Understanding the Credit Multiplier: The Working Capital Channel

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Motivation

Credit multiplier/financial accelerator

Financing frictions amplify and **propagate** the impact of economic shocks

Economic shock→ changes in firms' balance sheets

→ changes debt capacity→ amplify changes in balance sheets… (dynamics)

<u>Limited empirical evidence on the dynamics of multiplier and the specific channel driving them</u>

Existing empirical literature

Investment-cash flow sensitivities (Fazzari et al., 1988, Rauh, 2006, Bakke and Whited, 2010)

- Failed search for a "pure financial shock"

Difference-in-differences tests around macro shocks (Lemmon and Roberts, 2010, Duchin, Ozbas and Sensoy, 2010, Almeida et al, 2012)

- Focuses mostly on capital expenditures and other long-term investments
- No evidence on propagation

This Paper

Novel test for importance of credit multiplier at the firm level - working capital channel

Our test focuses on setting where:

- Firms need to pay upfront for inputs (before production)
- Credit constraints limit input demand and production

The working capital channel

Adverse shock to profitability

- Harder to finance inputs, production goes down (amplification)
- Reduction in profits and net worth affects production next period

(propagation)

But how would we know that the response of production to this adverse shock is due to the credit multiplier?

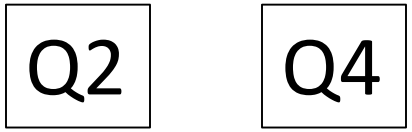
Identification using seasonality

We explore predictable fluctuations in firm profitability due to seasonality

Firms have “main quarters”, the quarter in which they are most profitable (Chang, Hartzmark, Solomon, and Soltes (2017))

Identification using seasonality

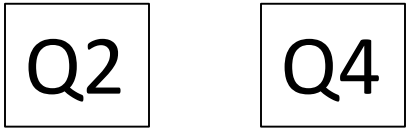
Consider shocks that are frequent and may happen in different quarters



Shock in Q2

Q2 = Treated

Q4 = Control



Shock in Q4

Q2 = Control

Q4 = Treated

Identification using seasonality

Q2

Shock in Q2

Q2 = Treated

Q2

Shock in Q4

Q2 = Control

Similar for Q1, Q3 and Q4 firms

Identification captures how a **same firm** responds to shocks when the shock happens to take place in its main quarter or not

Seasonality and the multiplier

How does seasonality interact with the multiplier?

We modify Kiyotaki and Moore (1997) in two ways

Working capital constraint (pay upfront for inputs) rather than constraint on financing of long-term investment

Predictable cycle in profitability, to capture seasonality (high profits, low profits, high profits…)

Seasonality and the multiplier

We derive a unique constrained steady state under some conditions (high sales, low sales, high sales…)

Starting from steady state, consider an unexpected permanent increase in the input price and measure deviations in firms sales over the next periods relative to the steady state (previous trajectory)

Consider how the effect of the shock on firms' sales within one (immediate) or two periods (entire cycle) depends on the state at the time of the shock

Key intuition

Multiplier is higher in the high profitability period

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

P = price

m_t* is constrained input demand

w_t is initial net worth

θ is the fraction of sales firm can borrow against

$b_t(m_t^*)$ is profitability of inputs

When b is high, the multiplier is high

Firm can lever up more in the high profit period

Results

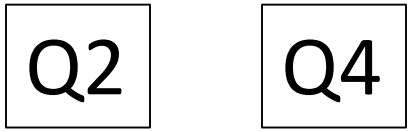
Result #1: Immediate percentage drop in sales is larger when firm is hit during high profitability period

- Important to analyze percentage differences
- Same drop in net worth induced by the price increase leads to larger response when multiplier is larger

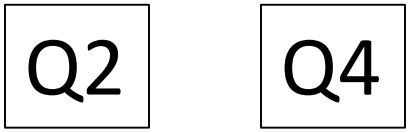
Result #2: Average percentage drop in sales in the first two periods (entire cycle) is larger when firm is initially hit in the high period

- Drop in production in first period leads to lower net worth in the second period: **propagation**

Seasonality and persistence



Input price shock in Q2
Q2 responds more than Q4



Shock arrives in Q4
Which firm will respond more?

Symmetry: it seems that Q4 should respond more than Q2 and eliminate the differential response

But **propagation** under constraints creates **asymmetry –** Q2's net worth is lower than Q4's net worth, because of the effects of the initial shock

Building counterfactual

Alternative steady state where the firm is unconstrained – despite need to finance upfront inputs

Result #1 does not hold with specific functional form we analyze (Cobb-Douglas) – more generally, depends on sign of third-derivative of production function

Result #2 does not hold – the average effect of a permanent shock over the entire cycle does not depend on when the shock hits – **symmetry**

Discussion: production cycles

In the model, there are multiple production periods in a year (two)

This timing assumption will capture real world situations in which production gap (or receivable gap) is within a quarter or semester

What if the production cycle is longer than a semester? (e.g., construction takes more than one semester)

Logic of model may still apply if company needs to pay for inputs upfront within a period, to complete orders

Shock affects ability to complete orders within a period

Shocks initiated during most profitable period will have stronger effects and propagate over time

Discussion: asymmetry

In the model, binding working capital constraint is a necessary condition for asymmetry in response

What if there are also dynamics in the adjustment of firms in the absence of the multiplier?

Adjustment costs

Changes in long-term investment

Identification assumption: Dynamics (without credit multiplier) does not lead firms to respond differently over time when initially hit in their main quarter

Firms do not adjust differetly when shock hits in the main quarter

Long-term investment depends more on annual conditions

Sorting on supplier financing helps address these alternatives

Data

Focus on shocks to oil prices

- Key input for many firms
- Frequent shocks
- Persistence

Oil Price

Spot Crude Oil Price: West Texas Intermediate (WTI) Dollars per Barrel, Monthly, Not Seasonally Adjusted, 1970-2015

Industry Oil Beta

1. Estimate firm-level oil beta is from the regression of $\Delta CashFlow$ on Δ*Log(Oil Price)*. $\Delta CashFlow$ is the difference between the cash flow in quarter *t* and its average value between quarters *t-1* and *t-4.* Δ*Log(Oil Price)* is the changes in the average oil price of quarter *t* and *t-1*.
2. Compute the average oil beta at SIC-3-digit industry

Data

Seasonality

Identify the quarter of the year historically with highest cash flow – based on the quarters from *t-1* to *t-20*

Compustat Quarterly 1980-2015

For Negative Beta firm sample, 3609 firms and 46185 observations

Empirical Specification

$$\Delta \log(Sales)_{ijt} = \theta_{jt} + \beta OilShock_{jt} \times MainQuarter_{ijt} + \gamma' X_{ijt} + \varepsilon_{ijt} \ ,$$

$\Delta\log(Sales)_{ijt}$ is difference between the log of sales in quarter *t* and its average value between quarters *t-1* and *t-4*

Annual responses to shocks – outcome = difference between averages for the log of sales between quarters *t* and t+3 and quarters *t-1* and *t-4*.

θ_{jt} is industry-quarter fixed effect

Oil Shock is an industry-level oil shock

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

Oil Price Growth is the log difference between oil prices in quarter *t* and *t-1* and *Industry Oil Beta* is the absolute value of the oil beta for the 3-digit SIC industry, estimated over the entire sample

Empirical Specification

$$\Delta \log(Sales)_{ijt} = \theta_{jt} + \beta OilShock_{jt} \times MainQuarter_{ijt} + \gamma' X_{ijt} + \varepsilon_{ijt} \ ,$$

Main Quarter is an indicator that equals one in the firms' main quarter

X denotes a vector of control variables

- Average Q between t-1 and t-4
- Oil price growth * Main quarter
- Industry Oil Beta * Main quarter
- Firm-type (Q1, Q2, Q3, Q4) fixed effects
- **Firm-type*Oil Shock fixed effects (and also other oil variables)**

Coefficient of interest is β and tells us the **differential effect of the oil shock on firms when they are hit in the main quarter**

Sub-samples

Working capital channel requires a binding working capital constraint

We use firms' reliance on borrowing from suppliers (accounts payable) as a proxy

High cost, financing of last resort (Petersen and Rajan, (1994, 1997))

Suppliers offer more credit to costumers facing liquidity problems (Giannetti et al., 2007, Cunat, 2007)

Sort on accounts payable

Firms with high accounts payable (27% of sales) are

- Smaller
- Younger
- Less profitable – but not with lower Q
- More likely to carry inventory/receivables

than firms with low accounts payable (3% of sales)

Note this is not the key variation driving identification (main quarter)

Differences are consistent with these firms being more likely to face working capital constraints

Diagnostics

Oil price shocks are relevant in all quarters

Firms have their main quarters well distributed across the four quarters

Main quarter is a stronger predictor of profitability

Oil price shocks used in the analysis are significant and persistent

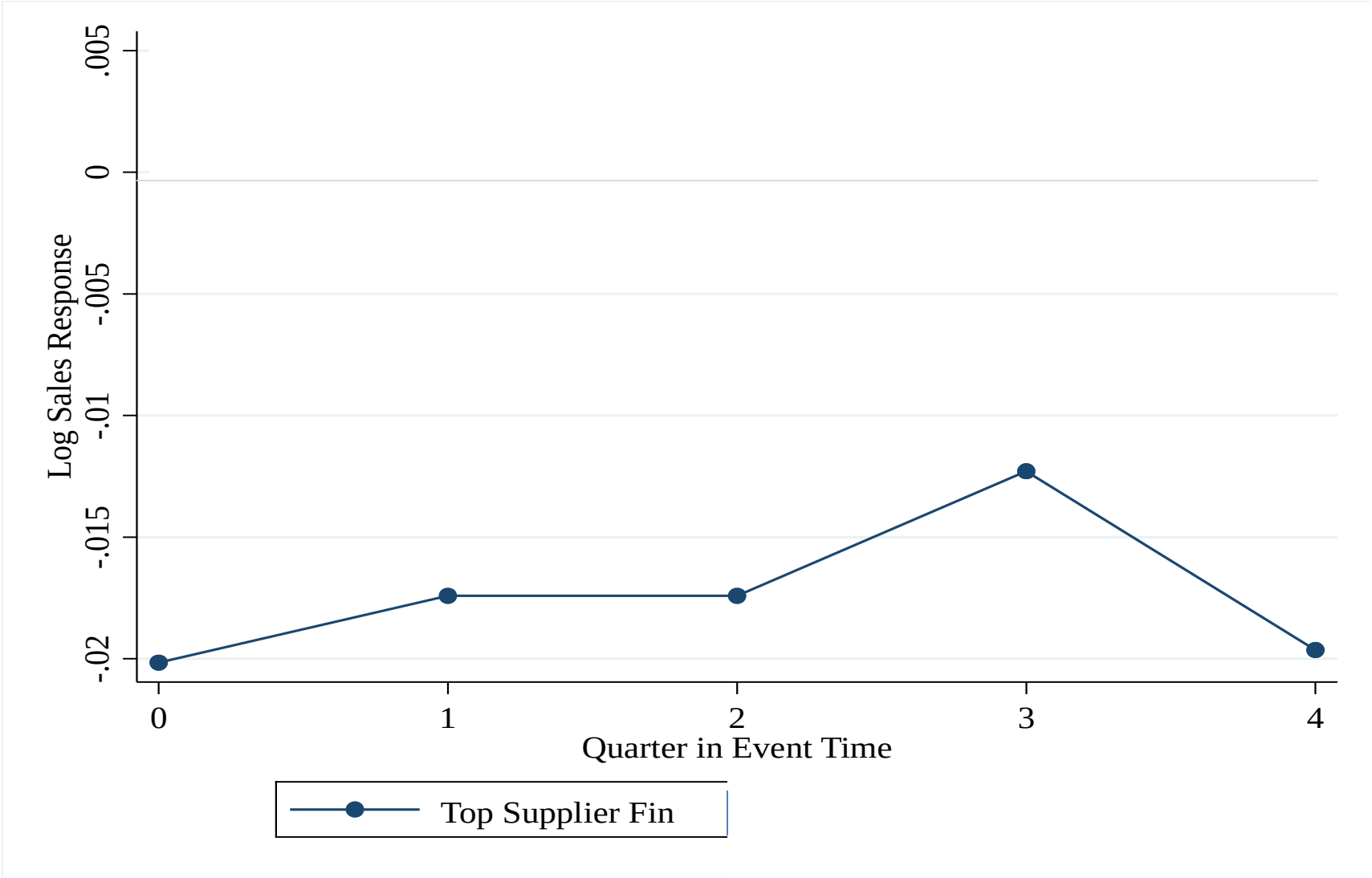
Main Results – Log of Sales

Panel A: Top 33% Supplier Fin

	ΔSale_t	ΔSale_t	ΔSale_t,t+3	ΔSale_t,t+3
	(1)	(2)	(3)	(4)
OilShock*MQuarter	-0.019**	-0.020***	-0.017***	-0.016**
	(-2.393)	(-2.700)	(-2.919)	(-2.350)
Observations	12378	12378	11755	11755
R-Squared	0.007	0.009	0.006	0.010
Firm Type FE	No	Yes	No	Yes
Firm Type FE*Shock	No	Yes	No	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes

Reported coefficients are percentage changes in sales predicted by a typical oil price shock for a firm with significant exposure to oil prices

Figure 1 – Dynamics of Sales Response



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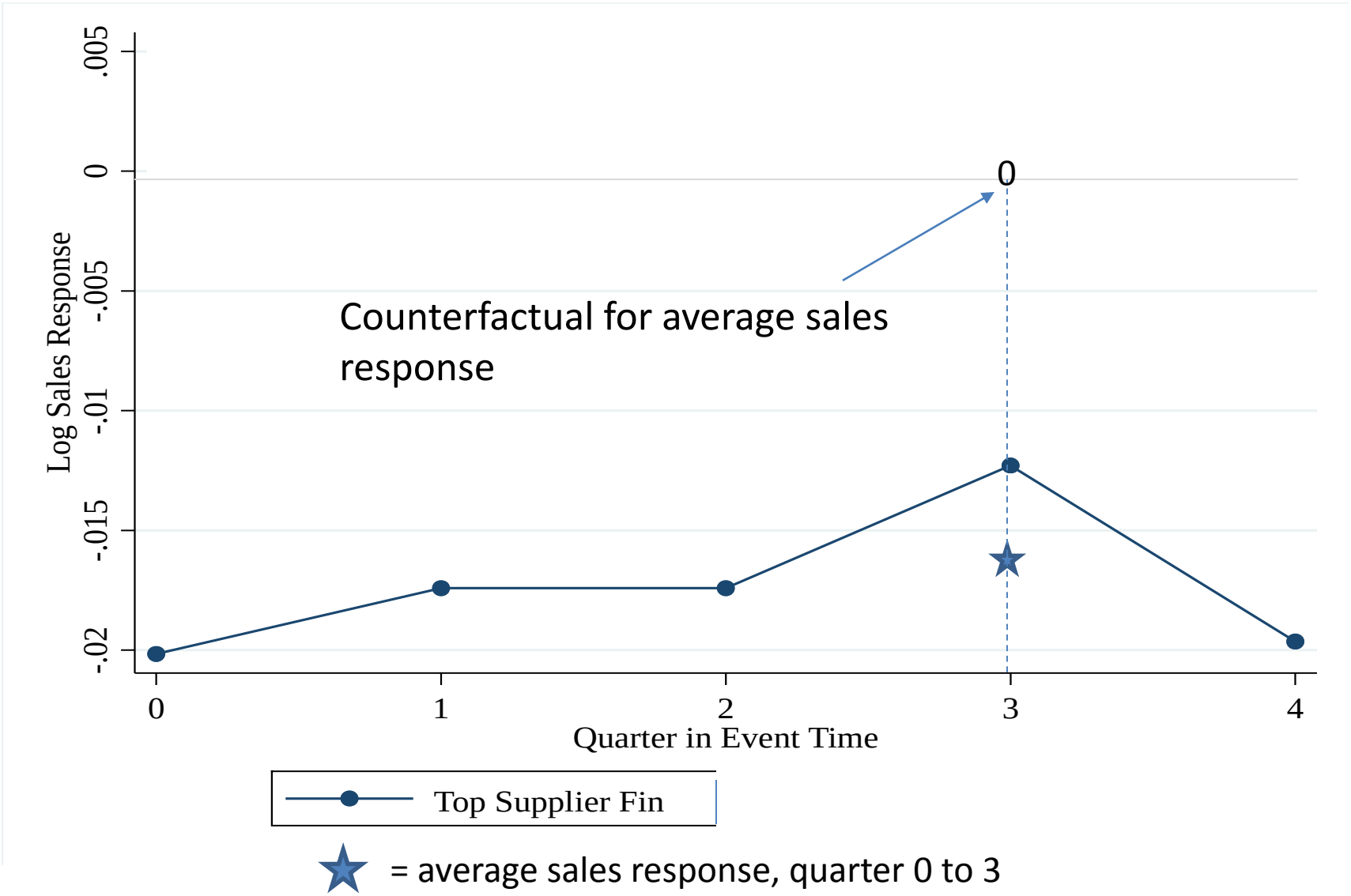

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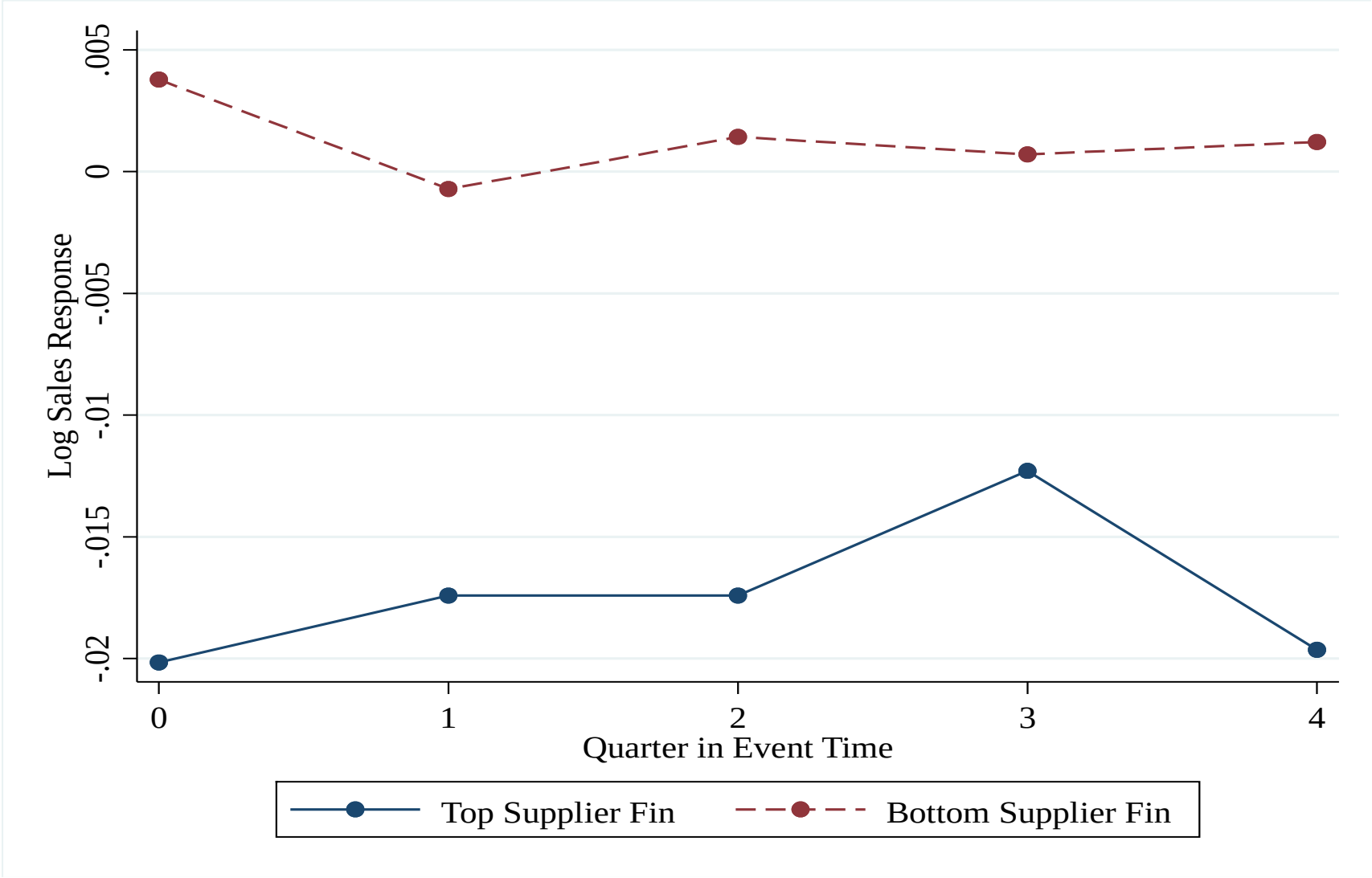

Summary of main results

When oil price shock happens during a firm's main quarter…

Both the immediate (same quarter) and the annual drops in sales are stronger than for firms not in their main quarter when the shock arrives

These patterns are only present for firms that significantly rely on financing from suppliers

Robustness

No results on sub-samples in which we don't expect to see working capital channel

Small firms with limited dependence on payables

Small firms that rely on short-term debt other than payables

Large, high payout, high cash, rated firms

Additional Evidence

Results are matched with drops in importance of (Receivables + Inventory) and (Payables) in firms' balance sheets

Results are matched with drops in operating costs

All these effects are also only relevant among firms in the top supplier financing group

Drop in sales is matched with reductions in the upfront financing of inputs by firms

Magnitude of Multiplier

Conceptually, additional drop in output of a constrained firm in period t+1, induced by a given drop in output in period t

Our identification strategy provides us with a way of estimating a lower bound

Incremental annual drop in sales when firms are hit in their main quarter, relative to when they are hit outside of their main quarter (- 1.6%), is due to multiplier

Immediate (first semester) sales shock when firms are hit in the high period = (- 2.9%)

Magnitude of Multiplier

Lower bound for the multiplier

CM = 1.6 / 2.9 = 0.55

Initial drop in sales of 10% leads to additional drop of 5.5% due the multiplier

Lower bound since it assumes that any additional drop in t+1 when firms are hit outside of the main quarter is **not** due to multiplier

Implications for Macro

Effect is concentrated in a small subset of firms in our sample: small, high payables firms

But it should also be relevant for a large number of firms outside our sample (e.g. private firms)

Suppose these firms represent 20% to 40% of GDP

-1% GDP shock would translate into an additional drop of 0.12% to 0.28% over the following 2 years

Related literature

Most of the literature focuses on long-term investment, rather than working capital channel

Recent macro-finance literature emphasises that working capital channel creates more immediate and direct effect of financial conditions on real output (Mendoza (2010), Jermann and Quadrini (2012), and Mendoza and Yue (2012))

Working capital constraint can be relevant for exporting activity during such events in Japan and Peru (Amiti and Weinstein (2011), and Paravisini et al (2015))

Conclusion

We provide evidence that financial accelerator/credit multiplier can operate through a working capital channel

New test to identify credit multiplier and role of working capital constraints at the firm level

- Identification using seasonality

Can our approach can be applied in other contexts?