The Working Capital Credit Multiplier

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We provide novel evidence that funding frictions can limit firms' short-term investments in receivables and inventories, reducing their production capacity. We propose a credit multiplier driven by these considerations and empirically isolate its importance by comparing how a similar firm responds to shocks differently when these shocks are initiated in their most profitable quarter ("main quarter"). We implement this test using recurring and unpredictable shocks (e.g., oil shocks) and provide extensive evidence supporting our identification strategy. Our results suggest that funding constraints and credit multiplier effects are significant for smaller firms that heavily rely on financing from suppliers.

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One of the central questions in finance is to understand how financing frictions affect firms and the real economy. 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, short-term operating losses can induce borrowing problems that are both amplified and propagated over time through their impact on firms' balance sheets. This effect can play an important role in explaining the causes and consequences of funding problems faced by firms during recessions, industry downturns, or episodes of financial distress.

In this paper, we propose and analyze a new mechanism through which the credit multiplier can affect firms' operations and economic activity. We call this mechanism the "working capital credit multiplier". The key idea behind this multiplier is that funding frictions can also matter for short-term investments in assets such as account receivables and inventories. In contrast, existing literature focuses mostly on the idea that financing problems matter primarily for longer-term investment.[1] This focus on long-term investment is reasonable in principle because short-term assets may be easier to finance. On the other hand, financing frictions that affect short-term investments can have important implications because these investments have an immediate effect on firms' operations: lower inventories or receivables translate into lower sales. For example, consider a retailer that needs to buy inventories prior to sales or a construction company that needs to perform its work prior to billing clients. As firms need to cover operating costs prior to the collection of cash from sales, there is a need for the short-term financing of their production. Constraints on firms' ability to fund these short-term investments can limit their production capacity and directly influence firms' sales and economic activity.[2] This point has been emphasized by a theoretical macro-finance literature.[3] But as far as we know, there is no micro-level, empirical evidence on whether financing frictions do matter for short-term investments and

[1] For example, see Fazzari, Hubbard, and Petersen (1988), Stein (2003), Rauh (2006), Almeida and Campello (2007), Gan (2007), Lemmon and Roberts (2010), Duchin et al. (2010), Almeida et al. (2012), Chaney, Sraer, and Thesmar (2012), and Carvalho (2015).

[2] These short-term investments are economically important. Receivables and inventories represented approximately one third of total assets (book value) on average for U.S. listed nonfinancial firms between 1980 and 2016.

[3] While drops in long-term investment can lower aggregate demand and have other indirect effects on economic activity, this effect on production capacity can directly lower output through supply conditions. For example, see Mendoza (2010), Jermann and Quadrini (2012), and Mendoza and Yue (2012), and the references therein. This effect has also been emphasized as important for understanding the effect of monetary policy shocks (Barth and Ramey (2001) and Christiano, Eichenbaum, and Evans (2005)).

production capacity, or not.[4] Our main goal in this paper is to provide such evidence as well as document a new credit multiplier effect driven by these specific considerations.

We start our analysis by outlining this credit multiplier effect and its predictions. When firms need to cover operating costs prior to the collection of cash from sales, it is natural for firms to use short-term credit. We label this short-term funding as working capital financing and consider firms that largely rely on suppliers (payables) to cover this financing need. As customers purchase inputs from suppliers, a share of these inputs is sold by suppliers on credit, which is repaid after the collection of cash from sales by customers. The idea that suppliers provide this type of short-term funding to smaller firms has been highlighted by previous research and is supported by both anecdotal evidence and empirical patterns.[5] We analyze a constrained firm that uses all the credit available from suppliers and faces funding frictions that limit the availability of this credit.

The working capital credit multiplier captures the implications of these financing frictions for the amplification and propagation of shocks over time. Since a share of new short-term investments made by the firm is financed by suppliers, the response of these investments to shocks is levered and amplified. For example, suppose a firm can borrow 30% of the value of inputs and finances the remaining 70% of this cost using internal funds. If the firm reduces the internal funds allocated to short-term investments by $1.0 in response to a shock, these investments will drop by $(1.0)/(0.7) = $1.43. In addition, this levered response of short-term investments to shocks is propagated over time. As firms cut receivables and inventories, their production capacity and sales are reduced, what lowers their net worth in the subsequent periods. Lower internal funds in subsequent periods then lead to further reductions in firms' short-term investments and sales in the future, propagating the effects of funding constraints over time.

A central feature of our analysis is the idea that these effects interact with seasonal patterns in firm profitability. As we document in Section 3.2, there are strong seasonal patterns in the cash flows of a broad range of U.S firms (Chang, Hartzmark, Solomon, and Soltes (2017)). Firms have

[4] Recent research has suggested that these effects of financing frictions on production capacity were relevant in the context of exporting activity during the last financial crisis (see references below). However, it is challenging to infer the broader importance of these effects. For example, Amiti and Weinstein (2011) argue that these effects might not be relevant outside of exporting activity.

[5] As highlighted by Petersen and Rajan (1997), financing these short-term investments with short-term credit from suppliers allows firms to match the maturity of assets and liabilities. Murfin and Njoroge (2015) mention that "trade credit provides bridge financing to cover the gap between the purchase of inputs and the sale of output." See Section 1 for more details.

main periods (quarters), where their cash flows are predicted to be significantly stronger. We illustrate how the effects described above should be stronger when shocks are initiated during a firm's main quarter. The intuition is that customers should be able to finance a larger share of inputs on credit during the main quarter, when they are more profitable and have more cash flows to repay suppliers.[6] This increased leverage in the main quarter amplifies responses of firms' sales and short-term investments to shocks (in percentage terms).[7]

If propagation effects are strong enough, our framework leads to the following implication. Shocks that initially hit firms inside their main period can have stronger percentage effects on the short-term investment and production (sales) not only contemporaneously, but also in subsequent periods. Suppose we contrast a firm that is hit by a shock inside its main period (say firm i in period t) to a similar firm (firm j) that is outside of its main quarter in period t. As we move forward in time, firm j will eventually move into its main period (say period $t+1$). If the shock is persistent in nature, then there is a *direct* effect in period t+1 that is stronger for firm j (now inside its main period) than for firm i. However, the stronger initial effect of the shock for firm i in period t will translate into stronger propagation effects in period $t + 1$. Hence, significant propagation effects can lead to stronger responses by firm i in both periods t and t+1.

In our empirical analysis, we compare how similar firms respond to shocks differently when these shocks are initiated in the main quarter. We label this contrast as the main quarter effect and focus this effect for two reasons. First, these seasonal interactions are interesting in themselves and illustrate how initial conditions can shape credit multiplier effects. Second, the analysis of main quarter effects helps us empirically isolate the importance of these multiplier effects.

Our empirical approach to isolate the working capital credit multiplier is to examine if there are significant main quarter effects in both immediate and subsequent responses of firms to shocks. While the presence of a main quarter effect in firms' immediate responses to shocks is a prediction of the multiplier we analyze, this pattern could be driven by alternative effects. That is, even

[6] This should be the case as long as the share of inputs that customers can finance on credit from suppliers is not entirely determined by the value of these inputs but also affected by customers' cash flows, which are higher in the main quarter. This point is consistent with both anecdotal and empirical evidence (see Section 1 and the text below).
[7] Returning to the numerical example above, suppose a customer can buy 35 percent of its inputs on credit from suppliers when inside its main quarter. Then, the same \$1.0 change in internal funds allocated by a constrained firm to input investment translates into a short-term change in investment equal to \$(1.0)/(0.65) = \$1.54 inside the main period.

without frictions in working capital financing, firms might have stronger immediate responses to economic shocks such as input price increases during their main quarter. In contrast, main quarter effects in both immediate and subsequent quarters must capture a stronger *propagation* over time for shocks that hit in the main quarter. The intuition for this point is as follows. If firm j (the control firm above) is outside its main quarter when the shock is initiated (say quarter t), it eventually will move into its main quarter in a subsequent period (say quarter t+1). Hence, a stronger response to the shock by firm i (the treated firm) in quarter t implies that the direct effect of the shock should be stronger for firm j (the control firm) in quarter t+1. But suppose we find that firm i also shows a greater response to the shock in quarter $t+1$, relative to firm j. Such a result must indicate a propagation of the shock over time.

This propagation effect is consistent with the credit multiplier, as changes in net worth propagate the effect of the shock over time. However, in principle, this propagation effect could be driven by alternative mechanisms. For example, consider an input price shock that has a stronger immediate effect on firms' sales in the main quarter. If the firm fires some workers as it cuts back its sales, the initial effect of the shock on employment could drive its propagation over time. To address these possibilities, we examine whether propagation effects are concentrated among firms that strongly rely on credit from their suppliers. We also refine our approach to incorporate additional contrasts between effects for short- versus longer-term investments, as well as contrasts between different types of firms and shocks. These refinements allow us to further address potential concerns with our empirical approach.

An important issue for the implementation of our analysis is the comparison of *similar* firms hit inside versus outside their main quarter. As we discuss in Section 2, we implement this idea by analyzing recurring shocks that are unpredictable, i.e., have a constant probability over time that cannot be predicted using past information. We illustrate how the analysis of such shocks leads to a random assignment of treated firms (hit inside the main quarter) and control firms (hit outside the main quarter). Consistent with this argument, we provide direct evidence that the treated and control firms in our analysis are very similar in terms of many basic characteristics and that controlling for potential differences across them has virtually no effect on our results.

The credit multiplier that we want to isolate should be particularly relevant for shocks that more strongly affect the internal funds allocated by firms for short-term investments. In particular, our theoretical framework predicts that shocks to input prices (production costs) should matter the most. Motivated by these considerations, in our main results, we construct a broad sample of industry shocks using industries' negative exposures to oil shocks. These shocks are largely unpredictable, recurring, and associated with significant changes in production costs. We analyze the differential effect of these industry shocks (within a same industry-time) on firms that happen to be inside their main quarter when the shock is initiated and also consider alternative recurring shocks when implementing our analysis.

Using this approach, we detect significant propagation effects for smaller firms that strongly rely on credit from suppliers but not for other smaller firms. Shocks that hit these firms in their main quarter have significantly stronger effects on their sales and short-term investments (receivables and inventories) both in the first and second semesters after the start of the shock. Moreover, these patterns are differentially stronger for firms that strongly rely on credit from suppliers, relative to other smaller firms, and this contrast across the responses of different types of firms remains stable as we control for differences in basic firm characteristics.

We then contrast these effects for short- and long-term investments (capital expenditures). In principle, propagation effects could be equally or more important for long-term investments. As the initial effects of the shock lower the firm's net worth, the firm has less internal funds to finance all investments. However, our framework can also generate an asymmetric effect on short-term investment. To show this point we build on previous work analyzing the implications of financing frictions (Bernanke, Gertler, and Gilchrist (1999)), and assume that drops in firms' internal resources adversely affect new borrowing terms.[8] When firms finance a share of their short-investments with credit from suppliers, reductions in firms' internal funds will immediately increase the marginal cost of expanding these investments. Intuitively, these short-term investments are exposed to changes on refinancing terms for this short-term credit. Since long-term investments are more likely to be financed using long-term term financing (Petersen and Rajan (1997)), these investments are less exposed to this refinancing effect (see Section 4.3). This asymmetry in the exposure to refinancing terms induces a substitution across these two types of

[8] For example, lenders might charge higher spreads or impose stricter borrowing limits on new credit when borrowers have less internal funds. Bernanke, Gertler, and Gilchrist (1999) and Gertler and Gilchrist (2018) argue that this effect is implied by standard models of lending with information asymmetry and is consistent with the data. See Section 4.3 for more details.

investment, which amplifies propagation effects for short-term investments and mitigates these effects for long-term investments.

Consistent with this idea, we find that the previous effects are differentially stronger for firms' short-term investment relative to their long-term investment. The main quarter effects for both the immediate and subsequent responses of firms to shocks are stronger for short-term investments (payables and receivables). Moreover, also consistent with the intuition described above, we do not estimate economically or statistically significant propagation effects for long-term investment.

As described above, the main quarter effects that we analyze build on the idea that customers can finance a larger share of inputs on credit during the main quarter and that they are constrained, borrowing all the credit available from suppliers. If this condition is satisfied in the data, firms' payables should increase relative to their short-term investment (inventories and receivables) during their main quarter, i.e., their leverage from suppliers should increase in the main quarter ("leverage seasonality"). Leverage seasonality is a *necessary* condition for the mechanism we propose to be empirically relevant. We use this insight to check which firms could be potentially exposed to multiplier effects. First, we further motivate our focus on smaller firms that strongly rely on credit from suppliers. We show that leverage seasonality is present for these firms but is not present for other smaller firms.[9] Second, we show that there is no leverage seasonality for firms that strongly rely on short-term debt rather than credit from suppliers.[10] Thus, we should not detect main quarter effects for these firms. That is precisely what we find. We also find that main quarter effects are differentially stronger for firms that rely on credit from suppliers, when compared to firms that rely on short-term debt. Third, we document that leverage seasonality is not present for firms that are unlikely to face significant liquidity issues: large firms, high cash firms, and high payout firms. We then show that the main quarter effects that we document are not present for any of these firms.

[9] We note that this empirical pattern could be driven by alternative explanations and is not necessarily an indication of funding constraints from suppliers, but it represents an important consistency check for our analysis.

[10] We discuss why this leverage seasonality might not be present for firms relying on short-term debt. For example, firms might rely on pre-committed lines of credit with limits tied to assets or factors that do not significantly change with short-term fluctuations in profitability.

Additionally, we examine the previous effects using a broader range of different economic shocks. As discussed above, the mechanism we analyze predicts that these effects should be mostly relevant for shocks strongly associated with changes in production costs. Across a range of additional results, we provide direct support to this idea.

As a final step in our analysis, in Section 6, we discuss whether alternative explanations can plausibly explain our results. We explain how our approach to isolate propagation effects relies on the idea that firms hit by shocks inside (treated) versus outside (control) their main quarter are otherwise similar. In particular, our approach does not depend on assumptions about other factors such as the persistence of shocks. Our empirical approach is designed to ensure that treated and control firms are otherwise similar, and we provide multiple sources of evidence supporting this idea.

We interpret these propagation effects as evidence of a working capital credit multiplier. However, in principle, alternative mechanisms could also rationalize the propagation effects that we document (even when treated and control firms are similar). For example, stronger initial effects on sales might lead the firm to lose some customers that do not switch back to the firm in future periods, translating into a propagation of initial conditions over time. We discuss the multiple reasons why our evidence is not consistent with these alternative explanations. For example, we find that these propagation effects are stronger for firms' short-term investments and are not associated with significant changes in long-term investment. As firms persistently face a reduced demand by customers, their return on long-term investments should become lower. Thus, under this alternative explanation we should see reductions in long-term investment (but we don't). Additionally, the propagation effects that we document are only significant and differentially important for firms that strongly rely on credit from suppliers (which as we show are exposed to our mechanism). It is unclear why alternative explanations would only lead to propagation effects in this specific subset of firms, but not in other firms. Also consistent with our mechanism, we detect significant propagation effects only for shocks more strongly associated with changes in production costs.[11] While it is challenging to completely rule out alternative interpretations for the

[11] Another alternative explanation for propagation effects is that firms' internal resources lead to propagation effects by limiting firms' ability to make long-term investments, as opposed to having direct effects on firms' short-term investments and sales. In Section 6, we also discuss why our evidence is not consistent with this explanation.

propagation effects that we document, our collective evidence is most consistent with the working capital credit multiplier.

Overall, our main contribution it to provide micro-level evidence that an important subset of firms faces funding frictions limiting their ability to finance short-term investments in payables and receivables and reducing their production capacity. This analysis of short-term investment considerations, and a credit multiplier driven by such effects, distinguishes our paper from the literature that focuses on the impact of financing frictions on long-term investments.[12] Our paper is also related to Amiti and Weinstein (2011) and Paravisini et al. (2015), who provide evidence that working capital financing constraints are relevant for exporting activity during financial crises in Japan and Peru, respectively. In addition, our focus on supplier financing connects our work with the literature on trade credit as well as previous evidence on contagion effects from financially constrained suppliers (Costello (2020)).[13] In contrast with previous research, we illustrate the role of supplier financing in limiting the short-term investments and production capacity of customers. Our evidence on the propagation of funding problems over time is also a relevant contribution to the literature. While this over-time propagation mechanism is an important feature of theories of the credit multiplier (e.g., Kiyotaki and Moore (1997)), there isn't much empirical evidence of this propagation. Our analysis of this within-firm propagation and the role of short-term investments in this process complements the evidence of Huber (2018) on the propagation of funding problems over time at the regional level in Germany.

1. Theoretical Framework

As a first step in our analysis, we discuss the theoretical framework that we use to motivate our empirical tests. We focus on presenting the main intuitions here and show a simple model formalizing them in the Appendix. The starting point for our analysis is that firms' operations require short-term investments in accounts receivable and inventories, what creates a need for

[12] See the references discussed above on this literature. Some studies have also examined the effect of funding constraints on firm employment (e.g., Benmelech, Bergman, and Seru (2011), and Chodorow-Reich (2014)), which could be driven by working capital financing constraints or other effects (Bai, Carvalho, and Phillips (2018)).

[13] For example, see Petersen and Rajan (1997), Wilner (2000), Cunat (2007), and Giannetti, Burkart, and Ellingsen (2011) and the references therein for previous research on trade credit. Barrot (2016) provides evidence that the need to provide trade credit to customers can limit the ability of liquidity-constrained firms to compete with other firms. Amberg et al. (2021) provide evidence that, after a liquidity shortage event in Sweden, firms reduced the provision of trade credit to customers but were able to borrow more from their suppliers.

working capital financing. In each period (e.g., quarter), firms need to cover operating costs prior to the collection of cash from sales and need working capital financing to fund this gap. Two examples would be a retailer that needs funding to buy goods prior to their sale to final customers, or a construction company that needs funding to make progress on construction projects prior to billing their clients. We label this investment in input costs in each period as the firm's short-term investment. In our empirical analysis, we interpret this investment as capturing short-term investments in inventories and receivables.

We consider a firm that largely relies on funding from suppliers (accounts payable) to cover this financing need. Suppliers provide short-term credit at the beginning of each period and get paid at the end of the period when the firm generates cash from sales. The idea that suppliers provide this type of short-term funding to smaller firms has been highlighted by previous research and is supported by both anecdotal evidence and empirical patterns.[14] We label this short-term funding as working capital financing.

We examine a constrained firm that would like to expand its short-term investment using additional working capital financing but faces frictions. The firm uses all the credit available from suppliers and these frictions limit the credit that is available. Because firms rely on short-term investments for the completion of their sales, binding constraints on the funding of these investments translate into immediate reductions on sales, reducing the firm's production capacity. We examine the implications of these financing frictions for the amplification and propagation of shocks over time. We label these effects as the working capital credit multiplier.

The predictions we analyze build on two points that are consistent with previous research and anecdotal evidence. First, a share of new short-term investments made by the firm is financed by suppliers. This comes from the fact that suppliers sell inputs on credit. For example, consider a firm that decides to buy \$1.0 in additional inputs from suppliers. This investment in inputs allows the firm to raise financing that is backed by the increase in inputs. To give a numerical example,

[14] Consistent with this idea, trade credit typically has a very short maturity. Klapper, Laeven, and Rajan (2012)) find that most trade credit has a maturity below 90 days. Petersen and Rajan (1997) explain that trade credit is largely used to finance current assets (excluding cash) as this allows firms to match the maturity of assets and liabilities. Murfin and Njoroge (2015) mention that "trade credit provides bridge financing to cover the gap between the purchase of inputs and the sale of output." The Economist (Oct 12, 2017) states that: "Suppliers, of course, have always needed to finance the gap between production and payment." The Internet Appendix provides additional evidence supporting this idea.

suppose that the firm can borrow 30% of the value of inputs. Then, if the firm expands its inputs by \$1.0, it can raise \$0.3 in financing and only needs to internally fund \$0.7. When the firm is constrained and uses all the available credit, this financing leads to a levered response of the firm's short-term investment to economic shocks. For example, if the firm reduces the internal funds allocated to short-term investments by \$1.0 in response to a shock, these investments will drop by \$(1.0)/(0.7) = \$1.43.[15]

Second, the share of the short-term investment that customers can finance on credit from suppliers is not entirely determined by the value of the investment, but it is also affected by customers' cash flows. For example, Petersen and Rajan (1997) document that more profitable customers receive significantly more credit from suppliers.[16] In the context of the example above, the share of the investment in inputs that customers can finance on credit from suppliers is higher when costumers are more profitable. As we document in Section 3.2, there are strong seasonal patterns in the cash flows of a broad range of U.S firms. Firms have main periods (quarters), where their cash flows are predicted to be significantly stronger. Since the borrowing from suppliers is very short term, firms' have more cash flows to repay suppliers in their main period and can finance a larger share of goods on credit during these periods.

Returning to the numerical example above, suppose a customer can buy 35 percent of its inputs on credit from suppliers when inside its main quarter, rather than 30 percent (fraction outside of the main quarter). Then, the same \$1.0 change in internal funds allocated by a constrained firm to input investment translates into a stronger short-term change in investment during the main period. The short-term change in investment is \$(1.0)/(0.65) = \$1.54 inside the main period, rather than \$(1.0)/(0.7) = \$1.43 outside of the main period. Intuitively, the firm can leverage more aggressively its short-term investment with short-term funding from suppliers during the main period. Consequently, economic shocks that generate identical reductions in internal funds

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[15] One can consider an analogy with a household financing a new house with a mortgage. If the household finances 70 percent of this new house on credit, a shock increasing the internal funds allocated by the household to the house by \$1,000 allows the household to buy a house that is (\$1,000/0.3) =\$3,333 more expensive. Another example would be a firm financing a share of a new equipment purchase with credit from the manufacturer of the equipment.

[16] The alternative possibility is that customers' borrowing capacity is only determined by the value of its hard assets. Lian and Ma (2021) provides evidence on the importance of firms' income, as opposed to only hard assets, in shaping corporate lending terms in the U.S. The Wall Street Journal (July 15, 2020) mentions that: "vendors assess the health of their wholesale customers… against the value of customers' sales channels… to figure out if it's worth providing goods on credit." The framework in Tirole (2006) also builds on the idea that firms can (imperfectly) use their income to back their borrowing.

allocated to short-term investments will translate into more amplified immediate responses when these shocks happen during the firm's main period.[17]

These ideas lead to the following predictions for firms that face binding constraints on the financing of the short-term investment. The short-term investment response of these firms to a same economic shock should be more levered during their main period. Thus, the immediate percentage response of short-term investments and production (sales) to shocks should be stronger during the main period. We build on this intuition in our strategy to identify the working capital multiplier.

We then examine the implications of this multiplier for the propagation of shocks over time. In our empirical analysis, we build on these implications to help separate the working capital multiplier from alternative mechanisms that can also generate a correlation between cash flow seasonality and the response of short-term investment to shocks.

The starting point is that cuts in short-term investments today translate into immediate reductions in firm sales and cash flows, reducing internal funds available to fund operations moving forward. Lower internal funds in subsequent periods then lead to further reductions in firms' short-term investments and sales in the future, propagating the effects of funding constraints over time. We also build on previous work analyzing the implications of financing frictions (Bernanke, Gertler, and Gilchrist (1999)), and assume that drops in firms' internal resources adversely affect new borrowing terms.[18]

We consider the differential propagation of shocks that are initiated inside a firm's main period. A firm that is hit by a shock inside its main period (say firm *i* in period *t*) should suffer from a stronger propagation effect relative to a similar firm that was outside of its main period

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[17] Using the analogy with a household buying a new home, the idea is that the income and credit score of the borrower should also shape the share of the home price that can be financed. Higher-income borrowers should be able to finance a larger portion of the house using credit. If households rely on all the available credit, higher-income households will have more levered responses to shocks changing the funds allocated to home purchases.

[18] We rely on this last assumption only for some of the refined tests of our analysis (Section 4.3). Bernanke, Gertler, and Gilchrist (1999) argue that this effect is implied by standard models of lending with information asymmetry as the divergence of interests between lenders and borrowers is greater when borrowers have less net worth. Gertler and Gilchrist (2018) discuss how this effect is consistent with the data. Our framework uses this assumption for some predictions, but the propagation effects that we analyze are different from the ones in Bernanke, Gertler, and Gilchrist (1999) and focus on the role of short-term investment and working capital financing.

during period t (say firm j). This differential propagation effect is a consequence of the higher immediate drop in production capacity for firm i relative to firm j, which causes a stronger drop in internal funds and net worth for firm i relative to firm j on future periods.

However, this higher differential *propagation* for firm i does not necessarily mean that future short-term investment and sales will decrease relatively more for firm i than for firm j. As we move forward in time, firm j will eventually move into its main period (say period $t+1$). If the shock is persistent in nature (such as oil price shocks), then there is a *direct* effect in period t+1 that is stronger for firm j (now inside its main period) than for firm i. Future short-term investment and sales will decrease relatively more for firm i than for firm j if the propagation effect is stronger than the direct effect.

If propagation effects are strong enough, our framework leads to the following key implication. Shocks that initially hit firms inside their main period can have stronger percentage effects on the short-term investment and production (sales) not only contemporaneously, but also in subsequent periods. This persistence in the multiplier is a consequence of the propagation of shocks over time through endogenous changes in net worth. Responses that are initially more levered translate into more levered effects in subsequent periods. As we discuss in Section 2 (when we discuss identification), this additional consequence of the multiplier helps us distinguish the working capital credit multiplier from alternative explanations.

2. Empirical Approach

We build on the predictions discussed in Section 1 to develop our empirical approach. We examine the differential percentage response of firms' short-term investment and sales to shocks initiated during firms' main quarter. The idea is to contrast how a firm responds over time to an economic shock when this shock hits the firm (say firm i, the treated firm) inside its main quarter, with a similar firm's (say firm j, the control firm) response to a shock that hits outside of the main quarter. We label this contrast as the main quarter effect. Our empirical approach to isolate the working capital multiplier is to examine if there are significant main quarter effects in both firms' immediate and subsequent responses to shocks.

While the presence of a main quarter effect in firms' immediate responses to shocks is an important prediction of the multiplier we analyze, in principle, this pattern could be driven by alternative effects. For example, even without frictions in working capital financing, firms might have stronger immediate responses to economic shocks such as input price increases during their main quarter. In contrast, main quarter effects in both immediate and subsequent quarters must capture a stronger *propagation* over time for shocks that hit in the main quarter. The intuition for this point comes from a key point discussed in Section 1. If firm j (the control firm above) is outside its main quarter when the shock is initiated (say quarter t), it eventually will move into its main quarter in a subsequent period (say quarter t+1). Hence, a stronger response to the shock by firm i (the treated firm) in quarter t implies that the direct effect of the shock should be stronger for firm j (the control firm) in quarter t+1. Recall that the two firms are assumed to be similar and only differ in terms of the timing of their main quarter. Therefore, firm j is in a similar position in quarter t+1 to firm i in quarter t. Going back to the example above, the effect of higher input prices should be stronger for firm i in quarter t and firm j in quarter t+1. But suppose we find that firm i also shows a greater response to the shock in quarter $t+1$, relative to firm j. Such a result must indicate a propagation of the shock over time.

The argument described above does not rely on assumptions about the persistence of the shock over time (between quarter t and t+1). For example, suppose that the shock is not totally persistent, so that the effect of the shock on short-term investment fades out over time. In that case, firm j may show a weaker response to the shock in time $t+1$, when compared to firm i's response in time t. But notice that our propagation test compares the response of firm i to firm j **in time t+1**. Limited shock persistent alone cannot generate a stronger response of firm i in time t+1.

This propagation effect is consistent with the credit multiplier, as endogenous changes in net worth propagate the effect of the shock over time. However, in principle, this propagation effect could be driven by alternative mechanisms. For example, consider an input price shock that has a stronger immediate effect on firms' sales in the main quarter. If the firm fires some workers as it cuts back its sales, the initial effect of the shock on employment could drive its propagation over time. To address these possibilities, we examine whether propagation effects are concentrated among firms that strongly rely on credit from their suppliers. We also refine our approach to incorporate additional contrasts between effects for short- versus longer-term investments, as well as contrasts between different types of firms and shocks. These refinements allow us to further address potential concerns with our empirical approach. After showing our results, we discuss the challenges for alternative mechanisms to explain these contrasts in the importance of propagation effects in Section 6.

The analysis of main quarter effects requires contrasting similar firms hit by shocks inside versus outside the main quarter. To isolate these effects, we analyze recurring shocks that are largely unpredictable. We refer to unpredictable shocks as shocks that have a constant probability over time (in each quarter *t*), which cannot be predicted using past information (known prior to the realization of the shock in quarter *t*). The use of such shocks allows us to eliminate differences between firms hit inside their main quarter (treated firms) and firms hit outside their main quarter (control firms). For example, suppose we study a shock affecting firms in calendar quarter Q4 and contrast firms hit inside their main quarter with firms that had their main quarter in Q3. Denote firms with their main quarter in calendar quarters Q4 and Q3 as Q4- and Q3-type firms, respectively. It is possible that Q4-type firms are systematically different from Q3-type firms in a way that could contaminate our identification strategy. For example, Q4-type firms are larger in our data and shocks could have a different persistence for larger firms. However, because we use **recurring** shocks that are largely **unpredictable**, our approach should address such potential issues. As we analyze shocks over time, Q4-type firms have the same chance of being hit by a shock in their main quarter as Q3-type firms. Similarly, these two types of firms have the same probability of being hit by shocks outside their main quarter. Therefore, as we examine a large sample of unpredictable shocks, the assignment of treated and controls firms should be random, and our treated and control groups should be virtually identical.[19]

An important issue in the implementation of this idea is the choice of the recurring and unpredictable shocks to be analyzed. The effects we want to isolate should be particularly relevant for shocks that more strongly affect the internal funds allocated by firms for short-term investments. In particular, our theoretical framework predicts that shocks to input prices (production costs) should matter the most. Higher input prices increase the relative costs faced by constrained firms when using their internal funds to cover operating expenses (short-term

[19] More broadly, in a sample with quarterly firm data, the characteristics of firms inside versus outside the main quarter should be very similar since all firms alternate between these two subsamples. If shocks have the same distribution in each of these two subsamples, then firms hit by shocks inside versus outside the main quarter (treated versus control firms) should also be very similar.

investment) versus other purposes.[20] Alternatively, adverse shocks to demand conditions do not lead to these direct increases in the costs of buying inputs. When economic shocks have a smaller effect on the funds allocated by firms for operating costs, the multiplier effect will be harder to detect in the data.

We construct a broad sample of industry shocks. For each industry shock, we contrast the response of same-industry firms inside and outside their main quarter at the time of the shock. When searching for industry shocks, we focus on shocks that are driven by aggregate observable conditions such as oil shocks or GDP fluctuations and are hard to predict. These shocks are largely unpredictable, recurring, and comparable over time, which are the key features of industry shocks required by our analysis. To ensure that the shocks are associated with significant changes in production costs, in our main results we focus on industry shocks using oil prices (see Section 3.3).

While our results should be most significant for shocks that affect firms' production costs (such as changes in oil prices), our analysis does not require isolating pure shocks to production costs. To the extent that the shocks in our analysis capture changes in other conditions, the mechanism that we want to isolate will have muted effects. For example, changes in oil prices can also affect firms through changes in demand conditions. We are not trying to say that oil prices should affect firms only through input prices, but simply that the multiplier effects that we are trying to measure will be stronger when oil prices do change input prices for firms.

In principle, the industry shocks that we analyze could affect firms' short-term investment and sales through a range of alternative effects. These shocks should have an effect on the decisions of firms that are not exposed to the working capital credit multiplier. They can be correlated with or partially driven by changes in the conditions faced by firms' competitors, suppliers, and customers. Our identification strategy builds on the idea that these alternative mechanisms would not lead to the specific contrasts in firms' responses to shocks described above. Namely, these alternative mechanisms should not lead to propagation effects that are stronger when shocks hit in the main quarter, and that are concentrated on firms that strongly rely on credit from suppliers. As described above, we further refine our approach to incorporate contrasts between effects for short- versus longer-term investments, as well as contrasts between different types of firms and shocks.

[20] Constrained firms have to allocate their scarce internal funds across different needs, e.g., operating costs versus longer-term investments. When faced with higher input prices, these firms should move their internal funds more towards alternative purposes (e.g., long-term investments) and away from operating costs.

These refinements allow us to further address potential concerns that alternative mechanisms drive our evidence on propagation effects.

3. Data, Variables, and Motivating Patterns

3.1. Data and Summary Statistics

We use listed firms because our analysis requires using current and historical quarterly financial statements on firms. We start with data from COMPUSTAT's North America Fundamentals Quarterly. Following standard practice in the literature, we exclude financial firms (SIC codes 6000 to 6999) and regulated utilities (SIC codes 4900 to 4999). In our main analyses, we drop the largest firms in our data (top 33%) in terms of size, measured using the one-quarter lag of total assets (*atq*). Previous research has suggested that the importance of payables among the largest firms is less driven by financing needs. Instead, it is more motivated by economic considerations such as ensuring the quality provided by suppliers (Klapper, Laeven, and Rajan (2012)). In the Internet Appendix, we show the average importance of payables by size decile for a broad sample of firms. Firms in the bottom of the size distribution significantly rely on payables and this importance declines with size until one reaches the top three size deciles, where this importance becomes relevant again and is potentially driven by these alternative economic considerations. Motivated by this pattern, we drop firms in the top size tercile. Our main results remain similar if use alternative cutoffs for these large firms such as the top decile or quartile (see the Internet Appendix).[21]

We implement our main tests using oil price shocks to ensure that the shocks are associated with significant changes in production costs (see Section 2). For this same reason, we focus on industries (3-digit SIC codes) with a negative cash-flow exposure to oil price increases. We consider broader samples and shocks below. Finally, the construction of the variables used in our analysis 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 restrictions, we arrive at the main sample used

[21] This pattern is consistent with previously documented links between firm size and trade credit. For example, see Murfin and Njoroge (2015) and the references therein.

in our results, which covers 3,170 firms and has 46,185 observations over this 36-year period. Table 1 provides summary statistics for this main sample.

We capture firms' short-term investments in their operations using receivables and inventories. For example, one can think of a construction company paying for costs prior to billing (receivables) and a manufacturing firm completing an order prior to delivery (inventories). Panel A of Table 1 shows that these two assets combined represent approximately one third of firms' total assets in our main sample. As a comparison, this magnitude is similar to the average ratio of net property, plant, and equipment (Net PPE) over total assets. This importance of receivables and inventories is similar in broader samples such as all U.S. listed nonfinancial firms between 1980 and 2015.

3.2. Seasonality and Supplier Financing

We document the existence of a strong predictability of firm profitability within a year and link it to firms' reliance on credit from suppliers. Firms have main quarters within calendar years when their profitability is predicted to be significantly larger. We capture this pattern 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 which, intuitively, measures seasonality in firms' operating conditions. For each calendar year, we use data on the previous five calendar years (twenty quarters) to identify a firm's main quarter. We follow the approach in Chang, Hartzmark, Solomon, and Soltes (2017) and first rank these twenty quarters in terms of their profitability (*Cash Flow*). Note that each quarter (Q1, Q2, Q3, and Q4) is ranked five times and, for example, can be in the five top positions among the twenty quarters (ranks one to four). We then estimate the average rank for each quarter and define the main quarter as the quarter with the lowest average rank (highest average position). The use of an average rank, as opposed to an average cash flow, reduces the influence of individual quarters with abnormal cash flows in this classification.

Panel A of Table 2 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 relate *Main Quarter* in quarter t both to contemporaneous *Cash Flow*, and also to the sum of *Cash Flow* in quarters t and t+1. Our regressions include fixed effects for firms with different calendar quarters (e.g., Q1) as their main quarter (four firm types) because these firm types could predict systematic differences in firm profitability. We scale the coefficient of *Main Quarter* by dividing the estimated coefficient by the mean of the outcome being analyzed in the main sample (see Table 1). We find that firms' main quarter is associated with predictable differences in profitability that are economically large for both definitions of *Cash Flow* (45% to 80% of the mean of cash flows). These results confirm the view that the seasonality we analyze does predict cash flows within a year.

An important issue is what drives these significant differences in seasonality within an industry (3-digit SIC code). Note that conditional on a same industry, there can be significant differences across firms in their specific product markets (subject to different cycles). The location of firms can also be an important source of variation in seasonality. Markets can be geographically segmented (e.g., services) and firms' local conditions can shape seasonality for other reasons such as weather patterns within a year (e.g., construction firms operating in Illinois versus Texas). Indeed, in the Internet Appendix, we show that a combination of more detailed industry definitions with firms' location can largely explain within-industry differences in seasonality. The Internet Appendix also shows that firms in our main sample have main quarters well distributed throughout the year.

We then link this seasonality in profitability to firms' reliance on credit from suppliers. Recall that the mechanism we propose in Section 1 builds on the following condition. Customers are using all the credit available from suppliers, i.e., they face a binding borrowing limit, and the share of their short-term investment that they can finance on credit from suppliers is larger in their main quarter, when they have more cash flows to repay suppliers. If this condition holds in the data, firms' payables should increase relative to their short-term investment (inventories and receivables) during their main quarter. We directly examine this prediction. Intuitively, this prediction captures the idea that customers are leveraging more when buying goods on credit in their main quarter. Only firms significantly relying on supplier financing are potentially exposed to this binding borrowing limit from suppliers. Therefore, we focus on differential patterns for these firms.

We measure the importance of supplier financing using *Supplier Financing*, the ratio of accounts payable to sales.[22] As a first step, we rank firms into three terciles using the average value of *Supplier Financing* in the previous four quarters (sorted by year). We use the ratio of accounts payable over sales because this ratio captures the importance of these liabilities as a share of firms' overall production.[23] We then separately analyze the top two groups of firms, that we label as middle and top supplier financing firms. Specifically, we examine the growth of payables relative to working capital assets and check if this growth differentially increases for each of these groups during the main quarter, controlling for basic firm characteristics (size, age, and *Q*) in some of the results. We relate firms' borrowing from suppliers at the end of quarters t and t+1 to the presence of their main quarter in t. This timing captures the response of firms' borrowing to their main quarter. Recall that firms with their main quarter in t have a significantly stronger profitability in quarters t and t+1 (Panel A).

Panel B of Table 2 (columns (1) and (2)) shows that top supplier financing firms borrow more aggressively from suppliers during their main quarter, i.e., their payables increase relative to their working capital assets (receivables and inventories). This effect is not economically or statistically important for the middle supplier financing group. Notice that in these regressions the coefficients are measured relative to the low supplier financing group (bottom tercile).

This result supports the prediction above for top supplier financing firms. We note that this empirical pattern could be driven by alternative explanations and is not necessarily an indication of funding constraints from suppliers. For example, this pattern could be driven by a pecking order, where firms first rely on internal funds or short-term debt and rely more on suppliers during their main quarter as they need additional funds during this period. However, we highlight that this prediction represents an important consistency check for our analysis. The mechanism we propose in Section 1 should only be present and detected in the data when firms satisfy this prediction. Our identification approach to isolate the importance of this mechanism is described in in Section 2.

A comparison of the magnitudes across the results in Panels A and B of Table 2 is also consistent with the idea that firms' higher cash flows in their main quarter allows them to borrow

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[22] 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. Note that we excluded large firms since the importance of payables among these firms is less driven by financing needs.

[23] 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.

more from suppliers in this period. The results in Panel A (column (2)) imply that cash flows are predicted to increase for these firms by the equivalent of 5 percent of their payables. The results in Panel B suggest that these same firms use approximately 1.5 percent more credit from suppliers during their main quarter.

Since this pattern is concentrated on the top supplier financing firms, in the analysis that follows we focus on contrasting this group with all other firms (the bottom and middle terciles). Columns (3) and (4) in Panel B show the previous effect using this contrast. In these regressions, the coefficient on the top supplier financing group is measured relative to the two other groups (bottom and middle terciles). The coefficients are similar to those in columns (1) and (2). Finally, we also find similar patterns when we examine the growth of payables relative to sales, as opposed to working capital assets. Panel C of Table 2 shows that these effects have comparable magnitudes to the previous ones. In the Internet Appendix, we also provide a description of the industries covered in this group of top supplier financing firms.

3.3. Industry Shocks

An important step in our analysis is the construction of industry shocks. As discussed in Section 2, we construct a broad sample of industry shocks and focus on recurring shocks that are driven by aggregate observable conditions such as oil shocks or GDP fluctuations and are hard to predict. In our main results, we analyze industry shocks using oil prices and focus on industries (3-digit SIC codes) with a negative cash-flow exposure to oil price increases. We follow this approach to ensure that the shocks are associated with significant changes in production costs. However, we also consider a range of other approaches to construct industry shocks, such as predicting changes in industry cash flows using GDP shocks and using predicted effects from oil prices for industries with positive oil betas. Additionally, in the context of industries with negative exposure to oil shocks, we also decompose the effects of oil prices on industries' revenues and profitability. As we move into shocks that are less likely to capture shifts in production costs and more likely to reflect other conditions such as product-market demand, we should expect the mechanism we analyze to become weaker and less likely to be detected in the data.

When measuring industry oil betas (3-digit SIC codes), we start by estimating 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.[24] 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. We construct industry-level shocks as *Ind Shock = Oil Price Growth* × *Oil Exposure*, where *Oil Exposure* is the value of the estimated industry oil beta and is fixed over the sample. These industry-level shocks are predicted shocks based on the differential sensitivity of the cash flows of industries to innovations in oil prices. We construct industry shocks using GDP growth in an analogous way (see Section 5.1 for more details). As previously discussed, when constructing our main sample, we keep only industries with a negative value for this industry beta (fixed over time).

In the Internet Appendix, we show that the main industry shocks used in our analysis have strong effects on firms' cash flows, and that these shocks significantly matter for firms' operating performance. Another important advantage of analyzing oil shocks is that previous research has provided direct evidence that these shocks are largely unpredictable. For example, when discussing the evidence on the (lack) of predictability of oil prices, Hamilton (2009) explains that this evidence shows that "the real price of oil is not easy to forecast" and that is "not at all naïve to offer as a forecast [for the future price of oil] whatever the price currently happens to be."

As discussed in Section 2, if these shocks are largely unpredictable, firms hit inside versus outside their main quarter should have very similar distributions for different firm characteristics. Panel C of Table 2 provides direct support to this idea by analyzing four basic firm characteristics (*Size*, *Age*, *Q*, and *Cash flow*) in the year prior to oil price shocks. We contrast firms hit by shocks inside versus outside their main quarter, where shocks are values above the median for the absolute value of *Oil Price Growth*. We confirm that these two subsamples are very similar across multiple basic firm characteristics. The Internet Appendix shows the same patterns using alternative definitions for these shocks. This supports our argument in Section 2 that our research design leads to treated and control groups that are randomly assigned, i.e., similar firms that are only different in terms of when they are hit by shocks (inside versus outside the main quarter).

[24] 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. In the Internet Appendix, we also estimate betas using only a component of *Oil Price Growth* that is less likely to be anticipated and find that our results remain similar.

3.4. Hedging and the Lead-lag Structure of Shocks and Production

Our empirical analysis builds on some points about hedging and the lead-lag structure of shocks and production that we clarify here. First, we rely on the idea that firms cannot fully hedge their exposure to these shocks. Specifically, our analysis is designed to isolate a direct effect of industry shocks on top supplier financing firms, which should not be present if these firms can completely hedge their exposure to oil price shocks. Previous research has provided direct evidence that smaller firms do not typically fully hedge such shocks (e.g., Froot, Scharfstein, and Stein (1990), and Stulz (1996)). This research has also 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. In a scenario where the credit multiplier we analyze is relevant, top supplier financing firms are facing funding constraints and these limits on their ability to hedge are more likely to be relevant. This idea that hedging is costly and limited among firms facing funding issues is also consistent with anecdotal evidence.[25]

In terms of the lead-lag structure of shocks and production, we rely on the following timeline. Shocks initiated in quarter t immediately affect firms' new short-term investments (receivables and inventories), which can then significantly influence their production capacity between quarters t and $t+1$. This timeline builds on the idea that firms make significant short-term investments in these assets during the six months prior to the collection of cash form sales. Both previous research and anecdotal evidence support this timing. For example, Petersen and Rajan (1997) discuss how credit from suppliers is largely used to finance such short-term investments as this allows firms to match the maturity of assets and liabilities. Since trade credit has a very short maturity (Klapper, Laeven, and Rajan (2012))), the demand for this credit must come from significant short-term

[25] For example, consider the construction company Dycom Industries Inc (DY)). Their 2017 10-K discusses their exposure to fuel costs and their limited ability to fully hedge this exposure: "higher fuel prices may negatively affect our financial condition and results of operation … there can be no assurance that, at any given time, we will have financial instruments in place to hedge against the impact of increased fuel costs." They mention the previously discussed costs of hedging to justify this exposure.

investments with an equally short maturity.[26] While firms can make investment in these assets (e.g., inventories) with longer maturities, as we discuss in Section 4.3, these longer-term investments do not lead to the predictions that we analyze. Hence, the predictions that we analyze should only be present in the data if these investments with short maturities are important.

4. Main Results

4.1. Empirical Specification

We implement the empirical approach described in Section 2 by estimating the following specification:

$$\Delta Y_{ijt+k,t+l} = \theta_{jt} + \beta_0 MainQuarter_{ijt} + \beta_1 IndShock_{jt} \times MainQuarter_{ijt} + \gamma' X_{ijt} + \varepsilon_{ijt}, \quad (1)$$

where $\Delta Y_{ijt+k,t+l}$ is the average value of outcome Y between quarter $t + k$ and $t + l$ minus its average value between quarter $t\text{-}1$ and $t\text{-}4$, θ_{jt} is an industry × quarter fixed effect, *Ind Shock* is a predicted industry-level shock taking place in quarter t (see Section 3.3), *Main Quarter* is an indicator that equals one in the firms' main quarter (see Section 3.2), and X denotes a vector of control variables (described below).

The outcome $\Delta Y_{ijt+k,t+l}$ measures the response of firms' short-term investment or sales during a period after a shock in quarter t. We first measure the immediate effect of the shock during the first semester (average between quarters t and $t + 1$, or $\Delta Y_{ijt,t+1}$) and then analyze the effect of the shock on the subsequent semester (average between quarters $t + 2$ and $t + 3$, or $\Delta Y_{ijt+2,t+3}$). These two periods cover firms' entire annual responses to the shocks. We examine the percentage responses of firms' short-term investment and sales (see Sections 1 and 2) using $\Delta log(ST\ Assets)_{ijt+k,t+1}$ and $\Delta log(Sales)_{ijt+k,t+1}$, respectively, where *ST Assets* = *Receivables* + *Inventories*. *Sales*, *Receivables*, and *Inventories* denote firms' total sales, accounts receivables, and inventories, respectively, and are all measured using quarterly data.

The coefficient of interest is β_1 and formalizes the empirical approach described in Section 2. We measure the immediate differential effect of the shock when using the outcome $\Delta Y_{ijt,t+1}$, and we measure the differential propagation of the shock when using the outcome variable $\Delta Y_{ijt+2,t+3}$.

[26] See Section 1 for additional references and anecdotal evidence supporting this point. The Internet Appendix also provides additional evidence consistent with this idea. Specifically, increases in receivables and inventories forecast significantly higher firm sales over the following two quarters (six months), especially in the first quarter, but not in subsequent quarters.

As explained above, in the presence of the working capital credit multiplier, shocks that initially hit firms inside their main period can have stronger percentage effects on short-term investment and production (sales) not only contemporaneously, but also in subsequent periods (propagation effects). This can lead the coefficient β_1 to be positive for both outcomes ($\Delta Y_{ijt,t+1}$ and $\Delta Y_{ijt+2,t+3}$). As we explain in Section 2, this pattern (positive β_1 for both outcomes) must indicate the propagation of shocks over time. Our focus on these propagation effects helps us distinguish the working capital credit multiplier from other mechanisms.

Note that *Main Quarter* indicates if the firm is inside its main quarter at the time where the shock is initiated (quarter *t*). Also note that industry shocks and industry × quarter fixed effects (θ_{jt}) are defined at the same level (3-digit SIC codes), what ensures that β_1 captures differences in firms' responses to a same industry shock. Recall that in our main approach industry shocks are determined as *Ind Shock = Oil Price Growth × Oil Exposure*. The controls in the estimation of Equation (1) include *Main Quarter* and its interaction with *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.

As motivated in Section 3.2, we focus our analysis on the top supplier financing firms, and contrast patterns for this group with the ones for other firms (the bottom and middle terciles). Only firms significantly relying on supplier financing are potentially exposed to the mechanism we propose in Section 1. Importantly, we show in Section 3.2 that only top supplier firms use more leverage from suppliers during their quarter, a necessary condition for the presence of the mechanism we propose. We first separately estimate Equation (1) for these three terciles and then contrast these effects for top supplier financing firms versus other firms.

As discussed in Section 2, an important aspect of our research design is that firms hit by industry shocks inside and outside their main quarter should be very similar. Indeed, in the context of the oil shocks used in our main results, Section 2.3 provides direct support for this point. In our analysis, we control for some potential differences across firms hit by shocks inside versus outside the main quarter. Specifically, we classify firms with a main quarter in Q1, Q2, Q3, and Q4 as Q1-, Q2-, Q3, and Q4-type firms, respectively. We then include indicators for these four different firm types (e.g., Q2-type firm) as controls. These controls are included in a symmetric way to *Main Quarter* and we add interactions between these indicators and the variables used to construct industry shocks as control variables. Consistent with our research design, in the Internet Appendix, we show that our results remain virtually unchanged without these controls.[27]

4.2. Firms' Responses to Shocks and Seasonality

We show our main results analyzing firms' differential responses to industry shocks when these shocks are initiated in the main quarter, estimated following the approach in Section 4.1. Table 3 reports the results for firm sales. We first show these effects separately for firms in each of the three terciles of supplier financing (Panel A). The estimated coefficient of *Ind 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 (average absolute oil exposure in the sample). This allows us to interpret the results as capturing the effect of an industry shock implied by a typical oil-price shock on an industry with significant (negative) exposure to oil prices. Since only top supplier financing firms are potentially exposed to the mechanism we propose (see Section 4.1), we start by analyzing the results for these firms (columns (1) and (4)). We find that, when industry shocks are initiated in the main quarter, their (percentage) effect on firms' sales is stronger both in the initial semester (column (1)) and the subsequent semester (column (4)). These results support the predictions from our mechanism outlined in Section 1. In particular, our empirical approach detects a significant propagation effect when industry shocks hit these firms in their main quarter. Estimates in columns (1) and (4) imply significant effects with the same sign in both semesters for top supplier financing firms. This pattern helps us distinguish the working capital multiplier from other potential mechanisms.

On the other hand, our empirical approach does not detect significant propagation effects in the responses of other firms (middle and bottom supplier financing) to these same shocks. While shocks initiated in the main quarter can affect these firms' responses in one of the two semesters after the shock, we do not find a significant effect in the same direction in both of these periods. For example, shocks initiated in the main quarter have a weaker immediate effect (first semester) for bottom supplier financing firms (column (3)), but there is not a significant effect with the same

[27] These controls address a potential concern that oil shocks could be seasonal. For example, if shocks are more likely in Q4, the treated group (hit inside the main quarter) will have more Q4-type firms than the control group (hit outside the main quarter). Consistent with previous evidence (Hamilton (2009), we also find that such seasonal patterns have limited economic importance in predicting oil price shocks.

sign during the subsequent semester (column (6)). As discussed in Section 2, there can be differences in firms' immediate responses to shocks initiated in the main quarter. Our main approach to isolate the importance of the working capital multiplier is to examine the propagation of these initial effects over time. The results in Table 3 show that we detect this propagation only in the group of firms that is potentially exposed to the multiplier.

Panel B explicitly contrasts the effects measured in Table A for top supplier firms versus other firms and examines if there are differential propagation effects for top supplier firms. This approach allows us to control for common patterns in the response of all firms to shocks. We implement this idea by estimating Equation (1) using our overall sample (all subsamples in Panel A) and interacting the main effect of interest (*Ind Shock* × *Main Quarter*) with *Top Supplier Fin*, an indicator variable that equals one for top supplier financing firms. We also include interactions of all oil variables, *Ind Shock*, *Main Quarter*, and industry × quarter fixed effects with *Top Supplier Fin* as controls. In some results, we also include controls for basic firm characteristics (*Age*, *Size,* and *Q*), measured as average values between quarter *t-1* and *t-4* and treated in a symmetric way to *Top Supplier Fin*.[28] This specification allows us to control for differences across firms that can be explained by these basic firm characteristics as opposed to the importance of supplier financing. The estimated coefficients are scaled in the same way as in Panel A.

Columns (1) and (4) show that our results for top supplier financing firms remain similar when estimated using this approach. We label the incremental effect of shocks initiated in the main quarter as main quarter effects. The results confirm that main quarter effects are stronger for top supplier financing firms in both the first and second semesters after the shock and document the importance of a differential propagation of industry shocks for these firms. As in Panel A, we do not detect a significant propagation effects for firms that are not top supplier financing firms. This is now captured by the coefficients for *Ind Shock* × *Main Quarter* in columns (1) and (4). Additionally, columns (2), (3), (5), and (6) show that these effects remain stable when we control for basic firm characteristics that could be related to *Top Supplier Fin*.

Table 4 shows these same results for the response of firms' short-term investment (receivables and inventories). Panels A and B show that the previous findings for the response of firm sales are

[28] We focus on basic firm characteristics and avoid including additional controls which could be jointly determined with firms' reliance on credit from suppliers.

associated with qualitatively and quantitively similar patterns in the response of short-term investment. The results also detect a significant propagation effect for short-term investment that is only present for top supplier financing firms and is differentially stronger for these firms.

Our approach to isolate propagation effects requires us to compare similar firms being hit inside (treated firms) versus outside (control firms) their main quarter. As discussed in Section 2, this assumption is valid if oil shocks are unpredictable. Moreover, this idea is consistent with our data, as Section 3.3 shows that treated and control firms are virtually identical. Our analysis further supports this idea by showing that the previous results in Table 3 and 4 are not sensitive to the inclusion of controls for potential firm characteristics correlated with *Main Quarter.* First, in the Internet Appendix, we show that our results remain virtually the same when we exclude the controls for the four different firm types (Q1-, Q2-, Q3-, and Q4-type firms) used in our main specification. For example, if oil shocks are seasonal, our results could capture systematic differences across firms with main quarters in different parts of the year. This finding suggests that this concern is not important. We also note that our estimates in Panel B of Tables 3 and 4 (columns (2), (3), (5), and (6)) show results controlling for basic firm characteristics (*Age*, *Size,* and *Q*) that could be related to *Main Quarter*. These results include interactions of these characteristics with *Ind Shock* in an analogous way to *Main Quarter*. The stability of our results after the inclusion of these controls provides further evidence supporting the idea above that our research design eliminates potential differences across firms hit inside versus outside their main quarter. This evidence is consistent with the point that is hard to predict shocks to oil prices (Section 3.3).

4.3. Are the Results Stronger for Short-Term Investment?

We examine if the previous propagation effects are stronger for firms' short-term investment relative to their long-term investment. This asymmetric importance of short-term investment effects is a central aspect of the mechanism we propose in Section 1, which focuses on working capital financing issues and funding of short-term assets such as payables and inventories. We start by presenting the main intuitions for this prediction. We describe how these intuitions can be formally modeled in the Appendix.

We first consider firms' immediate (first semester) response to shocks. As we discuss in Section 1, the response of short-term investment to shocks is stronger in the main quarter, because customers are able to finance a larger share of their short-term investment on credit from suppliers during this period. In principle, one could apply a similar idea to the funding of firms' long-term investment. If firms finance a share of their long-term investment using new credit, this can also lead to a levered response of firms' long-term investment to shocks.

The key point to note is that, in contrast with short-term investments, the share of long-term investments financed on credit should not be significantly larger during firms' main period. As highlighted by Petersen and Rajan (1997), it is natural to expect firms to match the maturity of assets and liabilities and finance long-term (short-term) investments with long-term (short-term) funding. If this is the case, firms financing a share of their long-term investment on credit will rely on long-term debt. While firms' ability to raise short-term credit from suppliers should be shaped by temporary differences in their cash flows during the main quarter (Section 1), this should not be the case for long-term debt, which is paid over future periods. Empirically, if the mechanism we propose is also present for long-term investments, we should expect to see a positive link between firms' main quarter and their long-term leverage (ratio of long-term debt over long-term assets).[29] In the Internet Appendix, we document that this pattern is not present, what provides additional support to the arguments mentioned above. These points imply that our previous results analyzing firms' immediate (first semester) responses to shocks should be stronger for short-term investments.

When describing the propagation of shocks over time in Section 1, we highlight the role of changes in firms' internal funds. As firms cut their short-term investments and sales in their initial response to shocks, this reduces the funds available to fund operations in subsequent periods. In principle, lower internal funds in subsequent periods should limit firms' ability to fund both short- and long-term investments. We highlight why this propagation effect might asymmetrically affect firms' short-term investment. To do so, we build on previous work analyzing the implications of financing frictions (Bernanke, Gertler, and Gilchrist (1999)), and assume that drops in firms' internal resources adversely affect new borrowing terms. For example, lenders might charge higher spreads or impose stricter borrowing limits on new credit when borrowers have less internal

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[29] Our mechanism is relevant for long-term investment if firms can finance a larger share of this investment on credit during the main quarter and are using all the credit available from lenders. Suppose that this condition holds in the data and this credit consists of long-term debt (see the argument above). In this scenario, firms' long-term debt should increase relative to their long-term assets (PPE) during their main quarter. Notice that we document an analogous pattern for the short-term credit from suppliers in Section 3.2.

funds.[30] When firms finance a share of their short-term investment on credit from suppliers, reductions in firms' internal funds will immediately increase the marginal cost of expanding this investment. Intuitively, these short-term investments are exposed to changes on refinancing terms for this short-term credit.

In contrast, these increased refinancing costs are less relevant for the cost of expanding long-term investment. As we discussed above, when financing expansions to their long-term investment on credit, firms should rely on long-term debt. Because of issuance costs, firms do not raise long-term debt in every period that they make long-term investments (which contrasts with the need to refinance short-term funding every period). Therefore, the immediate effect of new refinancing terms on the cost of long-term investment is more limited. This asymmetry in the exposure to refinancing terms induces a substitution across these two types of investment. Intuitively, after drops in firms' internal funds, there is an increase in the relative cost of financing short-term investments and a substitution away from these investments into long-term investments. This substitution amplifies the response short-term investments over time, while it mitigates the response of longer-term investment. The Appendix has more details on these points.

We analyze this prediction by estimating our previous results (Tables 3 and 4) using the difference between firms' short- and long-term investment as the outcome and checking if the previously documented patterns are also present in this case. Specifically, we first measure percentage changes to firms' short-term investments (receivables and inventories) as before (Table 4). We then examine changes to capital expenditures using $\Delta Inv_{ijt+k,t+l}$, the average value of *Inv* between quarter $t + k$ and $t + l$ minus its average value between quarter *t-1* and *t-4*, where *Inv* is the ratio of capital expenditures to the one-quarter lag of Net PPE. This last variable is also measured as a percentage of PPE. When analyzing the differential response of firms' short-term investment, we use the difference between these two outcome variables.[31]

Table 5 reports the results, which are qualitatively and quantitatively similar to the ones in Tables 3 and 4. Our empirical approach detects propagation effects that are only significant for top

[30] Bernanke, Gertler, and Gilchrist (1999) argue that this effect is implied by standard models of lending with information asymmetry as the divergence of interests between lenders and borrowers is greater when borrowers have less net worth. Gertler and Gilchrist (2018) discuss how this effect is consistent with the data.
[31] In our sample, the ratio of these working capital assets to PPE is close to one and a differential percentage response across these assets translates also into a differential dollar response.

supplier firms (Panel A). These propagation effects for top supplier financing remain similar when we analyze the differential response of these firms versus other firms (middle and bottom supplier financing firms) to shocks (Panel B). Moreover, these patterns remain stable as we control for differences in basic firm characteristics across these groups of firms. Overall, this evidence confirms that the propagation effects that we emphasize are stronger for firms' short-term investment relative to their long-term investment.

4.4. Responses of Long-Term Investment and Payables

We provide additional evidence supporting the role of the mechanism we propose in Section 1 as an explanation for the previous propagation effects. In principle, as we discuss in Section 2, the propagation effects that we document could be driven by alternative mechanisms. For example, consider an input price shock that has a stronger immediate effect on firms' sales in the main quarter. If the firm fires some workers as it cuts back its sales, the initial effect of the shock on employment could drive its propagation over time. Alternatively, stronger initial effects on sales might lead the firm to lose some customers that do not switch back to the firm in future periods, translating into a propagation of initial conditions over time.

These alternative mechanisms are likely to be associated with drops in long-term investment. As firms persistently use less workers or face a reduced demand by customers, their return on long-term investments should become lower. In contrast, the mechanism we propose can rationalize a pattern where drops on sales over time are associated with a muted response of or even an increase in long-term investment. In our mechanism, the reduction in sales is associated with a substitution away from short-term investments and into longer-term investments (see Section 4.2).

To examine these possibilities, we estimate our main results using long-term investment as the outcome variable ($\Delta Inv_{ijt+k,t+l}$). We replicate our results from Table B of Table 3, which focuses on the differential patterns for top supplier financing firms. Panel A of Table 6 shows the results. We find that our previous findings analyzing firms' sales and short-term investments are not associated with economically or statistically significant effects on long-term investment. This evidence further supports the role of the mechanism we propose in driving our results.

We then examine an important prediction from our mechanism. Namely, our results for sales and short-term investment should be matched with similar percentage changes in customers' credit from suppliers (accounts payable). In the mechanism we propose, firms finance a share of their short-term investment on credit and changes in this investment should be matched with comparable effects on payables. Moreover, as we explain in Section 4.2, reductions in firms' internal resources adversely affect new borrowing terms for firms. This change in borrowing terms amplifies the effects on payables over time (in the second semester after the shock), as firms' experience changes in internal resources.

Panel B of Table 6 shows the results analyzing these predictions. We replicate our previous results (Panel B of Table 3) using percentage changes in payables as the outcome variable ($\Delta log(Payables)_{ijt+k,t+l}$). This variable measures the average value of *log(Payables)* between quarter $t + k$ and $t + l$ minus its average value between quarter *t-1* and *t-4*, where *Payables* is the firm's accounts payable. Consistent with the predictions from our mechanism, we find that our sales and short-term investment results are matched with qualitatively and quantitatively similar effects on payables. Moreover, these effects on payables become stronger over time (second semester after the shock). These findings confirm important additional predictions from our mechanism.

5. Additional Results

We study additional implications from our mechanism. These predictions consider firms' responses to a broader range of economic shocks and the contrast between top supplier financing firms and firms that strongly rely on short-term debt.

5.1. Firms' Responses to Different Industry Shocks

We examine the previous effects using a broader range of different economic shocks. As discussed in Section 2, the mechanism we analyze predicts that these effects should be mostly relevant for shocks strongly associated with changes in production costs. We explore this intuition in three ways. First, we predict industry shocks using oil prices for positive oil beta industries. Oil shocks are less likely to matter through input costs for industries that have higher profits when oil prices increase. Second, we decompose the effect of oil prices on industries sales and profitability for negative oil beta industries. Since our effects should be mostly relevant for shocks associated with changes in production costs, we expect this decomposition to show stronger results when looking at profitability than when looking at sales.[32] Third, we predict industry shocks using GDP growth. When compared to the industry shocks used in our main results, i.e., oil shocks for industries with negative betas, general shocks to GDP are less likely to capture shifts in production costs. Thus, we should see muted responses of sales and working capital to these industry shocks driven by GDP growth.[33]

Table 7 presents the results for the response of firm sales. The results in Table 7 match all these predictions. We report scaled effects in an analogous way to Table 3, by multiplying the coefficients of interest by the standard deviation of the aggregate shock (oil or GDP shock) in the sample and the typical exposure of firms to these shocks, i.e., average absolute value for the industry beta. Panel A shows that there are no significant propagation effects for top supplier financing firms, in industries with positive oil beta. Panel B shows that for negative oil beta industries, the results are driven by the impact of oil prices on production costs. There are no propagation effects for sales shocks that are driven by changes in oil prices. There are also no significant propagation effects for industry shocks that arise from changes in GDP growth (Panels C and D), even when focusing on the main sample used in our previous results. Table 8 analyzes these same results for firms' short-term investment. These results for short-term investment also match all of the predictions described above.

5.2. Firms' Responses to Shocks and Short-Term Debt

We also contrast our main results for top supplier financing firms with a similar specification results for firms that strongly rely on short-term debt. In principle, the mechanism we propose in Section 1 could also be relevant for firms that rely on short-term debt to cover working capital financing needs. Recall that this mechanism builds on the following points. Firms finance a share of their short-term investments on inputs using credit and borrow up to the credit limit made available by lenders. Additionally, lenders allow firms to finance a larger share of these investments using credit during their main quarter, when firms have higher profitability. This mechanism could be relevant for firms that constantly raise new short-term debt to finance their

[32] We implement this decomposition by first estimating industry betas with respect to oil prices for both profits and sales. Using these two different betas, we construct predicted industry shocks for each of these outcomes and jointly analyze their effects.

[33] We measure business cycle fluctuations in GDP (cyclical component) following the approach proposed by Hamilton (2018) and control for recent aggregate stock returns to better isolate economic shocks unlikely to be anticipated. We predict these shocks in an analogous way to oil shocks using industry betas with respect to these broader economic fluctuations.

short-term investments, when this debt has a very short maturity, similar to the one of trade credit. In this case, short-term debt is equivalent to credit from suppliers for the purposes of our mechanism.[34] Alternatively, this mechanism could be present if firms rely on pre-committed lines of credit with limits tied to short-term assets such as receivables. For example, suppose that firms can borrow up to a fraction of their receivables and can deliver more receivables with the same inputs in their main quarter because of their higher profitability. Imagine also that firms finance a share of their input costs using this credit, which is repaid after the collection of the cash from receivables. In this case, firms will also be able to finance a larger share of input costs on credit during their main quarter and our mechanism can still be present.[35]

However, in theory, is also plausible to expect our mechanism not to be relevant for firms strongly relying on short-term debt. For example, suppose that firms rely on pre-committed lines of credit with limits tied to assets or factors that do not significantly change with short-term fluctuations in profitability (e.g., PPE or total assets of the borrower). In this case, firms should not be able to finance a larger share of input costs using credit during their main quarter and our mechanism should not be present.

We examine if our mechanism could be empirically relevant for firms that strongly rely on short-term debt, that we label top short-term debt firms. To do so, we follow the same approach used in Section 3.2 for top supplier financing firms. If our mechanism is present for top short-term debt firms, their short-term debt should increase relative to their short-term investment (inventories and receivables) during their main quarter. This prediction follows the same logic discussed in Section 3.2 for the case of credit from suppliers. In the Internet Appendix, we show that this prediction is not supported by the data using a similar specification to the one in Panel B of Table 2. Relatedly, in contrast with these results for top supplier financing firms in Table 2, we show that the payables of top short-term debt firms do not increase relative to their short-term investment during their main quarter. These results show that the link we document between leverage and seasonality, as captured by the main quarter, is unique to top supplier financing firms. Importantly, these findings imply that our effects should not be empirically relevant for top short-term debt firms.

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[34] The short maturity is important to ensure that firms' higher cash flows during their main period allow them to repay more lenders providing credit in this same period. This increases their short-term borrowing capacity during this period.

[35] The simple model we provide in the Appendix helps to further illustrate the points here discussed.

Table 9 examines the importance of our results for top short-term debt firms. We first replicate our findings in Panel A of Tables 3 and 4 using the importance of short-term debt as opposed to credit from suppliers. We define top, middle, and bottom short-term debt firms in an analogous way to top, middle, and bottom supplier financing firms using the ratio of short-term debt to sales. Panels A and C show these results for the responses of firm sales and short-term investments, respectively. Consistent with the discussion above, we do not detect significant propagation effects in the response to shocks for top short-term debt firms. We also do not find these patterns for the groups of firms and these findings are similar for the response of sales and short-term investments.

We then examine if our previous effects for top supplier financing firms are differentially stronger than the ones for top short-term debt firms. Panels B and D reports the results for the response of sales and short-term investment, respectively. We expand the specifications in Panel B of Tables 3 and 4, to include *Top STD* and its interactions with *Ind Shock* × *Main Quarter*, where *Top STD* is an indicator for top short-term debt firms. Specifically, we include *Top STD* in a symmetric way to *Top Supplier Fin*, and control for the interactions of all oil variables, *Ind Shock*, and *Main Quarter* with *Top STD*. We also include interactions of industry × quarter fixed effects with *Top Supplier Fin* × *Top STD*. The results confirm that our previous findings for top supplier financing firms are differentially important when compared to the same results for top short-term debt firms. We also detect propagation effects when we analyze differences in the responses of these firms to industry shocks over time. Moreover, these patterns remain important and similar for the responses of both sales and short-term investment. Overall, these findings show that our results are not present for all firms that strongly rely on short-term funding. As predicted by our mechanism, these effects are only present when there is positive link between leverage and seasonality, as captured by the main quarter.

6. Alternative Interpretations

We interpret our findings above as driven by funding frictions in the financing of short-term investments (receivables and payables) that limit firms' production capacity. In this section, we discuss whether alternative explanations can plausibly explain our results. As we highlight in Section 2 and the discussion of our results, our main approach to isolate the importance of these funding frictions is the analysis of propagation effects from shocks. In principle, other considerations could explain why firms' immediate responses to shocks are significantly different during their main quarter. Our identification strategy focuses on the propagation of these initial effects from shocks over time.

A first potential concern with our evidence is that our results might not isolate the propagation of firms' response to shocks. For example, one might be concerned that our approach depends on assumptions about the persistence of economic shocks over time. As we highlight in Section 2, our approach does not rely on such assumptions. The key intuition for our test is that control firms initially hit by shocks outside of their main quarter eventually will move into their main quarter in a subsequent period. Hence, a stronger initial response to the shock by treated firms, inside their main quarter when the shock hits, implies that the direct effect of the shock should be stronger for control firms in subsequent quarters. However, we document that treated firms also show a greater response to shocks in subsequent quarters, relative to control firms. Thus, our results must indicate a propagation of the shock over time.

Our interpretation builds on the assumption that treated and control firms in our analysis are similar to each other. Under this assumption, our results capture the incremental effect of shocks initiated in the firm's main quarter. As we explain in Section 2, since the oil shocks we analyze are hard to predict (see Section 3.3), we expect the firms hit inside versus outside their main quarter to be similar. Indeed, consistent with this idea, Section 3.3 shows that firms hit by oil shocks inside versus outside their main quarter are very similar in terms of multiple basic characteristics. In addition, Section 4.2 describes how our main findings do not change as we control for potential differences across firms hit inside versus outside their main quarter. All this evidence suggests that treated and control firms are in fact very similar to each other.

We interpret these propagation effects as evidence of a working capital credit multiplier. As firms' initial responses to shocks reduce the internal resources available in future periods, this reduction adversely affects firms' ability to fund their short-term investments (receivables and payables) and limits their production capacity. In principle, alternative mechanisms could also rationalize the propagation effects that we document. For example, consider an input price shock that has a stronger immediate effect on firms' sales in the main quarter. If the firm fires some workers as it cuts back its sales, the initial effect of the shock on employment could drive its propagation over time. Alternatively, stronger initial effects on sales might lead the firm to lose some customers that do not switch back to the firm in future periods, translating into a propagation of initial conditions over time. We believe our evidence is not consistent with these alternative explanations for the following reasons.

First, the propagation effects that we document are only significant and differentially important for firms that strongly rely on credit from suppliers. We show that these effects are not present for firms that do not strongly rely on credit from suppliers (Section 4.2) or firms that strongly rely on short-term debt (Section 5.2). It is unclear why these alternative explanations would only lead to propagation effects in the specific subset of firms that are potentially exposed to our mechanism. We also find that these propagation effects are stronger for firms' short-term investments, when compared to long-term investments (Section 4.3). Moreover, these effects are not associated with economically or statistically significant changes in long-term investment (Section 4.4). If drops in sales over time are driven by these alternative mechanisms, it is plausible to expect these effects to be associated with reductions in long-term investment. As firms persistently use less workers or face a reduced demand by customers, their return on long-term investments should become lower. In contrast, the mechanism we propose naturally rationalizes a pattern where drops on sales over time are associated with a muted response of long-term investment (Section 4.4). Also consistent with our mechanism, we detect significant propagation effects only for shocks more strongly associated with changes in production costs.

A related possibility is that firms' internal resources lead to propagation effects by limiting firms' ability to make long-term investments, as opposed to having direct effects on firms' short-term investments and sales. For the same reasons listed above, we believe our evidence is not consistent with this explanation. In particular, in contrast with this interpretation, we find no significant propagation effects for firms' long-term investment. Additionally, the initial effects of shocks translate into immediate and strong subsequent effects on short-term investment and sales. If propagation effects matter because of changes in long-term capital, one might expect these effects on sales and short-term investments to be more gradual over time.

As a final check to address these identification concerns, we examine if these propagation effects are present for additional firms that are not exposed to our mechanism. As highlighted in Section 2, the mechanism we analyze should only be present when firms borrow more aggressively to fund their working capital in their main quarter, i.e., when their leverage from suppliers increases in the main quarter. This pattern is a key *necessary* condition for the mechanism we analyze. We now examine whether the effects that we document remain relevant for additional firms where this pattern is not present. If propagation effects capture the mechanism we propose, we should not estimate significant effects in these samples. As we search for firms where this pattern is not empirically present, we focus on natural candidates for firms that are not exposed to significant liquidity issues.

We examine samples of large firms, high cash, and high payout firms. We construct these samples using firms in the top tercile in terms of their size (assets), payout ratio, or cash holdings in our initial database. Panel A of Table 10 shows that these firms do not borrow more aggressively to finance their working capital during their main quarter. These results replicate the analysis in Panel B of Table 2 using these alternative samples. In Panels B and C of Table 10, we then examine the importance of propagation effects for sales and short-term investment in the response of these firms to shocks. Here, we replicate the estimates in Panel A of Tables 3 and 4 using these firms. The results show that the propagation effects we document are not present for any of these firms in the top tercile of size, payout, and cash. While it is challenging to completely rule out alternative interpretations for the propagation effects that we document, our collective evidence is most consistent with the idea that the working capital credit multiplier drives these propagation effects.

7. Conclusion

In this paper, we provide new micro-level evidence that funding frictions cause an important subset of firms to limit short-term investments in payables and receivables, reducing their production capacity. We propose and analyze a new credit multiplier effect driven by these considerations (working capital credit multiplier) and show how these effects interact with seasonal patterns in firm profitability. These seasonal interactions are interesting in themselves because they show how initial conditions can shape credit multiplier effects. Seasonal interactions also help us empirically isolate the working capital credit multiplier. We detect the importance of this multiplier by comparing how similar firms respond to recurring and unpredictable shocks differently when these shocks are initiated in the main quarter and label this differential response as the main quarter effect. We illustrate theoretically how the analysis of main quarter effects allows us to isolate the working capital credit multiplier and develop an identification strategy that considers predictions for these effects across different firms, investments (short- and long-term investments), and shocks. After implementing our empirical approach, we provide extensive evidence and discussion supporting our identification strategy.

Overall, our results suggest that these credit multiplier effect and funding constraints are significant for smaller U.S. firms that heavily rely on financing from suppliers (accounts payable), i.e., top supplier financing firms. Across different definitions of smaller firms (outside the top size tercile to top size decile), these top supplier financing firms represent between 27-33 percent of the aggregate sales and assets of smaller firms in Compustat. These estimates can give an idea of how pervasive these effects are outside the very largest firms. In addition, it is plausible to imagine that these considerations are even more relevant for smaller private firms outside of our sample.

Funding constraints on short-term investments have unique implications for the link between finance and the real economy, that contrast with the effects of financing frictions on long-term investment (primary focus of existing literature). At the macro level, the effect of short-term investments on production capacity can directly lower output through supply conditions. In contrast, changes in long-term investment will affect aggregate output by changing aggregate demand conditions. This contrast can be important for explaining the aggregate effects of financial or economic shocks (e.g., Mendoza (2010), Jermann and Quadrini (2012), and Mendoza and Yue (2012)) as well as understanding the effect of monetary policy shocks (Barth and Ramey (2001) and Christiano, Eichenbaum, and Evans (2005)). Connecting our micro-level evidence to these aggregate implications is an interesting area for future research.

At the micro level, shocks to firms' funding conditions can have direct and immediate effects on their sales and operations, that contrast with delayed effects through changes in long-term capital. Moreover, as highlighted by our analysis, these funding constraints can induce multiplier effects on liquidity as limits on firms' production capacity induce further liquidity problems, and so on. This propagation effect illustrates the importance of incorporating financing frictions associated with short-term investments into analyses of firms' financial and hedging policies.

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Appendix: Model of the Working Capital Credit Multiplier

We provide a simple model of the working capital credit multiplier which formalizes the intuitions discussed in the text.

Model Set Up

The model is a partial equilibrium model where some inputs are fixed (e.g., capital) and firms make choices of variable inputs over their cycle. As motivated in Section 1, firms cover operating costs prior to the collection of cash from sales and need working capital financing to fund this gap. Firms have to purchase the variable input m_t at the beginning of each period t to generate (cash) revenue $y_t = A_i(\varphi_t)f(m_t) = A_i(\varphi_t)m_t^{\beta}$ at the end of that period, where $A_i(\varphi_t) > 0$, $0 < \beta < 1$, φ_t captures demand conditions, and i is a state reflecting seasonal operating conditions.[36]

Periods alternate between two states $i = H, L$, which can be interpreted as the two seasons of the year, and H captures the firm's main period (higher profitability). The price of the variable input is p_t. One interpretation for this timing is that firms sell on credit (receivables) at the start of each period and collect the cash from these sales at the end of the period. Another possibility is that

[36] This revenue is net of costs from using fixed inputs. Since these inputs are fixed, changes in y_t capture changes on sales.

firms buy inventories at the start of the period and sell the goods for cash at the end. These two possibilities are equivalent for our purposes. The key point is that, in order to generate revenue, the firm needs to finance a short-term investment $SI_t \equiv p_t m_t$ at the start of the period. We consider a firm that largely relies on funding from suppliers (accounts payable) to cover this financing need. Suppliers provide short-term credit B_t (working capital financing) at the beginning of each period and get paid at the end of the period when the firm generates cash from sales.[37]

Firms maximize their value. In each period *t*, the firm starts with net worth w_t, decides how much to borrow B_t and invest SI_t, and collects the cash from sales at the end of the period. We follow Kiyotaki and Moore (1997, hereafter 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 assumption avoids a scenario in which firms save in perpetuity and never pays dividends.

We examine a constrained firm that would like to expand its short-term investment using additional working capital financing but faces frictions. The firm uses all the credit available from suppliers and these frictions limit the credit that is available. Specifically, the firm faces a borrowing limit $\overline{B_t} = \bar{B}(m_t, p_t, \beta, A_t, w_t)$ from suppliers (maximum value the firm can promise to repay). For simplicity, the interest rate on the credit from suppliers is zero.[38] The firm faces the following binding budget constraint (BC): $p_t m_t = w_t + \overline{B_t}$, where $w_t + \overline{B_t}$ is the value of the total funds available (internal and borrowed) to finance the investment. The borrowing limit of the firm and its net worth in period t shape its short-term investment and production in this same period. Importantly, the conditions faced by firms at time t also shape their investment and sales at period $t+1$ through changes in firms' net worth. The firm's net worth at period $t+1$ is given by condition (NW): $w_{t+1} = (1-\gamma)(y_t - B_t)$. This leads to a propagation of firm conditions over time, e.g., an increase in w_t leads to higher values for m_t and y_t, which then translate into increases in w_{t+1}, m_{t+1}, and y_{t+1}.

The predictions we analyze builds on two points that are consistent with previous research and anecdotal evidence (see Section 1 for a discussion). First, suppliers sell inputs on credit and customers can finance a portion of each additional unit of input on credit, i.e., we assume that $\frac{\partial \overline{B_t}}{\partial m_t} \equiv B_m > 0$. Intuitively, the investment in inputs allows the firm to raise more credit backed by the increase in short-term assets and sales (which improve repayment). This leads to a levered response of the firm's investment and sales to economic shocks, which become stronger in percentage terms. As the firm (marginally) expands its investment by \$1.0 ($\Delta m_t = \$1.0/p_t$), it can finance $\left(\frac{B_m}{p_t}\right) \times \$1.0$ on credit and only needs to internally fund $\left[1 - \left(\frac{B_m}{p_t}\right)\right] \times \$1.0$. Therefore, if the firm reduces the internal funds allocated to short-term investment by \$1.0 in response to a

[37] This approach to model the demand for working capital financing with upfront inputs decisions is also used in the macro literature (e.g., Jermann and Quadrini (2012)).

[38] We assume that firms face an arbitrarily small cost of raising external finance to break a potential indifference between using internal or external funds.

shock, this investment will drop by $\$(1.0) \times CM$, where $CM \equiv \frac{1}{\left[1-\left(\frac{B_m}{p_t}\right)\right]} > 1$ is a credit multiplier.[39] These levered responses are then propagated over time through changes in firms' net worth. We label these effects as the working capital credit multiplier.

Second, the share of inputs that customers can finance on credit is higher in the higher profitability period, i.e., we assume that B_m is larger in the main period. Intuitively, the same short-term investment leads to more cash from sales in the main period, inputs lead to more receivables or inventories translate into more sales, what allows the firm to raise more credit backed by the investment. As the firm can leverage more aggressively during the main period ($i = H$), i.e., CM has a higher value, the credit multiplier effects are stronger when shocks are initiated in this period.

To illustrate our predictions, we first examine the response of firms to shocks to the input price p_t (operating costs faced by firms). We then examine firms' responses to shocks to demand conditions (φ_t). While our predictions are qualitatively similar across different shocks, the effects we analyze should be stronger for shocks to operating costs (as we show later).

We assume that a constrained firm is initially in a steady state at $t = 0$. In the initial steady state, the value for p is constant for $i = H, L$, and the only difference between the states is A_i. For any variable x, we denote its value in state i of this steady state as x_i. The firm is affected at the start of $t = 1$ by an unexpected (marginal) shock to p_1 that they do not anticipate (in an analogous way to KM). Because we examine the firm's response to the shock in t = 1 and then in t = 2, we introduce additional notation to capture the states of the world. We denote the firm's state at t = 1 as s, and the firm's state at $t = 2$ as q. For example, if $i = H$ at $t = 1$, then $s = H$ and $q = L$.

The assumption that firms do not anticipate the shock is meant to capture a situation in which the firm does not fully hedge its direct exposure to the shock even when the shock is anticipated with some probability (see Section 3.4). We do not assume that shocks to prices are permanent. We focus on the two periods after the shock ($t = 1$, 2) and model the persistence of the shock to p using $\pi_p \equiv \frac{\partial p_2}{\partial p_1}\frac{p_1}{p_2}$, where p_t is the new value for p at period t and $0 \leq \pi_p \leq 1$.[40]

To further simplify the analysis, we focus on an example in which $\overline{B_t} = \theta y_t$. This functional form captures the key condition that customers can finance a larger share of inputs on credit from suppliers when they are more profitable (they can promise to repay a share of y). However, as we show in the Internet Appendix, the results below hold as long as the credit limit satisfies this condition. This functional form implies that $\frac{\partial \overline{B_1}}{\partial m_1}\frac{m_1}{\overline{B_1}} = \beta$, where β is a constant, and leads to a simple expression for the multiplier: $CM_s = \frac{1}{\left[1-\beta\left(\frac{B_s}{pm_s}\right)\right]}$, where $s = L, H$ is the firm's state in $t = 1$.

[39] This formalizes the intuition we discuss in Section 1. For example, suppose that the firm can borrow 30% of the value of inputs (at the margin), i.e., $\frac{B_m}{p_t} = 0.3$. Then the firm only needs \$0.70 in internal funds to increase its short-term investment by \$1.0, leading to CM = 1/0.7 = 1.43.

[40] We assume that the shock is uniquely defined by the initial value p_1, which determines the subsequent value $p_2(p_1)$.

In the Internet Appendix, we show that $\left(\frac{B_H}{pm_H}\right) > \left(\frac{B_L}{pm_L}\right)$, what implies that $CM_H > CM_L$.[41] Notice also that $\frac{B_s}{pm_s}$ is the total leverage of the firm in the initial state s. Thus, our framework implies *leverage seasonality*, i.e., leverage is higher during the firm's main period.

Firms' Responses to Shocks: Immediate Effects

We first analyze the immediate response ($t = 1$) to a shock to p in state s. We capture the responses of firms' short-term investment, inputs, and sales, using $\varepsilon_p^x \equiv \frac{\partial x_1}{\partial p_1} \times \frac{p_1}{x_1} = \frac{\partial x_1}{\partial p_1} \times \frac{p}{x_s}$, where $x = SI, m, y$. Note that the initial values of x_1 and p_1 when the shock hits are given by x_s and p. The expression $\frac{\partial x_1}{\partial p_1}$ denotes the change in outcome x at period $t = 1$ in response to marginal changes in input prices. We focus our analysis on ε_p^m but we note that all conclusions extend to the responses ε_p^{SI} and ε_p^y.[42] We also note that these responses are uniquely determined by the initial state s and, for expositional simplicity, we label ε_p^m as ε_p^s.

To illustrate credit multiplier effects, we consider firms' responses in an alternative scenario where $B_m = 0$ but all other factors remain the same, i.e., we consider how firms would respond to the same shock in the absence of the previous leverage effects. We label these responses as *unlevered responses* and denote them using $\frac{\partial m_1^u}{\partial p}$ and $u_p^s \equiv \frac{\partial m_1^u}{\partial p_1} \times \frac{p_1}{m_1} = \frac{\partial m_1^u}{\partial p_1} \times \frac{p}{m_s}$.

We determine a firm's levered and unlevered responses to a shock to p by differentiating (BC) with respect to p_1.[43] Using the functional form $\overline{B_t} = \theta y_t$, we can show that $u_p^s = -1$ and $\varepsilon_p^s = (CM_s) \times u_p^s = -CM_s = -\frac{1}{\left[1-\beta\left(\frac{B_s}{pm_s}\right)\right]} < -1$. Thus, the levered response ε_p^s is an amplified version of the unlevered response u_p^s. Since $CM_H > CM_L$, the amplification effect is stronger in the main quarter ($|\varepsilon_p^H| > |\varepsilon_p^L|$). We label the difference between ε_p^H and ε_p^L as the *main period effect*. The significance of this main period effect is connected to the importance of leverage seasonality.

Firms' Responses to Shocks: Propagation Effects

We then analyze the subsequent response at $t = 2$ to shocks initiated at $t = 1$ in state s. Recall that we denote the state at $t = 2$ as q. For example, if $s = H$, then $q = L$, and vice-versa. We capture firms' responses to a price shock initiated at $t = 1$ using $\varepsilon_p^{x,+1} \equiv \frac{\partial x_2}{\partial p_1} \times \frac{p_1}{x_2} = \frac{\partial x_2}{\partial p_1} \times \frac{p}{x_q}$, where $x = SI, m, y$. The expression $\frac{\partial x_2}{\partial p_1}$ denotes the change in outcome x at period $t = 2$ in response to marginal changes in the (initial) size of the shock (p_1). As before, we focus on $\varepsilon_p^{m,+1}$

[41] This result holds for any steady state with a constrained firm. We also show that, if $\gamma(1-\theta) > 1 - (A_L/A_H)\beta$, there exists such steady state, which is unique.

[42] To see this point, note that $\varepsilon_p^{SI} = 1 + \varepsilon_p^m$ and $\varepsilon_p^y = \beta \times \varepsilon_p^m$. Therefore, differences in ε_p^m are equivalent to differences in ε_p^{SI} and ε_p^y.

[43] In the case of an input price shock, this leads to $\left(\frac{\partial m_1}{\partial p_1}\right)(p - B_m) = \left(-m_1 + B_p\right)$, where $\frac{\partial \overline{B_t}}{\partial p_t} \equiv B_p$, and $\left(\frac{\partial m_1^u}{\partial p_1}\right) p = \left(-m_1 + B_p\right)$.

and extend our conclusions to $\varepsilon_p^{SI,+1}$ and $\varepsilon_p^{y,+1}$. We label $\varepsilon_p^{m,+1}$ as $\varepsilon_p^{s,+1}$. This variable captures the effect on input demand *m* of a price shock initiated in state *s,* in the following period (*+1*).

A central point in this analysis is that we can write $\varepsilon_p^{s,+1}$as a combination of a direct effect and a propagation effect. We note that $\frac{\partial m_2}{\partial p_1} = \frac{\partial m_2}{\partial p_2}\frac{\partial p_2}{\partial p_1} + \frac{\partial m_2}{\partial w_2}\frac{\partial w_2}{\partial p_1}$ and rewrite this expression as $\varepsilon_p^{s,+1} = \varepsilon_p^{q} \times \pi_p + CM_s^{+1} \times u_p^s$. The direct effect of the shock $\varepsilon_p^{q} \times \pi_p$ captures the immediate response to the price shock at $t = 2$ (when the state is q) and might be muted depending on the persistence of the initial shock ($\pi_p \leq 1$). The expression $CM_s^{+1} \times u_p^s$ captures the propagation effect. The initial effect of the shock on m_1 and y_1 affects the firm's subsequent net worth (w_2), changing its input decision at $t = 2$ (m_2). This amplification and propagation over time of the firm's initial response (u_p^s) is captured by the credit multiplier CM_s^{+1}.

In the absence of the propagation effect ($CM_s^{+1} = 0$), we have that $\varepsilon_p^{H,+1} - \varepsilon_p^{L,+1} = -\pi_p \times \left(\varepsilon_p^H - \varepsilon_p^L\right)$. Intuitively, a firm initially ($t = 1$) in state H transitions to state L at $t = 2$ and is less exposed to the price shock at that time. Therefore, a stronger initial response by the firm in the main period ($\left|\varepsilon_p^H\right| > \left|\varepsilon_p^L\right| > 0$) implies a weaker *direct* effect in the subsequent period.

Nevertheless, the *propagation* effect is stronger when the shock is initiated in the main period. Intuitively, the initial response is more levered and translates into greater changes in subsequent net worth when the shock hits in the main period ($CM_H^{+1} > CM_L^{+1}$). Therefore, the total effect of the shock at $t = 2$ (direct effect + propagation effect) can be stronger when $s = H$. When propagation effects are significant, firms' responses to shocks initiated in the main period can be stronger *both* at $t = 1$ and $t = 2$.

To illustrate this point, we use again the functional form $\overline{B_t} = \theta y_t$. In this case, we can show that $CM_H^{+1} - CM_L^{+1} = CM_H - CM_L > 0$.[44] Since $u_p^s = -1$ and $\varepsilon_p^s = (CM_s) \times u_p^s$ (see above), we can write $\varepsilon_p^{H,+1} - \varepsilon_p^{L,+1} = \pi_p \times (CM_H - CM_L) - (CM_H^{+1} - CM_L^{+1})$. When propagation effects $(CM_H^{+1} - CM_L^{+1})$ are strong, then $\varepsilon_p^{H,+1} - \varepsilon_p^{L,+1} < 0$ and firms are more responsive (at $t = 2$) to shocks that start in the main quarter ($\left|\varepsilon_p^{H,+1}\right| > \left|\varepsilon_p^{L,+1}\right|$). This last condition holds if and only if $\pi_p < 1$ (shock is not fully persistent) in this simplest version of our model.

However, we can have stronger responses (at $t = 2$) for shocks that hit in the main quarter, even when shocks are fully persistent ($\pi_p = 1$). To show this point, we build on previous work analyzing the implications of financing frictions (Bernanke, Gertler, and Gilchrist (1999)), and assume that drops in firms' internal resources adversely affect new borrowing terms, i.e., higher

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[44] We first obtain an expression for CM_s^{+1}. To do so, we determine $\frac{\partial m_2}{\partial w_2}$ by differentiating (BC) with respect to w_2. We also build on the fact that $\overline{B_t} = \theta y_t$ implies that $w_2 = (1-\gamma)(1-\theta)y_t$ and $\frac{\partial w_2}{\partial m_1}\frac{m_1}{w_2} = \beta$. Following these steps, we obtain that $CM_s^{+1} = \left[\left(1 - \frac{B_q}{pm_q}\right) CM_H CM_L \beta\right]$, where q is the state at $t = 2$.

net worth leads to a higher borrowing limit (θ increases with w_t).[45] In this case, changes in net worth matter more and translate into a larger value for $CM_H^{+1} - CM_L^{+1}$.

We focus again on the case where $\overline{B_t} = \theta y_t$, but now write $\theta(w)$ with $\frac{d\theta}{dw} > 0$. For expositional simplicity, we assume that $\frac{d\theta}{dw} \times y \equiv b$ has the same value in both states of the steady state. This ensures that marginal increases in net worth have the same effect on $\overline{B_t}$ in both states. Under this condition, we have the same expressions as before for firms' immediate responses ($\varepsilon_p^s, u_p^s, CM_s$). However, we now have that $CM_H^{+1} - CM_L^{+1} = (1+b)(CM_H - CM_L)$ and that $\varepsilon_p^{H,+1} - \varepsilon_p^{L,+1} = \pi_p \times (CM_H - CM_L) - (CM_H^{+1} - CM_L^{+1}) < 0$ for any value of $0 \leq \pi_p \leq 1$. Moreover, the magnitude of the main period effect $\left|\varepsilon_p^{H,+1} - \varepsilon_p^{L,+1}\right|$ increases with leverage seasonality, as in the case of firms' immediate responses.[46]

Response to Demand Shocks

Our main predictions hold for any shock, but the effects are stronger for shocks that have a stronger effect on firms' input decisions, i.e., when unlevered responses are more important. Firms' unlevered responses to input price shocks should be more significant than responses to demand shocks because operating costs directly affect the upfront cost required for m. To show these points, we define firms' responses to demand shocks (φ) in an analogous way to input price shocks. As before, we focus on the response of m ($\varepsilon_\varphi^s, u_\varphi^s, \varepsilon_\varphi^{s,+1}$) and extend our conclusions to y and SI.[47] Following the previous steps, we can write: $\varepsilon_\varphi^s = (CM_s) \times u_\varphi^s$ and $\varepsilon_\varphi^{s,+1} = \varepsilon_\varphi^h \times \pi_p + CM_s^{+1} \times u_\varphi^s$, where CM_s and CM_s^{+1} have the same values as before and $\left|u_\varphi^s\right| < \left|u_p^s\right|$. In other words, all previous results remain the same with the now weaker unlevered response to shocks.

Intuitively, conditional on the total available funds, a 10% increase in p requires a 10% reduction in m (shock directly increases the cost of expanding input). This explains $u_p^s = -1$. On the other hand, demand conditions shape the short-term investment indirectly by changing firms' expected income and the credit backed by this income, leading to weaker unlevered responses (see the Internet Appendix).

Model Extension: Long-Term Investment

In the Internet Appendix, we extend this simple framework to formally analyze the intuitions described in Section 4.3. In addition to $SI_t = m_t p_t$, we now assume that firms also make a long-term investment I_t (with a price normalized to one), and that they raise both short-term credit from

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45 Bernanke, Gertler, and Gilchrist (1999) argue that this effect is implied by standard models of lending with information asymmetry as the divergence of interests between lenders and borrowers is greater when borrowers have less net worth. Gertler and Gilchrist (2018) discuss how this effect is consistent with the data.

46 The new expression for CM_H^{+1} is equal to the previous expression multiplied by $(1+b)$, the additional leverage effect due to changes in w. This expression is obtained using the same steps as in the simplest version of our model and leads to $\varepsilon_p^{H,+1} - \varepsilon_p^{L,+1} = -(1 + b - \pi_p)(CM_H - CM_L) < 0$.

47 We note that note that $\varepsilon_\varphi^{SI} = \varepsilon_\varphi^m$ and $\varepsilon_\varphi^y = \beta \times \varepsilon_\varphi^m + \alpha_A$, where $\alpha_A = \frac{\partial A}{\partial \varphi}\frac{\varphi}{A}$ and β are constants. Therefore, differences in ε_φ^m are equivalent to differences in ε_φ^{SI} and ε_φ^y.

suppliers (B_t) and long-term debt (L_t), both exposed to borrowing limits ($\overline{B_t}$ and $\overline{L_t}$). The firm's budget constraint (BC) is now: $p_t m_t + I_t = w + \overline{B_t} + \overline{L_t}$. As motivated in Section 4.3, firms raise short-term (long-term) funding when expanding their short-term (long-term) investment. As firms can finance a share of new investments on credit, in addition to the previous positive link between $\overline{B_t}$ and m_t, there can also be a link between $\overline{L_t}$ and I_t. This leads to the same credit multiplier effect as before (for m_t, SI_t, and y_t), but also creates an analogous potential multiplier for I, which is driven by $\frac{\partial \overline{L_t}}{\partial I_t} \equiv L_I > 0$. However, since borrowing terms for $\overline{L_t}$ (long-term credit) are not shaped by short-term operating conditions, this multiplier effect for I, if present, is not stronger in the main period (L_I is not larger in this period).

Another key feature of this extension is that there is competition for limited available funds between $SI_t = p_t m_t$ and I_t. This competition increases the firm's response to shocks to input prices. Increases in operating costs cause the short-term investment to become relatively more expensive, leading the firm to substitute away from m_t (demand shocks do not change these relative costs). Also, initial drops in net worth lead to a substitution away from m_t and into I_t at $t = 2$, which amplifies the previous propagation effects for m_t and mitigates analogous propagation effects for I_t. Following the discussion above and in Section 4.3, we assume that $\overline{B_t} = \theta(w) y_t$ and $\frac{d\theta}{dw} > 0,$ i.e., drops in net worth affect new borrowing terms making it harder for firms to refinance their short-term credit at $t = 2$. Consequently, reductions in w make it more costly for the firm to expand m_t (using credit) and this refinancing effect is less relevant for I_t because the firm does not raise L_t in every period (only the short-term credit has to be refinanced frequently).

Table 1: Summary Statistics

This table presents summary statistics on the main sample used in the analysis. The unit of observation is a firm × quarter during the period 1980-2015. Panel A reports summary statistics for the overall sample, which includes firms with negative industry (3-digit SIC code) oil beta that are outside the top size tercile (see the text). This size tercile is constructed using the one-quarter lag of total (book) assets and all firms (sorted by calendar year). The sample in Panel B is constructed as the top terciles of the average value of *Supplier Financing* in the previous four quarters (sorted by year). *Supplier Financing* is the ratio of payables to sales (annualized) (see Section 3).

Panel A: Main Sample

	Nobs	Mean	Median	SD
Log of Sales	44,833	3.42	1.57	3.57
ΔLog(Sales)(t, t+1)	43,639	0.03	0.04	0.22
ΔLog(Sales)(t+2, t+3)	41,558	0.06	0.06	0.30
Size	45,939	4.65	4.82	0.42
Age	46,203	15.39	13.50	7.66
Q	42,245	1.82	2.75	1.10
Cash Flow	44,385	0.01	0.09	0.03
Cash	45,669	0.19	0.24	0.09
Book Leverage	44,268	0.24	0.36	0.16
Short-Term Debt/Assets	44,192	0.06	0.17	0.01
Short-Term Debt/Sales	42,931	0.07	0.31	0.01
Supplier Financing (= Payables/Sales)	44,385	0.14	0.58	0.06
Payables/Assets	45,712	0.10	0.12	0.07
Receivables/Sales	43,705	0.17	0.15	0.15
Receivables/Assets	45,093	0.18	0.14	0.16
Inventories/Sales	43,420	0.13	0.16	0.09
Inventories/Assets	45,042	0.16	0.18	0.10
ΔLog(ST Assets)(t, t+1)	41,936	0.03	0.03	0.23
ΔLog(ST Assets)(t+2, t+3)	39,840	0.05	0.06	0.32
Investment	42,626	0.07	0.10	0.05
Net PPE/Assets	45,865	0.25	0.22	0.18

Panel B: Top Supplier Financing Firms

	Nobs	Mean	Median	SD
Log of Sales	14,647	3.00	1.66	3.08
ΔLog(Sales)(t, t+1)	14,380	0.03	0.03	0.27
ΔLog(Sales)(t+2, t+3)	13,639	0.05	0.05	0.35
Size	14,660	4.37	4.53	1.64
Age	14,715	2.65	0.41	2.64
Q	13,432	1.96	3.55	1.01
Cash Flow	14,154	-0.01	0.10	0.02
Cash	14,592	0.18	0.25	0.07
Book Leverage	14,219	0.27	0.43	0.19
Short-Term Debt/Assets	14,156	0.08	0.22	0.01
Short-Term Debt/Sales	14,094	0.11	0.42	0.01
Supplier Financing (= Payables/Sales)	14,565	0.27	0.81	0.13
Payables/Assets	14,618	0.16	0.14	0.13
Receivables/Sales	14,148	0.20	0.19	0.17
Receivables/Assets	14,306	0.19	0.14	0.16
Inventories/Sales	14,097	0.16	0.19	0.11
Inventories/Assets	14,360	0.18	0.20	0.11
ΔLog(ST Assets)(t, t+1)	14,446	0.02	0.02	0.26
ΔLog(ST Assets)(t+2, t+3)	12,768	0.03	0.04	0.37
Investment	13,612	0.07	0.10	0.04
Net PPE/Assets	14,625	0.24	0.22	0.17

Table 2
Seasonality, Supplier Financing, and Industry Shocks

This table documents different empirical patterns used to motivate our empirical analysis. In Panels A and B, we show results estimated using the main sample from our analysis (Panel A of Table 1). Panel A documents the importance of seasonality on firms' cash flows. The results are based on linear regressions predicting *Cashflow* (t) or *Cashflow* (*t* , *t* +1) with *Main Quarter* and industry × quarter fixed effects. *Cashflow* (*t*) is a measure of firms' operating income over assets in quarter *t* . *Cashflow* (*t* , *t* +1) is the sum of *Cashflow* (*t*) between quarters *t* and *t* + 1. We report scaled coefficients, where estimated coefficients are dvided by the average value of the outcome variable in the sample. Panel B documents the importance of seasonality in firm supplier financing (payables). We analyze two outcome variables. △*Log(AP)* - △*Log(ST Assets)* (*t* , *t* +1) is △*Log(AP)* (t, t+1) minus △*Log(ST Assets)* (t, t+1), where △*Log(Z)* (*t* , *t* +1) is the difference between the average value of *Log(Z)* in quarters *t* to *t* +1 and the average value of this same variable between quarters *t* -1 to *t* -4. △*Log(AP)* - △*Log(Sales)* (*t* , *t* +1) is constructed in an analogous way. *AP, ST Assets,* and *Sales* denote firms' payables, short-term assets (receivables + inventories), and sales, respectively. In our baseline specification, we estimate linear regressions predicting the outcome variables with *Main Quarter* , *TopSupFin* , *Main Quarter* × *TopSupFin,* and fixed effects. *Main Quarte* r is an indicator that equals one if the firm is inside its predicted main quarter. *TopSupFin* is an indicator that equals one if the firm is in top tercile in terms of *Supplier Financing* , the average ratio of payables to sales over the four previous quarters (sorted by year). *MQuarter* × *Firm Controls* include three control variables for firm characteristics (*Avg_Q* , *Avg_Size* , and *Avg_Age*) and their interactions with *Main Quarter* . *Avg_Z* is the average value of *Z* between quarters *t* -1 and *t* -4. Industry × Quarter × TopSupFin FE includes interactions of Industry × Quarter fixed effects with *TopSupFin* . We extend this baseline specification by separately including *Top Sup Fin* and *Mid Sup Fin* , an indicator for firms in the middle tercile of *Supplier Financing* (sorted by year). We include both variables symmetrically in an analogous way to *Top Sup Fin* in the baseline specification. Industry × Quarter × SupFin Tercile FE includes interactions of Industry × Quarter FE with fixed effects for each of these *Supplier Financing* terciles. Firm type fixed effects are indicator variables for firms with their main quarter in terms of profitability in each quarter of the calendar year (Q1, Q2, Q3, or Q4). Panel C shows the distribution of basic firm characteristics (*Avg_Q* , *Avg_Size* , *Avg_Age* , *Avg_Cash Flow*) for firms hit by oil shocks inside versus outside their main quarter. *Oil Shock Quarter* includes all firm × quarter observations where |*Oil Price Growth* (t)| is above its median value in the sample. *Oil Price Growth* is the difference between the log of the average (deflated) oil price in the current and the previous four quarters. Firm characteristics are all measured between quarters *t* -1 and *t*- 4 (average values in this period). Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter level. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Seasonality in Firm Profitability- Main Quarter Effect

	Cashflow(t)	Cashflow(t, t+1)
	(1)	(2)
Main Quarter	0.801***	0.459***
	(12.11)	(8.51)
Observations	44,055	41,284
R-Squared	0.011	0.009
Industry × Quarter FE	Yes	Yes
Firm Type FE	Yes	Yes

Panel B: Supplier Financing During the Main Quarter

	△Log(AP)(t, t+1) - △Log(ST Assets)(t, t+1)				△Log(AP)(t, t+1)- △Log(Sales)(t, t+1)	
	(1)	(2)	(3)	(4)	(5)	(6)
MQuarter × TopSupFin	0.014**	0.016**	0.014***	0.014***	0.024***	0.021**
	(1.973)	(2.031)	(2.661)	(2.262)	(2.602)	(2.297)
MQuarter × MidSupFin	-0.002	0.001				
	(-0.325)	(0.205)				
Observations	40,297	36,403	40,297	36,403	42,183	37,971
R-Squared	0.001	0.003	0.001	0.003	0.001	0.002
MQuarter × Firm Controls		Yes		Yes		Yes
Industry × Quarter × SupFin Tercile FE	Yes	Yes				
Industry × Quarter × TopSupFin FE			Yes	Yes	Yes	Yes
Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel C: Firms Hit by Shocks Inside versus Outside the Main Quarter

	Oil Shock Quarter (|*Oil Price Growth*| > Median)					
	Main Quarter = 1 (Nobs = 5,896)			Main Quarter = 0 (Nobs = 16,972)		
	Mean	Median	SD	Mean	Median	SD
Average Size (t -1, t -4)	4.71	4.90	1.59	4.70	4.87	1.60
Average Age (t -1, t -4)	15.19	13.13	7.96	15.15	13.13	7.94
Average Q (t -1, t -4)	1.90	1.19	2.74	1.92	1.19	2.70
Average Cash Flow (t -1, t -4)	0.01	0.03	0.07	0.01	0.03	0.08

Table 3
Firms' Responses to Shocks and Seasonality: Sales

This table analyzes main quarter effects in the response of firm sales to industry shocks and their link with the importance of supplier financing. The results are based on the estimation of Equation (1) in the paper and shocks are predicted using oil prices. We examine the response of firm sales (Y) over two different time horizons. $\triangle$*Log Sale* (t, t+1) is the average value of the log of sales between quarters t and t+1 minus the average for this variable between quarters t-1 and t-4. $\triangle$*Log Sale* (t+2, t+3) is the average value of the log of sales between quarters t+2 and t+3 minus the average for this variable between quarters t-1 and t-4. *Main Quarter* is an indicator that equals one if the firm is inside its predicted main quarter. *Ind 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 four quarters. *Oil Exposure* is the value of the estimated industry oil beta (see Section 3.3). The overall sample is the one in Panel A of Table 1. In Panel A, we estimate this specification in three subsamples: the terciles of *Supplier Financing*, the average ratio of payables to sales over the four previous quarters (sorted by year). The controls include *Average_Q*, *Main Quarter*, oil controls (*Oil Price Growth* and *Oil Exposure*), as well as the interactions between each of the oil controls and *Main Quarter*. *Average_Q* is the average value of Q between quarters t-1 and t-4. *Shock* × *Firm Type* FE include four indicators for firms with their main quarter in each of the possible four quarters, as well as their interactions with the oil control variables and *Ind Shock*. In Panel B, we examine the differential importance of these main quarter effects for top supplier firms versus other firms. We estimate the previous specification using the overall sample and interacting the main effect of interest (*Ind Shock* × *Main Quarter*) with *Top Supplier Fin*, an indicator variable that equals one for top supplier financing firms. We also include interactions of the oil variables, *Ind Shock*, *Main Quarter*, and industry × quarter fixed effects with *Top Supplier Fin* as controls. In some results, we also include controls for basic firm characteristics (*Age*, *Size*, and Q), measured as average values between quarter t-1 and t-4 and treated in a symmetric way to *Top Supplier Fin*. In both panels, the reported coefficients are scaled to better capture their magnitude: they are multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (average absolute oil exposure in sample). Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Sales Effects by Supplier Financing

	△Log(Sales)(t, t+1)			△Log(Sales)(t+2, t+3)		
	TopSupFin	MidSupFin	BottomSupFin	TopSupFin	MidSupFin	BottomSupFin
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × *MQuarter*	0.020***	0.001	-0.011***	0.024***	-0.013	-0.008
	(2.549)	(0.172)	(-3.095)	(2.358)	(-1.185)	(-1.078)
Observations	12,714	12,556	12,826	12,052	11,972	12,256
R-Squared	0.014	0.025	0.054	0.016	0.032	0.061
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Differential Effects for Top Supplier Financing Firms

	△Log(Sales)(t, t+1)			△Log(Sales)(t+2, t+3)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × *MQuarter* × *TopSupFin*	0.018**	0.018**	0.020**	0.029***	0.028***	0.033***
	(2.477)	(2.531)	(2.319)	(3.835)	(3.992)	(3.321)
Ind Shock × *MQuarter*	-0.001			-0.008		
	(-0.289)			(-1.549)		
Observations	38,111	38,107	38,096	36,298	36,294	36,280
R-Squared	0.016	0.017	0.022	0.019	0.021	0.028
Industry × Quarter × TopSupFin FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age		Yes	Yes		Yes	Yes
Shock × MQuarter × Other Firm Controls			Yes			Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 4
Firms' Responses to Shocks and Seasonality: Short-Term Investment

This table analyzes main quarter effects in the response of firms' short-term investment (receivables and inventories) to industry shocks and their link with the importance of supplier financing. We estimate the same specifications as in Table 3 but now use the response of short-term investment as the outcome variable. The results are based on the estimation of Equation (1) in the paper and shocks are predicted using oil prices. We examine the response of short-term assets (Y = *ST Assets* = *Receivables* + *Inventories*) over two different time horizons. △Log(*ST Assets*)(t, t+1) is the average value of the log of short-term assets between quarters t and t+1 minus the average for this variable between quarters t-1 and t-4. △Log(*ST Assets*)(t+2, t+3) is the average value of the log of short-term assets between quarters t+2 and t+3 minus the average for this variable between quarters t-1 and t-4. In both panels, the reported coefficients are scaled to better capture their magnitude: they are multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (average absolute oil exposure in sample). Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Short-Term Investment Effects by Supplier Financing

	△Log(ST Assets)(t, t+1)			△Log(ST Assets)(t+2, t+3)		
	TopSupFin	MidSupFin	BottomSupFin	TopSupFin	MidSupFin	BottomSupFin
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × *MQuarter*	0.015***	-0.014***	-0.017**	0.031***	-0.011	-0.006
	(3.084)	(-3.335)	(-2.258)	(3.931)	(-1.566)	(-0.629)
Observations	12,000	12,104	12,320	11,370	11,535	11,732
R-Squared	0.021	0.021	0.056	0.020	0.029	0.073
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Differential Effects for Top Supplier Financing Firms

	△Log(ST Assets)(t, t+1)			△Log(ST Assets)(t+2, t+3)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × *MQuarter* × *TopSupFin*	0.023***	0.024***	0.024***	0.030***	0.028***	0.031***
	(3.033)	(2.908)	(3.166)	(3.189)	(2.801)	(3.006)
Ind Shock × *MQuarter*	-0.011***			-0.003		
	(-3.281)			(-0.991)		
Observations	36,433	36,429	36,424	34,656	34,652	34,637
R-Squared	0.025	0.018	0.025	0.021	0.022	0.029
Industry × Quarter × TopSupFin FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age		Yes	Yes		Yes	Yes
Shock × MQuarter × Other Firm Controls			Yes			Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5
Are the Results Stronger for Short-Term Investment?

This table analyzes the differential importance of the previous main quarter effects for short-term investment (receivables and inventories) versus long-term investment (capital expenditures). We estimate the same specifications used in Table 3 using the difference between responses of short-term investment and long-term investment as the outcome variable. The results are based on the estimation of Equation (1) in the paper and shocks are predicted using oil prices. The response of short-term assets (*ST Assets = Receivables + Inventories*) is determined in the same way as in Table 4. We also analyze the response of capital expenditures (*Inv*) over two different time horizons. △*Inv*(t, t+1) is the average value of *Inv* between quarters *t* and *t*+1 minus the average for this variable between quarters *t*-1 and *t*-4. △*Inv*(t+2, t+3) is the average value of *Inv* between quarters *t*+2 and *t*+3 minus the average for this variable between quarters *t*-1 and *t*-4. *Inv* is the ratio of capital expenditures to the one-quarter lag of net PPE. In both panels, the reported coefficients are scaled to better capture their magnitude: they are multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (average absolute oil exposure in sample). Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Short- versus Long-Term Investment - Effects by Supplier Financing

	△Log(ST Assets)(t, t+1) - △Inv(t, t+1)			△Log(ST Assets)(t+2, t+3) - △Inv(t+2,		
	TopSupFin	MidSupFin	BottomSupFin	TopSupFin	MidSupFin	BottomSupFin
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × MQuarter	0.013***	-0.013**	-0.015**	0.029***	-0.010	-0.003
	(3.589)	(-2.326)	(-2.367)	(4.182)	(-1.441)	(-0.408)
Observations	10,249	10,772	11,029	9,635	10,198	10422
R-Squared	0.016	0.027	0.053	0.019	0.039	0.076
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Differential Effects for Top Supplier Financing Firms

	△Log(ST Assets)(t, t+1) - △Inv(t, t+1)			△Log(ST Assets)(t+2, t+3) - △Inv(t+2,		
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × MQuarter × TopSupFin	0.018**	0.020***	0.019**	0.025***	0.025**	0.027***
	(2.499)	(2.507)	(2.285)	(3.749)	(3.519)	(3.496)
Ind Shock × MQuarter	-0.008***			0.001		
	(-3.543)			(0.039)		
Observations	32,054	32,050	32,050	30,266	32,063	30,255
R-Squared	0.017	0.018	0.026	0.025	0.026	0.035
Industry × Quarter × TopSupFin FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age		Yes	Yes		Yes	Yes
Shock × MQuarter × Other Firm Controls			Yes			Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 6
Additional Evidence: Responses of Long-Term Investment and Payables

This table analyzes main quarter effects in the response of long-term investment (capital expenditures) and payables to industry shocks. We estimate specifications from Table 3 using the responses of long-term investment and payables as the outcome variables. The response of capital expenditures (*Inv*) is determined in the same way as in Table 5. We also analyze the response of payables (*AP*) over two different time horizons. △Log(*AP*)(t, t+1) is the average value of the log of payables between quarters t and $t+1$ minus the average for this variable between quarters t-1 and t-4. △Log(*AP*)(t+2, t+3) is the average value of the log of payables between quarters t+2 and t+3 minus the average for this variable between quarters t-1 and t-4. In both panels, the reported coefficients are scaled to better capture their magnitude: they are multiplied by the product of the standard deviation of *Oil Price Growth* and 0.01 (average absolute oil exposure in sample). Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Long-Term Investment Results

	△Inv(t, t+1)		△Inv(t+2, t+3)	
	(1)	(2)	(3)	(4)
Ind Shock × MQuarter × TopSupFin	0.003	0.002	0.003	0.003
	(1.303)	(1.584)	(1.282)	(1.318)
Observations	33,545	33,545	31,760	31,752
R-Squared	0.002	0.004	0.002	0.004
Industry × Quarter × TopSupFin FE	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes	Yes	Yes
Shock × MQuarter × Other Firm Controls		Yes		Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes

Panel B: Payables Results

	△Log(AP)(t, t+1)		△Log(AP)(t+2, t+3)	
	(1)	(2)	(3)	(4)
Ind Shock × MQuarter × TopSupFin	0.019***	0.021***	0.046***	0.053***
	(6.907)	(3.448)	(3.534)	(4.498)
Observations	38,121	36,816	36,353	36,338
R-Squared	0.007	0.009	0.013	0.016
Industry × Quarter × TopSupFin FE	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes	Yes	Yes
Shock × MQuarter × Other Firm Controls		Yes		Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes

Table 7

Firms' Responses to Different Industry Shocks: Sales

This table reports results analyzing the effects in Table 3 (Panel B) with different industry shocks and samples. Panel A shows the results in the sample of industries with positive oil beta, constructed in a symmetric way to our main sample of industries with negative oil beta (e.g., we drop the largest firms). Panel B shows the results from a specification estimating the effects of two industry shocks: *Sales Ind Shock (OP)* and *CF Ind Shock (OP)*. These shocks are each included in an analogous way to *Ind Shock* in our main specification, in a specification estimated using the same sample as in Table 3. These industry shocks capture predicted shocks (using oil prices) to industry sales and cash flows. *Sales Ind Shock = Oil Price Growth × Sales Oil Exposure*, where *Sales Oil Exposure* is the value of an estimated industry oil beta for sales (constructed in an analogous way to the cash-flow beta). *CF Ind Shock = Oil Price Growth × CF Oil Exposure*, is the same cash-flow industry shock previously analyzed. As in Table 3, the reported coefficients are scaled: the estimated coefficients are multiplied by the product of the standard deviation of *Oil Price Growth* and the average (absolute) oil exposure in sample. Panels C and D show results from a specification estimating the effects of industry shocks predicted using GDP growth: *Ind Shock (GDP) = GDP Shock × GDP Shock Exposure*. *GDP Shock* is the residual of a time-series regression of quarterly GDP growth on a constant and past GDP growth for each of the four past quarters. This residual measures business cycle fluctuations in GDP (cyclical component) following the approach proposed by Hamilton (2018). *GDP Shock Exposure* is an average industry beta of firms' cash flows with respect to *GDP Shock*. This exposure is measured in an analogous way to industries' exposures to oil shocks, but we here control for aggregate quarterly stock returns in each of the past four quarters when estimating each beta (to better capture unexpected shocks). We include *Ind Shock (GDP)* in an analogous way to *Ind Shock (OP)* in our previous results, but now also control for aggregate stock returns in the past quarter (*StockRet*) to better isolate unexpected shocks. These controls include *StockRet*, *StockRet × MQuarter*, and the interaction of these two variables with *Top Sup Fin*. Reported coefficients are scaled as before: they are multiplied by the product of the standard deviation of *GDP Shock* and the average (absolute) exposure to these shocks in the sample. In Panel C, we use a broad sample that only excludes the largest firms (top tercile in terms of assets). In Panel D, we estimate these results using the same sample as in Table 3, which further restricts the data to industries with negative oil betas. Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Predicting Industry Shocks with Oil Prices - Positive Oil Beta Industries

	ΔLog(Sales)(t, t+1)	ΔLog(Sales)(t+2, t+3)
	(1)	(2)
Ind Shock (OP) × Mquarter × TopSupFin	-0.001	-0.004
	(-0.139)	(-1.541)
Observations	87,623	83,849
R-Squared	0.024	0.027
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Panel B: Predicting Industry Shocks with Oil Prices - Decomposition for Negative Oil Beta Industries

	ΔLog(Sales)(t, t+1)	ΔLog(Sales)(t+2, t+3)
	(1)	(2)
Sales Ind Shock (OP) × MQuarter × TopSupFin	-0.003	-0.007
	(-0.723)	(-0.931)
CF Ind Shock (OP) × MQuarter × TopSupFin	0.020**	0.033***
	(2.347)	(3.429)
Observations	38,096	36,280
R-Squared	0.024	0.029
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Panel C: Predicting Industry Shocks with GDP Growth - Broad Sample		
	ΔLog(Sales)(t, t+1)	ΔLog(Sales)(t+2, t+3)
	(1)	(2)
Ind Shock (GDP) × MQuarter × TopSupFin	0.006	0.007
	(1.392)	(1.199)
Observations	120,574	115,173
R-Squared	0.019	0.024
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Panel D: Predicting Industry Shocks with GDP Growth - Main Sample		
	ΔLog(Sales)(t, t+1)	ΔLog(Sales)(t+2, t+3)
	(1)	(2)
Ind Shock (GDP) × MQuarter × TopSupFin	0.004	0.013
	(0.537)	(0.829)
Observations	23,655	22,420
R-Squared	0.013	0.019
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Table 8
Firms' Responses to Different Industry Shocks: Short-Term Investment

This table reports results analyzing the effects in Table 4 (Panel B) with different industry shocks and samples. We use the same specifications and samples described in Table 7, but now use them to analyze the responses of firms' short-term investment (different outcome variable). △Log(*ST Assets*)(t, t+1) is the average value of the log of short-term assets between quarters *t* and *t*+1 minus the average for this variable between quarters *t*-1 and *t*-4. △Log(*ST Assets*)(t+2, t+3) is the average value of the log of short-term assets between quarters *t*+2 and *t*+3 minus the average for this variable between quarters *t*-1 and *t*-4. Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Predicting Industry Shocks with Oil Prices - Positive Oil Beta Industries

	Positive Oil Beta Industries	
	ΔLog(ST Assets)(t, t+1)	ΔLog(ST Assets)(t+2, t+3)
	(1)	(2)
Ind Shock (OP) × MQuarter × TopSupFin	0.004	-0.002
	(1.811)	(-0.938)
Observations	84,440	80,696
R-Squared	0.026	0.035
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Panel B: Predicting Industry Shocks with Oil Prices - Decomposition for Negative Oil Beta Industries

	Main Sample	
	ΔLog(ST Assets)(t, t+1)	ΔLog(ST Assets)(t+2, t+3)
	(1)	(2)
Sales Ind Shock (OP) × MQuarter × TopSupFin	-0.007	-0.009
	(-1.163)	(-1.082)
CF Ind Shock (OP) × MQuarter × TopSupFin	0.025***	0.031***
	(3.274)	(2.921)
Observations	36,424	36,424
R-Squared	0.027	0.027
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Panel C: Predicting Industry Shocks with GDP Growth - Broad Sample		
	Broad Sample	
	ΔLog(ST Assets)(t, t+1)	ΔLog(ST Assets)(t+2, t+3)
	(1)	(2)
Ind Shock (GDP) × MQuarter × TopSupFin	0.005	0.008
	(0.989)	(1.221)
Observations	115,933	110,583
R-Squared	0.026	0.029
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Panel D: Predicting Industry Shocks with GDP Growth - Main Sample		
	Main Sample	
	ΔLog(ST Assets)(t, t+1)	ΔLog(ST Assets)(t+2, t+3)
	(1)	(2)
Ind Shock (GDP) × MQuarter × TopSupFin	0.009	0.009
	(1.187)	(0.737)
Observations	22,682	21,498
R-Squared	0.017	0.026
Industry × Quarter × TopSupFin FE	Yes	Yes
Shock × MQuarter × Firm Age	Yes	Yes
Shock × MQuarter × Other Firm Controls	Yes	Yes
Shock × Firm Type FE	Yes	Yes

Table 9
Firms' Responses to Shocks and Short-Term Debt

This table analyzes the link between main quarter effects in firms' responses to shocks and the importance of short-term debt. Panels A and C replicate our analyses in Panel A of Tables 3 and 4 using the importance of short-term debt as opposed to credit from suppliers. We define top, middle, and bottom short-term debt firms in an analogous way to top, middle, and bottom supplier financing firms using the ratio of short-term debt to sales (average value of this ratio between quarters *t*-1 and *t*-4). Panels B and D check if our previous effects for top supplier financing firms are differentially stronger than the ones for top short-term debt firms. We expand the specifications in Panel B of Tables 3 and 4 to include *Top STD* and its interactions with *Ind Shock* × *Main Quarter*, where *Top STD* is an indicator for top short-term debt firms. Specifically, we include *Top STD* in a symmetric way to *Top Supplier Fin*, and control for the interactions of all oil variables, *Ind Shock*, and *Main Quarter* with *Top STD.* We also include interactions of industry × quarter fixed effects with *Top Supplier Fin* × *Top STD*. We report the difference between the estimated coefficients for *Ind Shock* × *Main Quarter* × *TopSupFin* and *Ind Shock* × *Main Quarter* × *TopSTD*. Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Effects by Importance of Short-Term Debt - Sales

	△Log(Sales)(t, t+1)			△Log(Sales)(t+2, t+3)		
	TopSTD	MidSTD	BottomSTD	TopSTD	MidSTD	BottomSTD
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × MQuarter	-0.001	0.008	0.003	0.003	0.004	0.001
	(-0.027)	(1.591)	(0.411)	(0.272)	-(.802)	(0.114)
Observations	16,585	11,209	14,721	15,246	10,942	13,726
R-Squared	0.015	0.018	0.033	0.014	0.029	0.039
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Top Supplier Financing versus Top Short-Term Debt Firms - Sales

	△Log(Sales)(t, t+1)		△Log(Sales)(t+2, t+3)	
	(1)	(2)	(3)	(4)
Ind Shock × MQuarter × TopSupFin -	0.026**	0.036**	0.052***	0.056***
Ind Shock × MQuarter × TopSTD	(1.964)	(2.654)	(3.086)	(3.015)
Observations	38,083	38,078	36,277	36,268
R-Squared	0.016	0.022	0.019	0.028
Industry × Quarter × TopSupFin × Top STD FE	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age		Yes		Yes
Shock × MQuarter × Other Firm Controls		Yes		Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes

Panel C: Effects by Importance of Short-Term Debt - Short-Term Investment

	△Log(ST Assets)(t, t+1)			△Log(ST Assets)(t+2, t+3)		
	TopSTD	MidSTD	BottomSTD	TopSTD	MidSTD	BottomSTD
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × MQuarter	0.001	0.001	-0.002	0.005	-0.001	0.008
	(0.914)	(0.775)	(-1.104)	(0.753)	(-0.102)	(1.348)
Observations	16,049	10,746	14,467	14,709	10,482	13,434
R-Squared	0.021	0.035	0.036	0.019	0.038	0.043
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel D: Top Supplier Financing versus Top Short-Term Debt Firms - Short-Term Investment

	△Log(ST Assets)(t, t+1)		△Log(ST Assets)(t+2, t+3)	
	(1)	(2)	(3)	(4)
Ind Shock × MQuarter × TopSupFin -	0.030**	0.036***	0.041***	0.039***
Ind Shock × MQuarter × TopSTD	(2.276)	(2.896)	(3.917)	(3.657)
Observations	36,416	36,411	34,636	34,627
R-Squared	0.015	0.024	0.019	0.029
Industry × Quarter × TopSupFin × Top STD FE	Yes	Yes	Yes	Yes
Shock × MQuarter × Firm Age		Yes		Yes
Shock × MQuarter × Other Firm Controls		Yes		Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes

Table 10
Results Using Alternative Firm Samples

We estimate main quarter effects in additional firm samples: large firms, high cash, and high payout firms. We construct these samples using firms in the top tercile in terms of their size (total assets), payout ratio, or cash holdings in our initial database (we do not drop the largest firms in this initial database). We sort firms (by year) using the average value of *Size*, *Cash*, and *Payout* between quarters *t*-1 and *t*-4. Panel A checks that if leverage seasonality pattern is present for these firms, i.e., we check if firms' payables increase relative to their short-term assets (receivables and inventories) in the main quarter. The outcome variable is △Log(*AP*) - △Log(*ST Assets*)(t, t+1), where △Log(*Z*)(t, t+1) is the difference between the average value of Log(*Z*) in quarters *t* to *t*+1 and the average value of this same variable between quarters *t*-1 to *t*-4. We estimate linear regressions predicting this outcome variable with *Main Quarter,* industry × quarter fixed effects, and firm type fixed effects (see Panel B of Table 2 for definitions). In Panels B and C, we estimate the specifications in Panel A of Tables 3 and 4 using these samples. Standard errors are heteroskedasticity robust and two-way clustered at the industry (3-digit SIC code) and quarter levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Seasonality and Supplier Financing

	△Log(AP)(t, t+1) - △Log(ST Assets)(t, t+1)		
	Top Size	Top Cash	Top Payout
	(1)	(2)	(3)
MQuarter	-0.003	0.003	-0.004
	(-0.441)	(0.699)	(-0.948)
Observations	15,072	18,939	15,564
R-Squared	0.001	0.003	0.003
Industry × Quarter FE	Yes	Yes	Yes
Firm Type FE	Yes	Yes	Yes

Panel B: Firms' Responses to Shocks and Seasonality - Short-Term Investment

	ΔLog(ST Assets)(t, t+1)			ΔLog(ST Assets)(t+2, t+3)		
	Top Size	Top Cash	Top Payout	Top Size	Top Cash	Top Payout
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × *MQuarter*	-0.001	0.002	0.004	0.003	0.004	0.002
	(-0.034)	(0.368)	(0.843)	(0.667)	(1.027)	(0.159)
Observations	15,341	19,061	16,517	14,650	18,033	15,829
R-Squared	0.042	0.036	0.031	0.044	0.041	0.039
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel C: Firms' Responses to Shocks and Seasonality - Sales

	ΔLog(Sales)(t, t+1)			ΔLog(Sales)(t+2, t+3)		
	Top Size	Top Cash	Top Payout	Top Size	Top Cash	Top Payout
	(1)	(2)	(3)	(4)	(5)	(6)
Ind Shock × *MQuarter*	-0.001	0.004	-0.003	-0.005	0.009	0.001
	(-0.339)	(0.682)	(-0.775)	(-1.152)	(1.278)	(0.023)
Observations	16,723	19,751	15,651	16,064	18,760	14,941
R-Squared	0.049	0.036	0.028	0.056	0.032	0.033
Industry × Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Shock × Firm Type FE	Yes	Yes	Yes	Yes	Yes	Yes