# Oil Shocks and their Impact on Corporate Profitability, Productivity, and Credit Risk: Firm-Level Evidence over two Decades

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# Caveat

The opinions expressed in this paper do not necessarily reflect the views of the Banque de France.

# Motivation/Question

- Climate change and climate change mitigation policies are expected to put upward pressure on prices, in particular on raw material prices
- Raw material price dynamics are particularly important for raw material-intensive firms such as manufacturing firms
- **To what extent do commodity supply shocks affect firms?**
  - In terms of profit margin, productivity, credit risk?
  - To what extent are the effects long-lasting?
  - To what extent do the effects depend on firm's characteristics?
- Understanding how firms cope with commodity shocks is of great interest to policymakers:
  - climate mitigation policy,
  - financial stability,
  - competitiveness

# What do I do? What do I find?

1. **I study the propagation of raw material shocks within firms:**
   - That is, on raw material costs, value added, wage bill, profit
   - Further breakdown: wage vs. workforce, dividends vs. net cash flow
   - Highlighting the dynamics of key ratios: productivity, credit risk
2. **However, raw material costs are endogenous to the firm**
3. **Tackle the endogeneity issue with a Bartik (shift-share) instrument**
   - Shift part: the fluctuations in commodity prices (crude oil price shocks)
   - Share part: the firm's dependence on raw materials
4. **Mains Results:**
   - Short term:
     - 50% of increase in raw material costs is absorbed by the value added
     - The value added reduction is absorbed by the profit (not the wage bill),
     - The profit decline is absorbed by the internal cash flow
     - There is a decline in productivity, and an increase in credit risk
   - Medium-term: persistent effects that disappears after 2 to 3 years.
   - Impact particularly large, energy-intensive firms
   - Asymmetries: No significant impact on falling input prices

# Data

- Balance sheet and financial statements of non-financial corporation (FIBEN database from the Banque de France)
  - Over 2000-2019
  - At legal entity level (unconsolidated accounts)
  - Focus on raw-material-intensive sectors: manufacturing
  - Restrictions
    - Variables are trimmed at 99% (and 1% when relevant)
    - Restrict the analysis on the 20,000 largest firms per year
- Raw material prices (spot prices) comes from the INSEE (French National Institute of Statistics and Economic Studies)

# Identification Strategy

# From Accounting Identity to Specification

- Accounting identity:

$$VA_{f,t} \equiv SA_{f,t} - (RM_{f,t} + OC_{f,t}) \tag{1}$$

$VA_{f,t}$: value added, $SA_{f,t}$: sales, $RM_{f,t}$: raw material costs, $OC_{f,t}$: other costs.

- Scaling with sales and taking the first difference lead to a basic specification:

$$\overbrace{\Delta(\text{Profit margin})_{f,t} + \Delta\left(\frac{W}{SA}\right)_{f,t}}^{\Delta\left(\frac{VA}{SA}\right)_{f,t}} + \Delta\left(\frac{OC}{SA}\right)_{f,t} \equiv -\Delta\left(\frac{RM}{SA}\right)_{f,t} \tag{2}$$

- The dynamics of each value-added component can be expressed as follows:

$$\begin{cases} \Delta\left(\frac{W}{SA}\right)_{f,t} = \alpha_W + \gamma_W \times \Delta\left(\frac{RM}{SA}\right)_{f,t} + \epsilon_{W,f,t} & \text{(3a)} \\ \Delta\left(\text{Profit margin}\right)_{f,t} \equiv \Delta\left(\frac{P}{SA}\right)_{f,t} = \alpha_P + \gamma_P \times \Delta\left(\frac{RM}{SA}\right)_{f,t} + \epsilon_{P,f,t} & \text{(3b)} \\ \Delta\left(\frac{OC}{SA}\right)_{f,t} = \alpha_{OC} + \gamma_{OC} \times \Delta\left(\frac{RM}{SA}\right)_{f,t} + \epsilon_{OC,f,t} & \text{(3c)} \end{cases}$$

# Specification:

- Changes in raw material costs can be written as follows:

$$\left(\frac{RM}{SA}\right)_{f,t} \equiv \frac{\sum_c^C [p_{c,f,t} \times q_{c,f,t}]}{SA_{f,t}} \tag{4}$$

$$\Delta\left(\frac{RM}{SA}\right)_{f,t} = \overbrace{\sum_c^C \left[\left(\frac{p_{c,f,t-1} \times q_{c,f,t-1}}{SA_{f,t-1}}\right) \times gr(p_{c,f,t})\right]}^{\text{Direct impact of change in input price}} + \overbrace{\sum_c^C \left[p_{c,f,t} \times \Delta\left(\frac{q_{c,f,t}}{SA_{f,t}}\right)\right]}^{\text{Firm's adjustments to variation in input price}} \tag{5}$$

- The Bartik instrument is:

$$Z_{f,t} = \left(\frac{RM}{SA}\right)_{f,t_0} \times gr\left(\text{Oil Price}\right)_t \tag{6}$$

- The main equation used in the empirical analysis is the reduced-formed equation:

$$\Delta\left(\frac{Y}{SA}\right)_{f,t} = \beta_Y \times Z_{f,t} + X_{f,t-1} + \alpha_f + \theta_{s,t} + \epsilon_{f,t} \tag{7}$$

with $Z_{f,t}$ the weighted oil price shocks and $X_{f,t-1}$ controls, $\alpha_f$ firm fixed effects, $\theta_{s,t}$ sector-year FE.

# Stylized facts

Figure: This figure shows the correlation between the weighted oil shocks, the change in firms' raw material cost per unit of sales and the change in value added per unit of sales with a "times-minus-one" transformation to be consistent with the (expected) negative relationship with the other variables, over the 2000-2019 period.

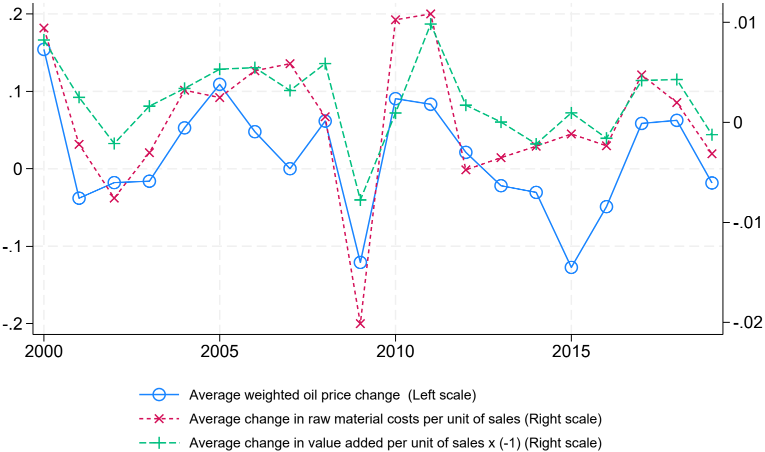
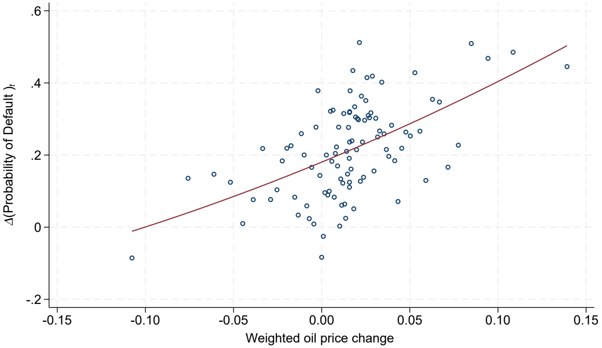
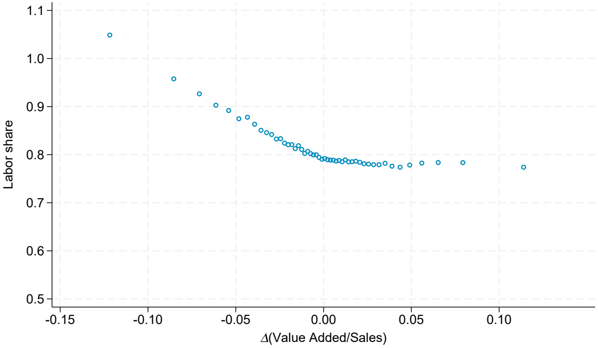


Figure: The relationship between weighted oil price shocks and credit risk




This figure shows the bin-scatter plot highlighting the positive relationship between the change in the probability of default (y-axis) and the weighted oil price shocks (x-axis).

Figure: **The relationship between the allocation of value added (labor share, %) and the shocks to value added**




Note: This figure is a bin-scatter plot showing the relationship between firms' labor share (%) on the y-axis and the shock to firms' value added per euro of sales on the x-axis.

# Descriptive Statistics

# Descriptive Statistics 1/2

Table: **Descriptive Statistics (all prices are in 2000 euros)**

Panel A: Main Descriptive Statistics — No. observations: 245,609 - No. Firms: 28,643

| | p10 | p50 | Mean | p90 | SD |
|---|---|---|---|---|---|
| Sales (M€) | 1.0 | 3.5 | 13.8 | 30.4 | 37.2 |
| Employees | 9 | 28 | 75.3 | 172 | 160.9 |
| Raw material costs / Sales | 9.1% | 30.7% | 31.5% | 54.3% | 17.1% |
| Wage bill / Sales | 13.3% | 27.3% | 28.5% | 45.5% | 12.4% |
| External staff and outsourcing costs/ Sales | 0.3% | 5.5% | 8.3% | 20.6% | 8.7% |
| Value added / Sales | 18.4% | 34.3% | 35.1% | 52.8% | 13.1% |
| Labor share (=Wage bill/VA) | 56.6% | 81.8% | 81.7% | 102.5% | 21.6% |
| Gross average wage (K€) | 25.3 | 34.5 | 36.0 | 48.5 | 9.5 |
| Productivity (K€/head) | 27.9 | 43.0 | 47.7 | 72.5 | 20.8 |
| Profit margin | -0.8% | 5.9% | 6.5% | 15.4% | 7.0% |
| Change in value added /Sales (p.p.) | -5.1 | -0.2 | -0.2 | 4.7 | 4.2 |
| Change in wage bill/Sales (p.p.) | -4.1 | 0.0 | 0.0 | 4.2 | 3.6 |
| Change in profit margin (p.p.) | -5.5 | -0.2 | -0.3 | 4.9 | 4.6 |
| Lag(Cash holdings/Total assets) | 0.2% | 8.6% | 13.9% | 36.4% | 14.8% |
| Lag(Equity/TA) | 15.2% | 42.2% | 41.7% | 69.0% | 21.2% |
| Lag(Log(TA)) | 6.4 | 7.7 | 7.9 | 9.9 | 1.4 |
| Weighted Brent price change | -6.05% | 0.05% | 1.58% | 11.02% | 7.78% |
| Probability of default | 0.2% | 1.6% | 3.9% | 12.1% | 5.8% |

# Descriptive Statistics 2/2

Table: **Descriptive Statistics (all prices are in 2000 euros)**

Panel B: Average values by firm size

| Firm size (=quartile of sales) | [p0-p25) | [p25-p50) | [p50-p75) | [p75-p100] |
|---|---|---|---|---|
| Sales (M€, in 2000 euros)) | 1.1 | 2.2 | 5.5 | 44.1 |
| Employees | 12.1 | 20.6 | 41.6 | 215.4 |
| Raw material costs / Sales | 25.1% | 28.7% | 32.9% | 38.3% |
| Wage bill / Sales | 36.2% | 31.4% | 26.4% | 21.6% |
| External staff and outsourcing costs / Sales | 7.0% | 8.5% | 9.3% | 8.2% |
| Value added / Sales | 42.7% | 37.8% | 33.0% | 28.2% |
| Labor share (=Wage bill/ Value added) | 85.1% | 83.3% | 80.8% | 78.2% |
| Gross average wage (K€) | 34.8 | 35.1 | 35.5 | 38.3 |
| Productivity (K€/head) | 42.8 | 45.1 | 47.7 | 54.3 |
| Profit margin | 6.5% | 6.4% | 6.5% | 6.5% |

# Empirical results

# Empirical results: Main Results

## Table: **Impact of weighted oil shocks on firms**

| | Raw Material Costs | Value Added | | Sales | Value Added Components | | | | | | Labor Share | Productivity | Ext. Staff, Outs. | Default Prob. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Wage Bill | | | Profit | | | | | | |
| Dependent | $\Delta(RM/SA)$ | $\Delta(VA/SA)$ | gr(VA) | gr(SA) | $\Delta(W/SA)$ | gr($\omega$) | gr(N) | $\Delta(P/SA)$ | $\Delta(CF/SA)$ | $\Delta(D/SA)$ | $\Delta(W/VA)$ | $\Delta(VA/N)$ | $\Delta(OW/SA)$ | $\Delta(PD)$ |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Panel A: Results pooling all types of oil shocks (positive vs. negative) | | | | | | | | | | | | | | |
| Weighted oil price changes | 0.039*** | -0.021*** | -0.061*** | 0.046*** | 0.008*** | -0.007 | -0.002 | -0.029*** | -0.026*** | -0.003** | 0.046*** | -2.625*** | -0.006*** | 2.232*** |
| | (0.003) | (0.003) | (0.012) | (0.009) | (0.002) | (0.007) | (0.007) | (0.003) | (0.003) | (0.001) | (0.010) | (0.638) | (0.002) | (0.352) |
| Observations | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 |
| R-squared | 0.119 | 0.104 | 0.181 | 0.244 | 0.148 | 0.084 | 0.191 | 0.128 | 0.109 | 0.070 | 0.129 | 0.123 | 0.094 | 0.199 |
| No firms | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry-year & Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-level cluster | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Panel B: Results with breakdown by type of oil shock (positive vs. negative) | | | | | | | | | | | | | | |
| Weighted oil price increases | 0.029*** | -0.019*** | -0.062*** | 0.053*** | 0.008** | 0.005 | 0.002 | -0.027*** | -0.023*** | -0.005* | 0.052*** | -3.423*** | -0.007** | 3.882*** |
| | (0.004) | (0.004) | (0.019) | (0.014) | (0.004) | (0.012) | (0.012) | (0.005) | (0.005) | (0.002) | (0.017) | (1.074) | (0.003) | (0.676) |
| Weighted oil price decreases | 0.052*** | -0.023*** | -0.061** | 0.038** | 0.009* | -0.023 | -0.008 | -0.032*** | -0.030*** | -0.002 | 0.038* | -1.572 | -0.006 | 0.052 |
| | (0.005) | (0.005) | (0.025) | (0.019) | (0.005) | (0.014) | (0.015) | (0.006) | (0.006) | (0.003) | (0.022) | (1.357) | (0.004) | (0.747) |
| Observations | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 |
| R-squared | 0.119 | 0.104 | 0.181 | 0.244 | 0.148 | 0.084 | 0.191 | 0.128 | 0.109 | 0.070 | 0.129 | 0.123 | 0.094 | 0.199 |
| No firms | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry-year & Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-level cluster | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

# Empirical results: By firm size

Table: **Impacts of weighted oil shocks by firm size**

| | Raw Material Costs | Value Added | | Sales | Value Added Components | | | | | | Labor Share | Productivity | Ext. Staff, Outs. | Default Prob. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Wage Bill | | | Profit | | | | | | |
| Dependent | $\Delta(RM/SA)$ | $\Delta(VA/SA)$ | gr(VA) | gr(SA) | $\Delta(W/SA)$ | gr($\omega$) | gr(N) | $\Delta(P/SA)$ | $\Delta(CF/SA)$ | $\Delta(D/SA)$ | $\Delta(W/VA)$ | $\Delta(VA/N)$ | $\Delta(OW/SA)$ | $\Delta(PD)$ |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Weighted oil increase×Lagged-Size[p0-p25) | 0.017** | 0.005 | -0.013 | -0.007 | 0.024*** | 0.047** | -0.035* | -0.019*** | -0.018** | -0.001 | 0.012 | -0.216 | -0.018*** | 0.463 |
| | (0.007) | (0.007) | (0.028) | (0.021) | (0.006) | (0.020) | (0.021) | (0.007) | (0.007) | (0.003) | (0.024) | (1.447) | (0.005) | (0.984) |
| Weighted oil increase×Lagged-Size[p25-p50) | 0.011* | -0.003 | -0.022 | 0.018 | 0.014*** | 0.015 | 0.001 | -0.017*** | -0.015** | -0.002 | 0.029 | -1.524 | -0.010** | 2.540*** |
| | (0.006) | (0.006) | (0.025) | (0.019) | (0.005) | (0.016) | (0.017) | (0.006) | (0.006) | (0.003) | (0.021) | (1.379) | (0.004) | (0.859) |
| Weighted oil increase×Lagged-Size[p50-p75) | 0.025*** | -0.021*** | -0.061*** | 0.053*** | 0.008* | 0.001 | 0.018 | -0.029*** | -0.025*** | -0.004 | 0.063*** | -3.937*** | -0.007* | 3.967*** |
| | (0.005) | (0.005) | (0.023) | (0.017) | (0.004) | (0.014) | (0.015) | (0.006) | (0.006) | (0.003) | (0.020) | (1.287) | (0.004) | (0.808) |
| Weighted oil increase×Lagged-Size[p75-p100] | 0.044*** | -0.031*** | -0.087*** | 0.086*** | 0.001 | -0.005 | 0.002 | -0.032*** | -0.025*** | -0.007*** | 0.063*** | -4.541*** | -0.003 | 5.129*** |
| | (0.005) | (0.005) | (0.022) | (0.016) | (0.004) | (0.012) | (0.013) | (0.005) | (0.005) | (0.003) | (0.020) | (1.215) | (0.003) | (0.787) |
| Observations | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 | 245,609 |
| R-squared | 0.120 | 0.107 | 0.186 | 0.262 | 0.160 | 0.084 | 0.191 | 0.130 | 0.111 | 0.070 | 0.131 | 0.125 | 0.095 | 0.201 |
| No firms | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 | 28643 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry-year & Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm-level cluster | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

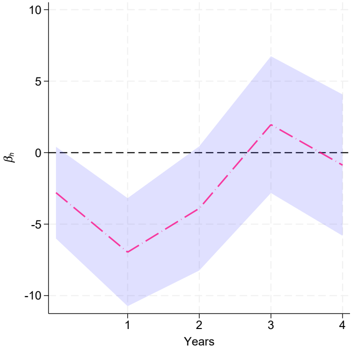
# Are the effects long-lasting effects?

- I use local projections (Jordà 2005).
- I run a series of regressions on a variable of interest at various horizons ($h$) after year $t$ of the oil price shock, on the independent variable of interest at $t$ (the Bartik instrument) and on control variables.
- Following (Jordà and Taylor 2024), I use a long-difference specification rather than a level specification.

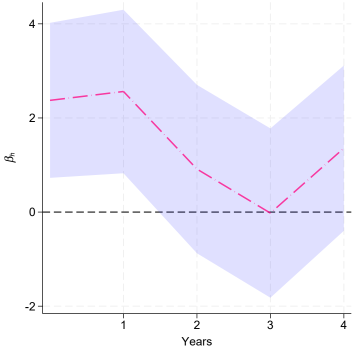
$$y_{f,t+h} - y_{f,t-1} = \beta_{y,h} \times Z_{f,t} + \sum_{j=1}^{p} \rho_{f,h}.\Delta y_{f,t-j} + \sum_{j=1}^{p} \rho_{f,h}.x_{f,t-j} + \alpha_f + \theta_{s,t+h} + \epsilon_{f,t+h} \quad (8)$$

# Impulse Responses

Figure: **The effect of weighted oil price increases on ...**




(a) Labor Productivity (K€ per employee)




(b) Probability of default (%)

# Conclusion

- I study the effects of oil shocks at firm-level:
  - namely the propagation of oil shocks through key metrics: value added, employment, wages, profit, dividends, productivity, and credit risk
- I show and quantify asymmetric effects:
  - an oil price increase (1 S.D.) leads to a decrease in productivity (€396) & an increase in credit risk (+0.30 pp),
  - while there is no effect in the case of price decreases
  - This leads to persistent effects of oil price increases in the medium term.
- I also show heterogeneous effects across firm size and energy intensity
- These results apply to unfiltered oil shocks and to oil-specific shocks
- Main policy implications relate to financial stability and climate risks
  - stress-tests should account for asymmetric energy shocks,
  - climate transition risk cannot be evaluated in isolation from commodity price volatility

Thank You!