any failure by us to manage our inventory effectively, including judgments related to consumer preferences and demand, will negatively impact our financial condition … We purchase much of our inventory well in advance of our selling period."

These ideas are also highlighted in discussions of lending practices addressing firms' working capital needs. For example, Udell (2004) provides a discussion of asset-based lending practices and explains how lending against the receivables or inventories of firms that need working capital financing works. The importance of tracking the previous risks and the gap between production or inventory acquisition and the collection of cash are emphasized. *The Economist* (Oct 12, 2017) also provides a discussion of the financing issues faced by suppliers due to the delayed payments by their customers and developments addressing them: "Suppliers, of course, have always needed to finance the gap between production and payment. Traditionally, they could borrow on their own account, or sell their receivables – unpaid invoices – at a discount to business known as factors. Modern supply-chain finance … also lets suppliers piggyback on the creditworthiness … of their big corporate customers."

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:

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

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 the gap between the initial payment of inputs and revenue collection typically happens within one quarter or semester. In this case, firms go through multiple complete production periods within a year and the effect of shocks on the initial period affects firms' net worth in the subsequent periods of the cycle (as in the model in Section 1). For example, one can imagine a retailer that acquires inventories a few months prior to sales. However, there might be a longer conversion cycle from initial input expenses into the final collection of cash from a given customer. 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 estimation of Equation (2) can be linked to the ideas in our framework in the following way. One can think that the company has a collection of incomplete orders (or projects) at any quarter or semester (a period). In each period, the firm completes a subset of these orders and this process still requires firms to pay upfront for inputs within that period. A shock in a given period can affect firms' ability to complete orders within that period, reducing its net worth in subsequent periods, and further limiting its ability to complete future orders (multiplier effect). The main quarter will capture a period in which firms have higher profitability and complete a larger volume of orders or projects. For example, depending on weather conditions, a construction company might be more profitable on winter or summer periods. As in the previous case, shocks initiated during the main quarter can also induce a larger multiplier effect going forward. Note that 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.[17] 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.

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

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

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 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.[18] The assumption for the identification of this effect is that pre-existing annual conditions faced by the firm are not correlated with the timing of the oil shock inside or outside its main quarter. This assumption is plausible because firms transition in and out of their main quarter in a cyclical and pre-determined way. 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

[18] A potential related approach to address this issue would be to include firm fixed effects interacted with the oil variables. The inclusion of these interactions 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)). Also, the inclusion of a reduced number of fixed effects (by firm type) are sufficient to address systematic differences in the sensitivity of different firm types to shocks.

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* 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. In some results we also use *Adjusted Cash Flow* as the outcome, the difference between *Cash Flow* and its average value during the firm-year (calendar year). The reported coefficient of *Main Quarter* is scaled to capture its magnitude. We divide the estimated coefficient by the mean of *Cash Flow* 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 (between 70-90% of the mean of cash flows). This confirms the view that the seasonality we analyze is important and captures patterns that are known ex ante. In non-reported results, we also find that firms have significantly higher sales, accounts receivables, and operating assets (accounts receivables and inventories) in their main quarter. This also supports the idea that firms leverage more aggressively their net worth to produce in their main quarter (see Section 1).

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 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)).

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 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: "Fuel prices fluctuate based on market events outside of our control … 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 when explaining limits on their hedging of fuel prices: "To the extent that we enter into hedge transactions, declines in fuel prices below the levels established in the financial instruments may require us to make payments, which could have an adverse impact on our financial condition and results of operation."

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

We estimate Equation (2) using the different broad 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 and groups where we should not expect working capital constraints to be binding. 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 2-3 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 C (B) reports these same results for firms in the bottom and middle groups in terms of supplier financing, respectively. These 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 these same patterns using alternative cutoffs for the importance of supplier financing. We estimate the same specifications as in Table 6 but now use different subsamples of firms with high and low supplier financing. These different subsamples are constructed in an analogous way to the ones in Table 1. 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 four quartiles of supplier financing, we first drop firms in the top 25% in terms of size, and then rank the remaining firms into these four 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 other 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).

We highlight that this contrast between different groups is not intended to capture an interaction between supplier financing and main quarter. Rather, our goal is to implement a falsification test for our identification strategy in groups where we should not expect binding working capital constraints. Recall that the characteristics of firms with low supplier financing are consistent with the idea that these firms can rely on internal funds to finance their inputs or have a reduced need to finance inputs in the first place (see Section 2.4).

Table 8 implements an additional important check on our basic approach. We analyze the results among the largest firms that have been previously excluded. As previously discussed (see Section 2.3), these firms are unlikely to face binding working capital constraints and provide an additional and independent falsification test for our identification strategy. We define the largest firms using the previous alternative cutoffs (top 25%, 33%, and 40%) for firms' total assets. This ensures that the firms in these results are the ones excluded in our previous analysis. As in our previous samples, we exclude industries with positive betas from this analysis (size cutoffs are determined using all firms). These results show that the patterns present among smaller firms in the top supplier financing group are also not present 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 less affected over the subsequent year by these adverse oil shocks. This effect has the opposite sign of our previous results and is both economically small and statistically weak. This provides additional evidence that our results are not present among firms without a binding working capital constraint.

Overall, these results suggest that the patterns in our test associated with a working capital multiplier are only present among smaller firms which significantly rely on external financing from their suppliers. These effects are not economically or statistically present among smaller firms with limited financing from suppliers or large firms, which are both unlikely to be facing a binding working capital constraint. 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 face a binding working capital constraint. While this last group represents a small subset of firms in our data of listed firms, it resembles a large number of private firms outside our data in terms of smaller size and strong reliance on accounts payables.

3.4. 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. As discussed in Section 3.1, our empirical results do not rely on the assumption that the conversion from the purchase of inputs into cash from sales takes place within a quarter or semester. If this conversion takes longer, one can imagine that firms complete a portion of their existing orders in each quarter and that our results capture shifts in their ability to complete these orders. 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.

Another possible reason for a mismatch between our results and the proposed test in Section 1 stems from 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. The shock is therefore weaker when these firms reach their main quarter and this argument could rationalize an average effect conditional on a stronger immediate response during the main quarter.[19] Recall that such stronger immediate drop in sales during the main quarter is not mechanical because we analyze percentage effects on sales. This short-term pattern is also not present among firms that are plausibly unconstrained. But the average effect would not be capturing a working capital multiplier in this alternative explanation.

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 are estimated using the same specifications and samples as in Table 6 with the different outcome variable. These results 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.

Another potential issue with the implementation of our test is a possibility that pre-existing annual conditions faced by firms could be correlated with the timing of the oil shock inside or outside their main quarter. Note that we control for fixed differences in the sensitivity of different types of firms to oil shocks, so this would have to be a concern about time-varying conditions faced by firms. As we argued in Section 3.1, this issue is unlikely to be relevant because firms transition in and out of their main quarter in a cyclical and pre-determined way. Moreover, the results in Table 6 suggest that including firm type fixed effects does not

[19] A related concern is that firms that are initially outside their main quarter when the shock hits could be better prepared for the shock when they enter their main quarter. For example, they can try to cut other expenditures to raise cash, or increase hedging. This possibility can also explain why firms that are initially outside their main quarter may react less to the shock on average, even if credit constraints are irrelevant.

significantly change our effects of interest. In non-reported results, we further address this concern by directly testing if oil shocks hitting firms inside their main quarter are correlated with pre-existing annual differences in firms' conditions. We implement this check by estimating the results in Table 6 with different outcome variables. We use the average values of *Cash Flow* and *Investment* between quarters *t-1* and *t-4* as two separate outcome variables. These variables capture firms' operating conditions and forward-looking decisions in the year prior to shocks. Following this approach, we find direct evidence that pre-existing annual conditions faced by firms are not correlated with the timing of the oil shock. Taken together, this additional evidence suggests that our main results do capture the test we propose in Section 1.

3.5. Additional Implications of the Working Capital Multiplier

We analyze additional implications of the working capital multiplier suggested by our previous results. We first analyze changes in firms' short-term operating assets and accounts payable. As discussed in Sections 2.4 and 2.5, short-term operating assets such as accounts receivables and inventories capture the timing gap between inputs purchase and revenues that we have in mind in our analysis. As firms are more limited in their ability to purchase inputs ahead of sales, we should expect them to accumulate less of these assets. If financing from suppliers is an important source of funding to help firms fill this timing gap, we should expect these drops in short-term operating assets to be also matched with 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.[20]

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 focus on average values over the cycle because the level of assets and liabilities might change slowly as firms adjust their decisions. Panel A of Table 10 shows 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 effects are only present among top supplier financing firms. We find no 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.

[20] 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 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.

These effects are also only important for firms in the top supplier financing group and are not present among firms with limited financing from suppliers. Overall, this analysis looking at additional margins supports the additional implications of the working capital multiplier suggested by our sales results.

3.6. The Immediate Response of Long-Term Investment

As a final step in our analysis, we contrast our previous sales effects with the immediate response of long-term investment. This helps us to further address concerns with the credit-multiplier interpretation for our results. Both our main empirical specification and our analysis in Section 3.4 address the possibility that our results might not match the test we propose in Section 1. However, one might still be concerned that considerations outside our framework in Section 1 could lead our test to detect a multiplier in the absence of a binding working capital constraint. The analysis of immediate investment responses can help us further rule out this possibility, as we now discuss.

We first illustrate why shocks might not immediately affect firms' long-term investment differently when they hit firms in their main quarter. An important point in our analysis of the working capital multiplier in Section 1 is that firms' ability to finance short-term production (variable inputs) should change within its cycle as the firm becomes more profitable. This rationalizes why we should expect firms' sales and net worth to be differentially affected (in percentage terms) at different points of their cycle. As the same inputs generate more sales, firms can more easily finance them and leverage more aggressively to produce in periods of higher profitability (within their cycle). This makes firms more sensitive to shocks in high profitability periods. In theory, the immediate response of firms' long-term investment to shocks is less likely to change in this way within their cycle. It is natural to expect that, in contrast with variable inputs, capital purchases will have a more delayed effect on firms' sales. It is also reasonable to expect delays in the process of installing and using capital. Additionally, the returns considered by investors when financing longer-term assets (internally or externally) should be evaluated over longer horizons. Therefore, cyclical fluctuations in firms' profitability within a year are less likely to affect their ability to finance long-term capital.[21] In other words, while permanent input price shocks are likely to affect firms' ability to finance their long-term investment, the immediate effect of these shocks on investment should be similar within a firm's annual cycle.[22] We focus on these immediate effects because the predictions for the investment response over the entire cycle are less clear. The previous sales effects will lead to change in firms' net worth and this channel might affect investment decisions over the rest of the cycle.

Table 11 reports results estimating our previous immediate responses to oil shocks (Table 6) with long-term investment as the outcome variable. As in our sales results, we measure immediate responses over one or two quarters after the shock and analyze changes in decisions over this period relative to the previous four quarters. These results show that oil shocks are not associated with a significantly stronger immediate drop in long-term investment by firms hit in their main quarter. These effects are not economically or statistically important among top supplier financing firms. These same effects are also not present in the other groups.

This result suggests that capital adjustments in response to shocks do not play an important role in driving our previous sales effects. While analyzing our test in Section 1, we assumed that capital is fixed. One might conjecture that the adjustment of capital could lead to the patterns we document in the absence of a binding working capital constraint. This investment analysis further supports the view that this is not the case. This analysis also reinforces the view that our effects are driven by financing considerations associated with variable inputs and short-term production, as opposed to issues with the financing of long-term capital.

4. Conclusion

We provide new evidence that the credit multiplier can work through a working capital channel where frictions in the financing of inputs help amplify and propagate the effect of economic shocks over time. We propose a new approach to empirically detect these financial

[21] More precisely, firms' cost or ability to finance each incremental unit of capital should not change within this cycle in the same way as it does for inputs. In the context of the framework in Section 1, we should expect the down payment for each unit of capital to fluctuate less than the one for the variable inputs.

[22] 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 a year 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.

amplification effects using the yearly and same-quarter response of sales to input price shocks. Firms that face frictions in the financing of working capital are more affected by persistent shocks that are initiated during 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 capture a working capital multiplier and not detect such multiplier in the absence of a binding working capital constraint. We implement our test using oil price shocks and provide extensive evidence supporting this identification hypothesis by conducting falsification tests in groups of firms that are plausibly unconstrained.

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 results suggest the significance of a credit multiplier that is only present in a specific subsample of listed firms that is potentially exposed to these constraints in the funding of working capital. 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.

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

Campello, Murillo, and Hackbarth, Dirk. 2012. "The Firm-Level Credit Multiplier." *Journal of Financial Intermediation,* 21(3), 446-472.

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.

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.

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Petersen. 1988. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity,* 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.

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 Moore, John. 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.

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 Ken Njoroge. 2015. “The Implicit Costs of Trade Credit Borrowing by Large Firms.” *Review of Financial Studies*, 28(1), 112-145.

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

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.

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.

Udell, Gregory. 2004. *Asset-Based Finance*. New York: Commercial Finance Association.

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. We then analyze the unconstrained steady state and relate this case to a version of the model without any timing gap between the use of inputs and sales.

Analysis of Constrained Steady State

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 $m_H^* < m_L^*$. In other words, firms start the high state with lower net worth. If the multiplier in the high state is also lower, they will face a lower input limit in the high state. So the multiplier and b_S^* have to higher in the high state. Alternatively, if $m_H^* < m_L^*$, the fact that $b_S^* = \dfrac{A_S}{(m_S^*)^{1-\varepsilon}}$ and $A_H > A_L$ imply 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 $\widetilde{b}_L = \dfrac{A_L}{(\overline{m}_L)^{1-\varepsilon}}$. The condition $\dfrac{\widetilde{b}_L}{p} > \dfrac{1}{\varepsilon}$ will imply that $\dfrac{b_L^*}{p} > \dfrac{1}{\varepsilon}$. 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 $\widetilde{m}_H(m^*) = m^*$. This solution can be interpreted as 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 these 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, as we move to the new intersection of these responses, there must be an increase in m_L^*. In other words, the value for m^* must be larger than the initial value for m_L^*.

The solution for m^* implies that $\widetilde{b}_L = \dfrac{A_L}{(m^*)^{1-\varepsilon}} = \left(\dfrac{A_L}{A_H}\right)\left(\dfrac{p}{1-\gamma(1-\theta)}\right)$ and $\dfrac{\widetilde{b}_L}{p} > \dfrac{1}{\varepsilon}$ 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 – a high payout and a low income pledgeability both limit firms' ability to grow outside of the working capital constraint by building net worth over time.

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 $\widetilde{y}_t(s_1) \equiv \dfrac{\partial y_t(s_1)}{\partial \widetilde{p}} \times \dfrac{p}{y_t^*(s_1)}$, 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 $\tilde{y}_t(s_1) = \varepsilon \times \tilde{m}_t(s_1)$ (constant factor elasticity in Cobb-Douglas revenue function) and focus on the analysis of $\tilde{m}_t(s_1)$.

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 by increasing the minimum down payment $p - \theta b_t(m_t^*)$ and is equivalent to a reduction in the available net worth for the firm. The effect of such reduction in available funds will depend on the multiplier on firms' net worth in Equation (A.2). These direct effects are present in both periods *t=1* and *t=2*. As firms' input decisions change in response to these direct effects, 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 $\tilde{m}_1(s_1)$ 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 $\tilde{w}_2(s_1) = \tilde{y}_1(s_1) = \varepsilon \times \tilde{m}_1(s_1)$. Finally, we can solve for $\tilde{m}_2(s_1)$ by also differentiating both sides of Equation (A.2) with respect to *p* and using the previous expression for $\tilde{w}_2(s_1)$.

Denote $b_t(s_1)$ as the value of $b_t(m_t^*)$ in the original steady state trajectory ($\tilde{p} = p$). 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 $\tilde{m}_{12}(s_1) \equiv (1/2)(\tilde{m}_1(s_1) + \tilde{m}_2(s_1))$. The previous steps lead to $\tilde{m}_1(s_1) = -\left(\frac{p}{p - \theta\varepsilon b_1(s_1)}\right)$. This captures the previous direct effect of the input price shock. The drop on the use of inputs has a stronger absolute magnitude when firms have higher profitability (high state) at the time of the shock – firms are leveraging more their net worth to produce and shifts in the available funds matter more. This expression implies that $\tilde{y}_1(H) < \tilde{y}_1(L) < 0$.

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 $D \equiv -(0.5)\left(\frac{p}{p - \theta\varepsilon b_1(s_1)}\right) - (0.5)\left(\frac{p}{p - \theta\varepsilon b_2(s_1)}\right)$. Note that this term does not depend on s_1 because the average captures all states and, conditional on the current state, the terms do not depend on the history of the shock. Consistent with this intuition, the previous steps lead to $\tilde{m}_{12}(s_1) = D + M(s_1)$, 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 $\tilde{y}_{12}(H) < \tilde{y}_{12}(L) < 0$. We summarize these results in the proposition below.

PROPOSITION A.1: *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* $\tilde{y}_1(H) < \tilde{y}_1(L) < 0$ *and* $\tilde{y}_{12}(H) < \tilde{y}_{12}(L) < 0$.

Proof. See the text above.

Analysis of Unconstrained Steady State

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 $y_S(m_S^*) = \left(\dfrac{p}{\varepsilon} \right) m_S^*$ 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 $b_S(m_S^*) = \left(\dfrac{p}{\varepsilon} \right)$. 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 $b_S(m_S^*) = \left(\dfrac{p}{\varepsilon} \right)$ 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). These direct effects only depend on the current state and are not affected by the history of the shock. 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 $m_t(s) = \left(\frac{A_S \varepsilon}{\tilde{p}}\right)^{\frac{1}{1-\varepsilon}}$ and this leads to $\tilde{m}_1(H) = \tilde{m}_1(L) = -\left(\frac{1}{1-\varepsilon}\right)$ and $\tilde{y}_1(H) = \tilde{y}_1(L)$. 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.

<u>PROPOSITION A.2</u>: *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 $\tilde{y}_1(H) = \tilde{y}_1(L)$ and $\tilde{y}_{12}(H) = \tilde{y}_{12}(L)$. 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.

Note that Equation (A.3) implies that a firm initially in the first best can build net worth over time. The firm does not need to use all of its net worth to continue financing the first best decision and this allows it to save over time until there is no need to raise external funds. Recall that there is an arbitrarily small cost of using external funds, so the firm will prefer to follow this strategy and will not rely on external funds in the steady state. 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.

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*)

Adjusted Cash Flow is *Cash Flow* at quarter *t* minus the average of *Cash Flow* for the firm in the same calendar year

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*)

Current Debt is the ratio of total current liabilities (*dlcq*) to total assets (*atq*)

Investment is capital expenditure (*capex*) divided by lagged total asset (*atq*)

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

Accounts Payable/Asset is the ratio of accounts payable (*apq*) to total asset (*atq*)

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

Accounts Receivable/Asset is the ratio of receivables (*rectq*) to total asset (*atq*)

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

Inventory/Asset is the ratio of inventory (*invtq*) to total asset (*atq*)

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

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

LogAP is log of account payable, log of (*apq* +1)

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

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

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

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

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*.

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). Panels B, C, and D partition this initial sample into three terciles, based on the average value of *Supplier Financing* in the previous four quarters (sorted by year). *Supplier Financing* is the ratio of accounts payable to sales (annualized). The subsamples in Panels B, C, and D represent the top, middle, and bottom terciles of the sample in Panel A, respectively. See Appendix B for variable definitions.

Panel A: All Negative Beta Firms

	Nobs	Mean	Median	SD	P10	P90
Main Quarter	38517	2.67	3.00	1.12	1.00	4.00
Log of Sales	38517	3.43	3.56	1.55	1.20	5.36
Log of Age	38460	2.80	2.77	0.51	2.20	3.50
Q	38165	1.69	1.09	2.30	0.55	3.21
Cash Flow	37023	0.01	0.03	0.07	-0.04	0.07
Cash	37884	0.18	0.10	0.23	0.01	0.51
Book Leverage	38283	0.23	0.16	0.33	0.00	0.53
Short-term Debt	38296	0.06	0.01	0.19	0.00	0.17
Investment	35921	0.07	0.05	0.09	0.01	0.16
Supplier Financing	38050	0.13	0.06	0.54	0.02	0.17
Accounts Payable/Assets	38279	0.10	0.07	0.10	0.02	0.22
Accounts Receivable/Sales	37817	0.17	0.15	0.14	0.04	0.27
Accounts Receivable/Assets	37613	0.18	0.16	0.13	0.03	0.35
Inventories/Sales	37606	0.13	0.09	0.15	0.00	0.30
Inventories/Assets	37186	0.15	0.11	0.16	0.00	0.39

Panel B: Top 33% Supplier Financing

	Nobs	Mean	Median	SD	P10	P90
Main Quarter	12592	2.56	3.00	1.12	1.00	4.00
Log of Sales	12592	2.99	3.05	1.68	0.59	5.21
Log of Age	12573	2.73	2.64	0.50	2.08	3.43
Q	12455	1.91	1.02	3.18	0.51	3.90
Cash Flow	12018	-0.01	0.02	0.10	-0.12	0.06
Cash	12217	0.20	0.09	0.26	0.01	0.59
Book Leverage	12518	0.27	0.18	0.46	0.00	0.57
Current Debt	12517	0.09	0.02	0.28	0.00	0.22
Investment	11637	0.07	0.04	0.09	0.00	0.16
Supplier Financing	12535	0.27	0.13	0.83	0.07	0.36
Accounts Payable/Assets	12565	0.16	0.13	0.14	0.04	0.32
Accounts Receivable/Sales	12281	0.19	0.17	0.18	0.03	0.32
Accounts Receivable/Assets	12217	0.18	0.16	0.13	0.02	0.37
Inventories/Sales	12191	0.16	0.11	0.19	0.00	0.37
Inventories/Assets	11967	0.16	0.11	0.17	0.00	0.42

Panel C: Middle 33% Supplier Financing						
	Nobs	Mean	Median	SD	P10	P90
Main Quarter	12401	2.71	3.00	1.11	1.00	4.00
Log of Sales	12401	3.68	3.80	1.45	1.61	5.50
Log of Age	12388	2.87	2.83	0.53	2.20	3.61
Q	12284	1.48	1.03	1.87	0.56	2.62
Cash Flow	11918	0.02	0.03	0.05	-0.02	0.06
Cash	12203	0.15	0.07	0.19	0.01	0.39
Book Leverage	12317	0.23	0.19	0.24	0.00	0.49
Current Debt	12325	0.06	0.02	0.12	0.00	0.17
Investment	11619	0.07	0.05	0.08	0.01	0.15
Supplier Financing	12356	0.07	0.06	0.04	0.04	0.10
Accounts Payable/Assets	12363	0.10	0.08	0.07	0.03	0.18
Accounts Receivable/Sales	12226	0.15	0.15	0.10	0.04	0.26
Accounts Receivable/Assets	12104	0.19	0.18	0.12	0.04	0.36
Inventories/Sales	12199	0.14	0.12	0.13	0.00	0.30
Inventories/Assets	12024	0.18	0.16	0.16	0.00	0.41
Panel D: Bottom 33% Supplier Financing						
	Nobs	Mean	Median	SD	P10	P90
Main Quarter	12692	2.75	3.00	1.11	1.00	4.00
Log of Sales	12692	3.68	3.80	1.38	1.76	5.40
Log of Age	12667	2.80	2.77	0.48	2.20	3.47
Q	12607	1.66	1.21	1.49	0.60	3.16
Cash Flow	12285	0.03	0.04	0.04	-0.00	0.07
Cash	12647	0.20	0.13	0.20	0.01	0.51
Book Leverage	12629	0.20	0.11	0.25	0.00	0.52
Current Debt	12635	0.04	0.01	0.09	0.00	0.10
Investment	11941	0.08	0.05	0.09	0.01	0.17
Supplier Financing	12619	0.03	0.03	0.02	0.01	0.05
Accounts Payable/Assets	12659	0.04	0.04	0.04	0.01	0.09
Accounts Receivable/Sales	12561	0.15	0.14	0.10	0.04	0.25
Accounts Receivable/Assets	12519	0.17	0.15	0.12	0.04	0.33
Inventories/Sales	12477	0.09	0.04	0.12	0.00	0.24
Inventories/Assets	12420	0.11	0.05	0.14	0.00	0.33

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*, repectively. 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 accounts receivable to sales (annualized) in the industry. *Median Invt Ratio* is the median ratio of inventories to sales

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 *Cash Flow* using *Main Quarter* and industry-quarter fixed effects (3-digit SIC code). *Main Quarter* is an indicator that equals 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* between quarters t-1 and t-20 (see Section 2 for details). *Cash Flow* is a measure of firms' operating income over assets. *Adjusted Cash Flow* is the difference between *Cash Flow* and its average value during the firm-year (calendar year). 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). The results are separately estimated in the samples listed in Table 1. The reported coefficient of *Main Quarter* is scaled to capture its magnitude. The estimated coefficient is divided by the mean of *Cash Flow* 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

	Cashflow	Cashflow	Adjusted Cashflow	Adjusted Cashflow
	(1)	(2)	(3)	(4)
Main Quarter	0.816***	0.829***	0.769***	0.769***
	(9.709)	(10.083)	(9.814)	(9.813)
Observations	42130	42130	42130	42130
R-Squared	0.002	0.010	0.011	0.011
Firm Type FE	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel B: Top 33% Supplier Financing Firms

	Cashflow	Cashflow	Adjusted Cashflow	Adjusted Cashflow
	(1)	(2)	(3)	(4)
Main Quarter	0.906***	0.926***	0.799***	0.799***
	(6.788)	(6.850)	(6.813)	(6.812)
Observations	13385	13385	13385	13385
R-Squared	0.001	0.021	0.008	0.008
Firm Type FE	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel C: Bottom 33% Supplier Financing Firms

	Cashflow	Cashflow	Adjusted Cashflow	Adjusted Cashflow
	(1)	(2)	(3)	(4)
Main Quarter	0.736***	0.744***	0.711***	0.712***
	(6.803)	(7.033)	(8.297)	(8.307)
Observations	13186	13186	13186	13186
R-Squared	0.004	0.007	0.031	0.031
Firm Type FE	No	Yes	No	Yes
Industry-Quarter FE	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*. *ΔCash Flow(t)* is *Cash Flow* in quarter t minus the average value of this variable between quarters *t-1* and *t-4*. *ΔCash 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

	ΔCash Flow(t)	ΔCash Flow(t,t+3)
	(1)	(2)
Oil Shock	-0.139***	-0.090***
	(-11.135)	(-7.871)
Observations	36717	32835
R-Squared	0.004	0.004
Quarter FE	Yes	Yes

Panel B: Top 33% Supplier Financing Firms

	ΔCash Flow(t)	ΔCash Flow(t,t+3)
	(1)	(2)
Oil Shock	-0.177***	-0.092***
	(-6.364)	(-3.600)
Observations	11485	10080
R-Squared	0.004	0.004
Quarter FE	Yes	Yes

Panel C: Bottom 33% Supplier Financing Firms

	ΔCash Flow(t)	ΔCash Flow(t,t+3)
	(1)	(2)
Oil Shock	-0.093***	-0.073***
	(-7.622)	(-7.063)
Observations	11851	10788
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 otucome 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				
	ΔLog Sale(t)		ΔLog 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	12378	12378	11755	11755
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: Middle 33% Supplier Financing				
	ΔLog Sale(t)		ΔLog Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.002	-0.001	0.002	0.002
	(-0.383)	(-0.249)	(0.315)	(0.322)
Observations	12213	12213	11704	11704
R-Squared	0.020	0.020	0.010	0.011
Firm Type FE × Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Panel C: Bottom 33% Supplier Financing				
	ΔLog Sale(t)		ΔLog 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	12483	12483	11987	11987
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

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 (Columns (1) and (2)). 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 Different Quartiles of Supplier Financing

	Top Supplier Fin Quartile (75% or higher)				Third Supplier Fin Quartile (50-75%)			
	ΔLog Sale(t)		ΔLog Sale(t,t+3)		ΔLog Sale(t)		ΔLog Sale(t,t+3)	
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.019**	-0.022***	-0.017***	-0.018**	-0.007	-0.006	-0.001	0.002
	(-2.418)	(-2.920)	(-2.762)	(-2.472)	(-0.927)	(-0.741)	(-0.143)	(0.232)
Observations	10235	10235	9725	9725	10499	10499	10045	10045
R-Squared	0.007	0.010	0.006	0.010	0.021	0.023	0.012	0.015
Firm Type FE × Shock		Yes		Yes		Yes		Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Firms in Different Quartiles of Supplier Financing (Continuation)								
	Second Supplier Fin Quartile (25-50%)				Bottom Supplier Fin Quartile (25% or lower)			
	∆Log Sale(t)		∆Log Sale(t,t+3)		∆Log Sale(t)		∆Log Sale(t,t+3)	
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
OilShock × MQuarter	0.001	0.003	-0.001	0.003	0.003	0.004	0.004	0.005
	(0.228)	(0.537)	(-0.240)	(0.540)	(0.504)	(0.632)	(0.644)	(0.816)
Observations	10499	10499	10098	10098	10772	10772	10362	10362
R-Squared	0.023	0.025	0.013	0.018	0.039	0.042	0.044	0.048
Firm Type FE × Shock		Yes		Yes		Yes		Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel C: Firms in the Top and Bottom 40% of Supplier Financing								
	Top 40% Supplier Fin				Bottom 40% Supplier Fin			
	∆Log Sale(t)		∆Log Sale(t,t+3)		∆Log Sale(t)		∆Log Sale(t,t+3)	
	(5)	(6)	(7)	(8)	(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	13179	13179	12508	12508	13716	13716	13151	13151
R-Squared	0.007	0.009	0.006	0.009	0.035	0.036	0.034	0.036
Firm Type FE × Shock		Yes		Yes		Yes		Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8

Sales Effects for Largest Firms

This table reports results estimating the effects in Table 6 using different samples of large firms. The results are estimated using the same specifications as in Panel A of Table 6 (Columns (1) and (2)). The different samples are constructed using alternative cuttoffs for firms' total assets (book value) in quarter *t-1*. These cutoffs are determined based on the distribution of all firms (positive or negative beta). Note that these largest firms 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 25% of Total Assets

	ΔLog Sale(t)		ΔLog Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × MQuarter	0.004	0.006	0.006	0.008*
	(0.670)	(1.121)	(1.348)	(1.701)
Observations	11464	11464	11119	11119
R-Squared	0.036	0.040	0.028	0.033
Firm Type FE × Shock		Yes		Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel B: Top 33% of Total Assets

	ΔLog Sale(t)		ΔLog 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		Yes		Yes
R-Squared	0.037	0.039	0.027	0.030
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel C: Top 40% of Total Assets

	ΔLog Sale(t)		ΔLog Sale(t,t+3)	
	(1)	(2)	(3)	(4)
OilShock × MQuarter	0.004	0.006	0.005	0.007**
	(0.770)	(1.450)	(1.177)	(2.104)
Observations	20007	20007	19392	19392
Firm Type FE × Shock		Yes		Yes
R-Squared	0.038	0.039	0.029	0.031
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 (Column (1) in each panel) with different outcome variables. *ΔLog 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*. *ΔLog 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**			
	ΔLog Sale(t, t+1)		ΔLog Sale(t+4)		ΔLog Sale(t, t+1)		ΔLog 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	12276	12276	11420	11420	12407	12407	11658	11658
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 (Column (1) in each panel) 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*. *AP* is the firms' outstanding accounts payable (short-term operating liability with suppliers). *AR + Invt* captures short-term operating assets (sum of inventories and accounts receivable). *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 (AR + Inventories) and Accounts Payable

	Top 33% Supplier Fin		Bottom 33% Supplier Fin	
	ΔLog AP(t,t+3)	ΔLog AR+Invt(t,t+3)	ΔLog AP(t,t+3)	ΔLog AR+Invt(t,t+3)
	(1)	(2)	(3)	(4)
OilShock × MQuarter	-0.019***	-0.017***	-0.004	-0.003
	(-2.643)	(-2.796)	(-0.396)	(-0.382)
Observations	11878	11280	11962	11508
R-Squared	0.003	0.006	0.013	0.043
Firm Type FE × Shock	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Panel B: Effects on Operating Costs - Top 33% Supplier Financing						
	∆Log Cogs(t)	∆Log Cogs(t,t+1)	∆Log Cogs(t,t+3)	∆Log SG&A(t)	∆Log SG&A(t,t+1)	∆Log 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	12146	11409	11409	10079	9966	9504
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 C: Effects on Operating Costs - Bottom 33% Supplier Financing						
	∆Log Cogs(t)	∆Log Cogs(t,t+1)	∆Log Cogs(t,t+3)	∆Log SG&A(t)	∆Log SG&A(t,t+1)	∆Log 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	12371	12257	11771	11109	11013	10585
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

The Immediate Response of Long-Term Investment

This table reports results estimating the effects in Table 6 with long-term investment as the outcome. The results are estimated using the same specifications and samples as in Panels A and C of Table 6 (Column (1) in each panel) 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 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		**Middle 33% Supplier Financing**		**Bottom 33% Supplier Financing**	
	ΔInv (t)	ΔInv (t,t+1)	ΔInv (t)	ΔInv (t,t+1)	ΔInv (t)	ΔInv (t,t+1)
	(1)	(2)	(3)	(4)	(5)	(6)
OilShock × *MQuarter*	-0.000	-0.002	0.000	-0.001	0.002	0.002
	(-0.316)	(-1.091)	(0.086)	(-0.643)	(1.218)	(1.031)
Observations	10707	10489	10937	10790	11251	11102
R-Squared	0.004	0.003	0.000	0.000	0.001	0.000
Firm Type FE × Shock	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	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 (1) 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 *k* (event time) 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).