Energy Price Shocks, Value-Added Allocation, Productivity, and Credit Risk

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Abstract

I study the impact of energy price shocks on firm activity from 2000 to 2019. Using a unique database, I show that rising energy prices lead to (i) a contraction in value added, (ii) an increase in the labour share, (iii) a reduction in the profit margin and (iv) a decline in productivity. These effects depend on firm characteristics, such as size and energy intensity, and on the time horizon considered. In particular, the effects follow a U-shape: they peak about two years after the shock and dissipate after four years, resulting in a cyclical pattern of productivity. More generally, I show that increases in raw material costs affect firms' default risk. This article has implications for policymakers, especially those concerned with financial stability, and for policymakers studying climate change risks and energy transition scenarios.

JEL classification: D33, G3, G30, G32, G33, G35, E32, H12, P18, Q49.

Keywords: value added, shock, wage bill, labor share, profit share, profit margin, cash flow, dividend, default, commodity, oil, raw materials, productivity.

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1 Introduction

How do firms allocate their value-added in response to external shocks? Value added is distributed among employees and shareholders, or internally, such as to finance investments. However, the dynamics of this allocation can undergo substantial shifts during periods of disruption. Firms may encounter rigidities –such as wage rigidities (Babecký et al., 2010) or constraints on profit distribution (Waters, 2018; Lintner, 1956)– that limit their ability to adapt to shocks. These constraints could impact firms' profitability, productivity, and even their survival. Understanding the impacts of value-added shocks is therefore crucial, particularly in times of high macroeconomic volatility (Schnabel, 2022b) and in the context of the energy transition (Schnabel, 2022a).

I therefore analyze the impact of exogenous supply shocks on firms' value added and the transmission of these shocks to the value-added sharing and key economic ratios like profit margin and productivity. To carry out this work, I rely on shocks stemming from raw materials. I use a unique dataset of firms' financial statements covering two decades (2000-2019), and focus on raw-material-intensive sectors (manufacturing). The identification strategy employs a shift-share instrument in which the exposure is quantified by the firm's reliance on raw materials and the shocks are fluctuations in raw material prices. Since the raw material production is highly dependent on fossil resources, in particular oil and gas (Pimentel, Patzek, and Cecil (2007) and Kim et al. (2021)), I focus on raw material shocks originating from the oil market.

Based on this framework, I show that (i) there is no full pass-through to cus-

tomers in the event of oil price shocks, in the sense that raw material costs increase faster than sales.(ii) The increases in raw material costs lead to a contraction in value-added per unit of sales, (iii) the other cost components (e.g. external staff costs) are, on average, less affected.

By breaking down the value added, I show that the transmission of the shock is not uniform across value-added components: nearly 100% of the value-added shock is transmitted to profit margin (that is, profit per unit of sales), leaving the wage bill (per unit of sales) largely unaffected. This leads to significant shifts in the value-added allocation, that is, an increase in the labor share, both in the short and medium term.

Then, breaking down the profit margin dynamics, I show that most of the shock (80%) is transmitted to internal cash flow (per unit of sales), while the impact on dividends are significant but more limited. Rising raw material costs therefore essentially reduce the net profit margin (net of dividends).

The rise in raw material costs also leads to a nondecreasing dynamics in the workforce, resulting in a decline in labor productivity. This dynamics is in line with (i) labor hoarding (Fay and Medoff, 1985), or (ii) a substitution of labor for raw material inputs (Berndt and Wood, 1975), for example, to optimize the production process. Quantitatively, positive shocks during 2000-2019 led to, on average, a decline exceeding €500 in per-capita productivity (in 2023 euros), that is roughly a 1% immediate decrease in productivity for an average oil shock.

Further examination by firm size reveals distinct adjustment mechanisms to raw material shocks and varying productivity impacts. Despite the ability of largest firms to increase sales, probably due to their pricing power, they are particularly

affected by shocks due to their high dependence on raw materials. This leads to (i) significant contractions in value added (per unit of sales) and (ii) a substitution of labor for raw material inputs, as their workforce increases. Conversely, small firms are less dependent on raw materials, but heavily rely on (external and internal) labor, prompting substantial adjustments in external staff costs that mitigate value-added contraction, and do not lead to significant change in internal workforce. This results in a smaller decline in labor productivity for smallest companies than for largest ones.

The effects persist in the medium term, more precisely the effects follow a U-shape: an analysis of the duration of the impact reveals that the decline in productivity peaks one to two years after the shock, with an €88 decrease in labor productivity for each percentage-point increase in oil prices. This decline remains significant even three years later, regardless of the metric used –value added per unit of sales, labor share, or labor productivity–, and disappears after four years.

Breaking down the analysis into energy-intensive and non-energy-intensive sectors gives similar (significant) results for both types of sector, albeit with a greater magnitude for energy-intensive firms. In particular, the productivity impact is twice the population average for the energy-intensive sectors.

Finally, since the main channel for absorbing raw materials shock is internal cash flow, I test to what extent this has an impact on the firm's default probability. I show that increases in raw material costs also impact the firms' default risk: a one-standard-deviation increase in raw material costs per unit of sales leads to around a 13% increase in the default probability one year after the shock.

This paper makes three main contributions. A first contribution is part of a

long-standing literature analyzing the impact of commodity shocks on the economy. That literature began at least in the late 1970s. As most U.S. recessions were preceded by a rise in oil prices, the literature has examined the impact of oil price shocks on macroeconomic growth (Hamilton, 1983). Subsequent works have called into question the stability of the relationships highlighted from World War II until the 1970s (Hooker, 1996; Hamilton, 1996). With the availability of more granular data, the transmission channels of oil shocks to the economy were broken down at industry level to estimate demand and supply side effects (see e.g. Lee and Ni, 2002; Kilian and Park, 2009). More recently a growing field analyzes the transmission of energy price shocks to output prices, and shows that, in line with my results, there is no full pass-through outside periods of energy crisis (Lafrogne-Joussier, J. Martin, and Mejean, 2023; Dedola, Kristoffersen, and Zullig, 2021; Cavallo, Lippi, and Miyahara, 2023). A related paper is Fontagné, P. Martin, and Orefice (2024) which studies firm's adjustment channels to gas and electricity price shocks. They point out that shocks to gas and electricity prices are passed-through into export prices, leading to a decline in competitiveness and demand for companies' products. My results on productivity are in line with Fontagné, P. Martin, and Orefice (2024) results on the competitiveness, but my paper addresses a different concern. My concern, which has not been investigated so far to the best of my knowledge, is to follow the shock throughout the financial statement variables: that is to track the exogenous shock across all key financial variables like the impact on firm's raw material costs, external staff costs, value added, value-added allocation, workforce, real wage, labor share, profit margin, productivity, and default risk. And then to break down the analysis by firms' characteristics and time horizon. So I provide a

complete and consistent framework to analyze the impact of value-added shocks on firms. This is of major interest for policy makers analyzing the ability of firms to absorb supply shocks, particularly at a times of increasing macroeconomic volatility (Schnabel, 2022b), especially on commodities (Schnabel, 2022a). More specifically, this work provides a wealth of information for policy makers studying climate change and energy transition scenarios (Allen et al., 2020): in particular point estimates of the impact of rising commodity price on corporate ratios. This methodology could be reused with data from the forthcoming new corporate sustainability reporting standards (CSRD-ESRS E1).

A second contribution relates to the long-standing literature on the productivity cycle (Biddle, 2014). Empirical studies have investigated the reasons for the procyclical behavior of labor productivity: e.g. rigidity of labor input relative to output (Hall, 1988), labor hoarding (Fay and Medoff, 1985). My work contributes to this literature by highlighting cycles due to raw materials shocks and differential impacts across firms, particularly in relation to characteristics like energy-intensity. So, my work completes previous works on the heterogeneity of the productivity dynamics depending on firm's characteristics such as balance sheet weakness (Giroud and Mueller, 2017), firm's long-run growth (Baily, Bartelsman, and Haltiwanger, 2001), or between booms and recessions (Kehrig, 2015).

A third contribution concerns the growing literature analyzing the link between commodity shocks and financial stability: for example the impact of oil price shocks on sovereign risk (Bouri et al., 2018; Filippidis, Filis, and Kizys, 2020) or energy firms (Sengupta, Marsh, and Rodziewicz, 2017), or the impact of CO2 emission price shocks, as CO2 emissions can be considered as a traded commodities (Capasso,

Gianfrate, and Spinelli, 2020; Delis, De Greiff, and Ongena, 2019). Most of these articles are not based on the direct observation of corporate defaults, but rely on the distance to default or credit ratings, and focus on large (listed) firms. I provide a larger set of firms, notably including small firms that generally fall outside of the scope of most corporate finance studies, and highlight specific behaviors. I also rely on the direct observation of firms' payment defaults. I thus provide an illustration of the link between an increase in corporate raw material costs due to an oil shock and the probability of corporate payment default, using a more representative sample of the economy than former studies, in particular regarding bank portfolios. This is of considerable interest for supervisory authorities carrying out bank stress tests, who need to assess the deterioration of bank portfolios under different scenarios (Dimitrov et al., 2024).

2 Data

The analysis carried out in this paper relies on FIBEN –*Fichier Bancaire des Entreprises*), a database of firms' tax statements managed by the Banque de France– to assess firms' credit ratings. Data are available from 1989 to 2022. The reporting is carried out yearly at the legal entity level (unconsolidated accounts). The database is particularly interesting due to its broad coverage: it accounted for 72% of the corporate value added in 2018 (see Lé and Vinas (2024) for more details on FIBEN).

The following restrictions are applied. First, only firms with a 12-month accounting period are retained. Second, as the analysis focuses on raw material costs, only

the most intensive sectors are kept, namely the manufacturing sectors, excluding the manufacture of coke and refined petroleum products (and the manufacture of tobacco products, which represents an average of two firms per year). Third, the data collection has grown over time. Indeed, collection thresholds have not been changed, which has led to data on more very small businesses being collected in recent years. Consequently, I restrict the number of observations each year to the 25,000 largest firms in terms of sales, to give equal weight to each year. Fourth, as the change in the price of Brent crude oil is based on the average yearly price over the calendar year, I limit the analysis to firms that end their fiscal year in December. Fifthly, as the 2020-2021 health crisis gave rise to public aids, notably the Job Retention Scheme, which affected the value-added allocation, I restrict the data to 2019. Finally, the main variables of interest are trimmed at 99% (and 1% when relevant).

This leads to a set of 233,106 observations. In the majority of the paper, I focus on positive price shocks, which represent 128,805 observations and 23,297 firms. The descriptive statistics are reported in Table 1. The average sales is 13.3M€ (in 2000 euros) and number of employees is 73.3 employees. Beyond these averages, there is considerable heterogeneity across firms: the first decile of sales is 1.1M€, while the last decile is 31.4M€, close to 30 times higher. The number of employees ranges from 2 to more than 4,000, with a median value of 29.

In addition to the heterogeneity of the firms provided by the database, an important feature of FIBEN is its coverage of small businesses. Corporate finance studies tend to cover large companies better than small ones, due to data unavailability or access difficulties. For example, studies based on Compustat data are biased to-

ward large firms as mentioned in Chodorow-Reich (2014, p.14). In Chodorow-Reich (2014), the median firms has sales of $500 million (in 2005 dollars) and 620 employees, compared to 3.7M€ (in 2000 euros) and 29 employees in the dataset used here.

Raw material costs and value added represent around one-third of sales, so other costs account for around one-third; in particular external staff and outsourcing costs amount to 8% of sales on average. Raw material costs per unit of sales increase with firm size, from 26% for the 25% smallest firms to 42% for the 10% largest. The average labor share represents 82% of value added and decreases with firm size from 85% for the smallest firms to 77% for the largest (in line with Bauer and Boussard, 2020, Figure V page 135). Large firms are also more productive than the smallest ones (in line with literature, OECD, 2014; Leung, Meh, and Terajima, 2008). Cash holdings accounts for 13% of total assets on average, and equity accounts for 41%. The profit margin is similar regardless of firm size, averaging 6.4%.

This dataset is merged with a database containing payment defaults, called the CIPE (*"Centrale des incidents de Paiement sur effets"*). The CIPE database, also managed by the Banque de France, collects firms' payment defaults to suppliers at a daily frequency. Default is defined as a missed payment on a trade bill, whatever the reason (not paid on time and/or in full, see Bureau, Duquerroy, and Vinas (2024) for more details on the CIIPE database). Data are available starting from 2000. This leads to a restriction of the years considered. I aggregate daily information on firms' defaults at the yearly level before merging this with tax data using the unique identifier of each firm. The yearly default probability is 3.1% over 2000-2019.

A third database, on raw materials prices, is made available by the French Na-

tional Institute of Statistics and Economic Studies (INSEE).[1] It provides over a hundred series in euros or foreign currencies (essentially dollars) over the period 1990-2022 at monthly frequency. These data cover fossil resources and their derivatives (naphtha, heating oil, etc.), as well as agri-food resources (corn, wheat, oilseeds, etc.), and ferrous and non-ferrous metals (copper, nickel, aluminum, lead). The series are either directly quoted market prices or price indexes.

As mentioned above, the shift-share instrument is based on the Brent crude oil spot price. As France is in the euro zone, I use the spot price reported in euros. In the robustness section, the results are challenged using other commodities. As balance sheet data are annual, commodity series are averaged over the year before being merged with firm balance sheet data.

3 Empirical results

3.1 Impacts of an oil price increase on value-added allocation

The aim of this work is to analyze how a firm changes its value-added allocation when it experiences a shock, such as a rise in raw material prices. I thus analyze the extent to which raw material price shocks impact firms' value added, noted $VA_{f,t}$, and its allocation between the wage bill $W_{f,t}$, and profit $P_{f,t}$. I extend the decomposition of profit into dividend $D_{f,t}$ and internal cash flow, $CF_{f,t}$, that is the

[1] Available here: https://www.insee.fr/en/statistiques/series/105299226 and for a direct access to the database see: https://www.insee.fr/en/statistiques/series/xlsx/famille/105299226

cash flow net of dividend payment. The main regression is:

$$\Delta y_{f,t} = \beta_X \times Z_{f,t} + X_{f,t-1} + \alpha_f + \gamma_{s,t} + \epsilon_{f,t} \tag{1}$$

where $y_{f,t} \in \left\{ \left(\frac{RM}{SA}\right)_{f,t}; \left(\frac{VA}{SA}\right)_{f,t}; \left(\frac{W}{SA}\right)_{f,t}; \left(\frac{P}{SA}\right)_{f,t}; \left(\frac{CF}{SA}\right)_{f,t}; \left(\frac{D}{SA}\right)_{f,t}; \left(\frac{W}{VA}\right)_{f,t}; \left(\frac{VA}{N}\right)_{f,t} \right\}$, $Z_{f,t}$ is the Bartik instrument defined in Equation (2), α_f is firm fixed effects, $\gamma_{s,t}$ is industry-year fixed effects (2 digits), and $X_{f,t-1}$ is a set of controls (see below).

I construct a shift-share instrument, $Z_{f,t}$, whose "share" part is the weight of raw materials in the firm's production process, measured as raw material costs per unit of sales before the price change. Following the convention in that literature (Goldsmith-Pinkham, Sorkin, and Swift, 2020), the firm's exposure to the shock is the first value observed in the dataset (t_0). The "shift" part is the change in the spot price of crude oil (for the motivation for using that instrument, see Section 7.1), calculated *à la* Davis and Haltiwanger (1992) to take into account the fossil dependence of raw materials. The oil price considered is that of Brent crude oil, as this is the reference price in Western Europe.

$$Z_{f,t} = \left(\frac{RM}{SA}\right)_{f,t_0} \times gr\left(\text{Brent Spot Price}\right)_{c,t} \tag{2}$$

A methodological remark should be made here: since standard corporate economic ratios typically employ different denominators—for instance, labor share is scaled by value added, profit margin by sales, and labor productivity by workforce, to simplify the analysis, I first scale the dependent variables of the income statement by sales. This approach helps in examining income statement dynamics and enables an intuitive tracking of the propagation of raw material shocks across key financial

variables. By consolidating these elements, a comprehensive understanding of the dynamics of standard economic ratios is achieved.

Columns (1) to (10) of Table (2) report the estimation of Equation (1) for the change in raw material costs per unit of sales $\Delta\left(\frac{RM}{SA}\right)_{f,t}$, the change in value-added per unit of sales $\Delta\left(\frac{VA}{SA}\right)_{f,t}$, the wage bill per unit of sales $\Delta\left(\frac{W}{SA}\right)_{f,t}$, the profit margin $\Delta\left(\frac{P}{SA}\right)_{f,t}$, the cash flow per unit of sales $\Delta\left(\frac{CF}{SA}\right)_{f,t}$, the dividend per unit of sales $\Delta\left(\frac{D}{SA}\right)_{f,t}$,[2] the labor share $\Delta\left(\frac{W}{VA}\right)_{f,t}$, and productivity $\Delta\left(\frac{VA}{N}\right)_{f,t}$.

Variables commonly used as controls in corporate finance are labelled X_{t-1} in Equation (1): (i) the share of cash holdings over total assets, to control for the firm's liquidity level, (ii) the leverage, to control for firm's indebtedness, and (iii) the logarithm of total assets, to control for firm's size. All estimations are carried out with (iv) firm fixed effects α_f, to control for firm's unobservable characteristics, and (v) industry-year fixed effects (2 digits), $\gamma_{s,t}$, to control for yearly shocks at industry level, in particular a demand shock. All the standard errors are clustered at the firm level.

In column (1) of Table (2) the dependent variable is the change in raw material costs per unit of sales. As reported, a one-percentage-point (pp) increase in the Bartik instrument (that is, a one pp increase in the Brent crude oil price weighted by the initial weight of raw materials in the firm's production process) leads to a 0.086 pp increase of in the firm's raw material costs per unit of sales. This increase in raw material costs is significant even when controlling for firm unobservable characteristics and a time-sector shock (2 digits) such as a demand shock. This first result means that, to make 1€ in sales, the input invoice paid by the firm increases when

[2]The dividend considered here is the dividend voted at the yearly general meeting following the closing of the accounts.

the oil price increases, so that (i) there is, on average, no full pass-through of the rise in input costs (in the sense that raw material costs increase faster than sales), and (ii) the increase in raw material costs impacts other components of the income statement: either through a fall in other costs (e.g. purchases of goods, external staff, outsourcing), or through a value-added contraction. The following columns answer this question.

In column (2), the dependent variable is the change in valued added per unit of sales. As reported, a 1 pp change in the weighted oil price leads to a 0.037 pp decline in value added per unit of sales. That result is illustrated by Figure (1), which shows the change in the yearly average weighted oil price and the average changes in firm value added over the 2000-2019 period. The Brent price change is displayed with a "times-minus-one" transformation in order to highlight the negative relationship between both measures.

More interesting is the breakdown of the value-added contraction. In columns (3) and (4), the value added is broken down between the wage bill and profit. A 1 pp increase in the weighted oil price leads to (a not significant) 0.001 pp increase in the wage bill per unit of sales, but to a (significant) 0.038 pp decrease in the profit margin. So 100% of the value-added contraction is transmitted to the profit margin and the wage bill is unaffected.

In columns (5) and (6) the profit margin is broken down into, respectively, net cash flow and dividend. A 1 pp increase in the weighted oil price leads to a 0.030 pp decrease in the cash flow part, but a 0.008 pp decrease in the dividend per unit of sales. So the wage bill and dividend are less impacted by raw material cost increase than net cash flow: 80% of the value-added contraction is transmitted to net cash

flow, while only 20% is transmitted to the dividend.

In column (7), the dependent variable is the change in the labor share, measured as the change in the ratio of the wage bill over value added. A 1 pp change in the weighted oil price leads to a 0.082 pp rise in the labor share. This is due to the fact that the value-added contraction is transmitted more strongly to the profit margin than to the wage bill. Put differently, the wage bill ratio per unit of sales is unaffected by the oil price increase, while value added per unit of sales decreases.

All estimates so far are unweighted. In column (8), the same regression as in column (7) is performed, but weighted by firm sales prior to the change in the oil price: a 1 pp increase in the weighted oil price leads to a 0.112 pp increase in the labor share. So (i) larger firms seems to report a higher adjustment, and (ii) unweighted estimates provide more conservative results. Unless otherwise stated, all the following results are unweighted.

In column (9), the dependent variable is the change in productivity measured as the change in (deflated) value added per capita. A 1 pp change in the weighted oil price leads to a 48€ (in 2000 euros) decrease in productivity per capita. The value-added contraction is not accompanied by a contraction in the number of employees. In column (10), the same regression as in column (9) is performed, but weighted by firm sales prior to the change in the oil price: a 1 pp increase in the weighted oil price leads to a 66€ decrease in productivity per capita.

So far, I have focused on the value-added contraction. An analysis of the dynamics of other costs shows that the adjustment to rising raw material costs is mainly made through value added. As an example, column (11) shows the change in external staff and outsourcing costs per unit of sales. It is of second-order magnitude

compared to the contraction in value added (-0.009 vs -0.037). The coefficient magnitude of other components has a similar ranking (-0.012 for goods purchases, and -0.028 for "other costs", for which I have no information in terms of content).

So far I have shown that the value-added allocation changes in response to oil price shocks: (i) the net profit margin (net of dividend) bears the brunt of the adjustment, and (ii) dividends and the wage bill are less affected (more rigid) than the net profit margin.

In the next section, I test the extent to which these results depend on firms' size.

3.2 Breaking down the impact by firm size

Table (3) reports the same regressions as Table (2) except that the main variable of interest is now broken down by firm size. Firm size is defined through a yearly segmentation of the sales distribution in the spirit of Covas and Den Haan (2011) and Lé and Vinas (2024), based on quartiles. The last quartile is, however, broken down to isolate the 10% largest companies, to take account of the very singular behavior of the largest firms. The size breakdown is as follows: [p0-p25),[p25-p50), [p50-p75), [p75-p90), [p90-p100]. The size taken to be the one prior to the shock.

As reported in column (1) of Table (3), the impact of a weighted oil price increase on raw material costs per unit of sales ranges from +0.068 to + 0.097, but with no continuous pattern by firm size. Note, however, that the highest increase in the raw material costs is reported for the largest firm sizes. This is consistent with the fact that the largest firms report the highest raw material costs per unit of sales compared to other firm sizes (see Section 2).

Column (2) highlights a clear monotonic trend in value added by firm size: the

larger the firm, the larger the value-added contraction. The range is from -0.019 for the 25% smallest firms to -0.048 for the top largest firms. To better understand the mechanism behind that result, I added the dynamic of external staff and outsourcing costs in column (9). This ratio highlights a monotonously decreasing contraction: the larger the firm, the smaller the contraction in external staff costs. So the shock results in a choice being made between cost components and the value added. For some firms, the raw material cost increase results in the adjustment of external staff costs and a limited impact on the value added created by the firm. This mechanism is particularly true for the smallest firms, and, to a lesser extent, for the second quartile of firms (i.e.[p25-p50)). But the mechanism vanishes for the largest firms –they do not adjust their external staff costs, leading to a stronger adjustment of value added for the largest firms than for the smallest firms. Other channels (goods purchases, other costs) play a second order role. One reason for this difference by firm size may be linked to the weight of (internal and external) staff costs: for largest firms, this component is much smaller than for smallest firms, this may limit adjustment opportunities via this channel. For smaller firms, however, (internal and external) staff costs are very large, leaving the room for adjustment.

Breaking down the value added allocation highlights other interesting patterns. As reported in column (3), when the oil price increases, the change in the wage bill per unit of sales decreases with firm size: the wage bill per unit of sales increases for the smallest firms (+0.025) and decreases for the largest ones (-0.011). That dynamic is essentially driven by the dynamic of sales. In columns (10)-(12), the dependent variables are respectively the growth rate of the firm's sales, real wage, and headcount. As reported, when the oil price increases, the firm's sales increase,

and the larger the firm, the larger the increase. This could be linked to greater pricing power of largest firms. The wage bill also increases, but at a slower pace: the real wage is almost unchanged while the headcount increases for the largest firms, but at a slower pace. So it is the increase in sales that drives the decrease in the wage bill per unit of sales for the largest firms. As the largest firms are major consumers of raw materials, and therefore highly exposed to rising raw material costs, the increase in headcount can be interpreted as a shift towards labor, as a means of adjusting to rising raw material prices: for example, to optimize the production process.

The dynamics of the profit margin (column (4)) and internal cash flow (column (5)) display no specific pattern, except that the biggest contraction in profit margin and internal cash flow is reported for the 25% smallest firms. This is the consequence of the increase in the wage bill per unit of sales for the smallest firms. In column (6), the contraction in the dividend per unit of sales increases with firm size, but remains more than half as large as the contraction in internal cash flow. So internal cash flow therefore remains the main channel for adjusting to the shock to value added, whatever the firm size.

Column (7) does not show a specific pattern in the dynamic of labor share by firm size. However, it should be noted that the impact is greatest for the largest companies. This is in line with the strong decrease in value added that large firms suffer due to their high reliance on raw materials. It is also consistent with the rise in the estimated coefficient when the estimate was weighted in Table 2 (see the former remark comparing columns (7) and (8) of Table (2) in Section 3.1).

As reported in column (8), the contraction in productivity increases with firm

size. When the oil price increases, there is no significant change in productivity for the smallest firms. But the larger the firm, the larger the productivity contraction. This is in line with the larger decrease in value added per unit of sales and the increase headcount (see column (12)): the largest firms tend to increase their headcount, while small firms do not. As large firms are strongly dependent on raw materials, when raw material costs increase, they might substitute labor for raw material inputs, leading to a decrease in their productivity compared to the smallest firms.

All in all, depending on their size, firms adapt differently to an increase in raw material costs. The smallest firms reduce their external staff costs to preserve their value added and their workforce, with no significant impact in terms of productivity, but a high impact on their profit margin. Conversely, the largest firms seem to substitute labor for raw material inputs when raw material costs increase, partly because of their heavy dependence on raw materials, leading to a fall in productivity.

3.3 Are the effects long-lasting?

To what extent do oil shocks have lasting effects? To answer that question, in Table (4), I carry out the same regressions as in columns (2), (7) and (9) of Table (2), that is for value added, labor share, and productivity, but I now consider a different time horizon. In the first three columns of Table (4) I report the former results for value added, the labor share and productivity, and then analyze the impact of an oil shock increase at one year (columns (4) to (6)), two years (columns (7) and (9)), three years (columns (10) and (12)), and four years (columns (13) and (15)) after the oil price increase.

As shown in columns (1), (4), (7), (10) and (13), a rise in oil prices leads to a contraction in value added per unit of sales for up to 3 years after the shock. The coefficient for the value-added contraction reaches its peak after two years and vanishes 4 years after the shock. This is undoubtedly linked in part to the time it takes to renew long-term contracts, which may protect the firm in the short term when a shock occurs, but commits it for some time.

The results on labor share (in columns (2), (5), (8), (11) and (14)) and on the productivity (in columns (3), (6), (9), (12) and (15)) show similar time effects. There is a significant increase in the labor share and decrease in productivity up to 3 years after the shock. The peak is reached after one year for productivity and two years for labor share. The coefficients start to decrease after 2 years for productivity, and 3 years for labor share. All coefficients become insignificant 4 years after the shock.

3.4 What is the impact of commodity cost shocks on payment defaults?

The previous sections show that, in the event of an oil price increase, the increase in raw material costs leads to an adjustment that primarily takes the form of a contraction in the internal cash flow component, rather than a fall in the wage bill or the dividend. Ultimately, are there any real effects? To what extent does it have an impact on the company's default risk?

In the present section, I test to what extent the increase in a firm's raw material

costs impacts its default risk, relying on the following linear probability model:

$$Default_{f,t} = \Delta\Big(\frac{RM}{SA}\Big)_{f,t-1} \times \Big[\beta + \rho \times \mathbb{1}_{(\frac{RM}{SA})_{f,t-1}>0}\Big] + X_{t-2} + \alpha_f + \gamma_{s,t} + \epsilon_{f,t} \quad (3)$$

where $\Delta X_{f,t} = X_{f,t} - X_{f,t-1}$, α_f are firm fixed effects, $\gamma_{s,t}$ are industry-year fixed effects, and $X_{f,t-2}$ are a set of controls similar to the ones in Equation (1). The dependent variable $Default_{f,t}$ is a dummy set to one if the firm defaults on its suppliers in year t and zero otherwise. The main variable of interest is the change in raw material costs per unit of sales, $\Delta\Big(\frac{RM}{SA}\Big)_{f,t-1}$ interacted with a dummy set to one for a positive change. So the analysis now covers now both positive and negative cost shocks. To test whether an increase in commodity costs constitutes forward-looking information on the firm's failure, the commodity cost shock is shifted forward by one year in order to test the one-year forecasting potential of that variable.

As in the former regressions, firm and industry-year fixed effects are set, along with control variables, X_{t-2}, namely: the firm's cash holdings, leverage and size. Note that here, for consistency, the control variables are two-year-lagged. In addition to this, starting from the year 2004, a credit rating is available at firm level. An additional control is therefore added, again with a two-year time lag, restricting the sample to the period 2006-2019.

The results are reported in Table (5). In column (1), only the main variable of interest is set in the model. As reported, a one-standard-deviation increase in a firm's commodity costs leads to a 16.4% (=13.4%*3.8%/3.2%) increase in its payment default probability.[3] In column (2), the main control variables are added.

[3]On whole dataset of 233,106 observations, the average the default probability is 3.2% over the period 2000-2019 and the standard deviation of the change in the ratio of raw material costs per

In column (3), the analysis is restricted to firms that had not defaulted in the previous year. In column (4), the credit rating is added. As that information is two-year-lagged and available only starting from 2004, then the period considered is restricted to 2006-2019. The main variable of interest remains economically and statistically significant. An increase in a firm's commodity costs per unit of sales in year $t-1$ leads to a higher default probability in year t: a one-standard-deviation increase in a firm's commodity costs leads to a 13.0% (=6.5%*3.8%/1.9%) increase in its payment default probability.

3.5 Robustness tests

3.5.1 Breaking down the analysis by sector energy-intensity

I break down the analysis into energy-intensive and low-energy-intensive sectors based on the "energy consumption to value added" ratio (see INSEE, 2023a). In France, the four most energy-intensive sectors are metallurgy, the paper and board industry, the chemical industry and the manufacture of other non-metallic products. I consider the first four because they are quite homogeneous in terms of energy consumption ratios, while the fifth (manufacture of wood and wood products) and the sixth (food industry) are around ten times less intensive than the first and around three to four times less than the fourth.

The results, provided in Table 6, are similar to those in the main Table 2, both for energy-intensive and low-energy-intensity sectors. But the magnitude of coefficients is stronger for energy-intensive sectors (see Table 6), about twice as large in terms of productivity decrease.

unit of sales is 3.8% (see Table (1).

3.5.2 Challenging the instrument variable

Placebo test. The main argument of the identification strategy (see Section 7.1 for more details) relies on the central role of fossil resources in the price of fossil *and* non-fossil raw materials, as reported in the literature on food (Pimentel, Patzek, and Cecil, 2007) or non-food (Kim et al., 2021, p.198) raw materials, causing shocks to fossil commodity price to impact all manufacturing sectors.

To challenge the role of fossil commodities compared to other commodities, in the present work I propose a placebo test where the shift-share instrument is built on shocks from other commodities. To do this, I focus on the food industry with the following intuition: the raw materials consumed by the food industry are essentially agricultural and energy-related (e.g. for heating/cooling purposes), rather than mineral resources. I therefore expect a shift-share instrument based on the spot price of agricultural commodities to explain changes in raw material costs per unit of sales at firm level in the food industry. On the other hand, I expect a weak or insignificant effect for mineral raw material prices on the raw material costs of those firms.

The results are reported in Table 7 where the same regression as the one in column (1) of Table 2 is carried out for different commodities: food (columns (2) and (3)), and minerals (columns (4) and (5)). As there are many possible choices of commodity, I prefer price indexes when they are available, for example the oilseed price index (column (2)) rather than a specific oilseed like sunflower or rapeseed. However, there is no cereal index in my database of input prices for French firms, so I choose the price of corn (column (1)), as corn is the most widely produced cereal

in the world (FAO, 2023). In column (3), the main variable of interest is the index price of minerals, and in column (4), the main variable of interest is the index price of ferrous metals.

As expected, the coefficients reported for food commodities are positive and significant, while the coefficients reported for mineral commodities are insignificant. Of course I could report results for further price indexes, and, indeed, some mineral commodities report a significant and (weakly) positive coefficient (0.023 for non-ferrous mineral price index), but, for the majority of mineral commodities that I tested, the coefficients are insignificant.

Challenging the Brent crude oil price. The main instrument used relies on the Brent crude oil price in euro. I challenge that instrument by relying on the Brent crude oil price in dollars (see column (6) of Table 7), or on other markets like Diesel-Domestic heating oil (traded in Rotterdam, see column (5) of Table 7), the Fuel Oil index in euro (traded in Singapore) or other fossil price indexes. They *all* provide similar (significant and positive) results (see the selection of results in columns (5) and (6) of Table 7).

Additional remarks I focus my analysis on positive shocks because they offer clear results. However, an analysis of negative shocks yields no clear pattern but more contrasting results. Contrasting results between price increases and decreases have also been documented in previous analyses (e.g. Lafrogne-Joussier, J. Martin, and Mejean, 2023).

4 Conclusion

This document shows that commodity price volatility can significantly impact macroeconomic dynamics (labor share, productivity) and jeopardize the survival of companies. This paper also shows the link between the commodity price, the value-added allocation and the risk of business failure, highlighting the interplay of key policy issues: the distribution of value added created by companies, climate and energy challenges, and financial stability.

But this work also calls for further analysis: to what extent does the amplitude of the shock (such as the energy crisis of 2022) or the uncertainty over commodity prices modify these results? Or, what would be the impact in an economy with a more flexible labor market?

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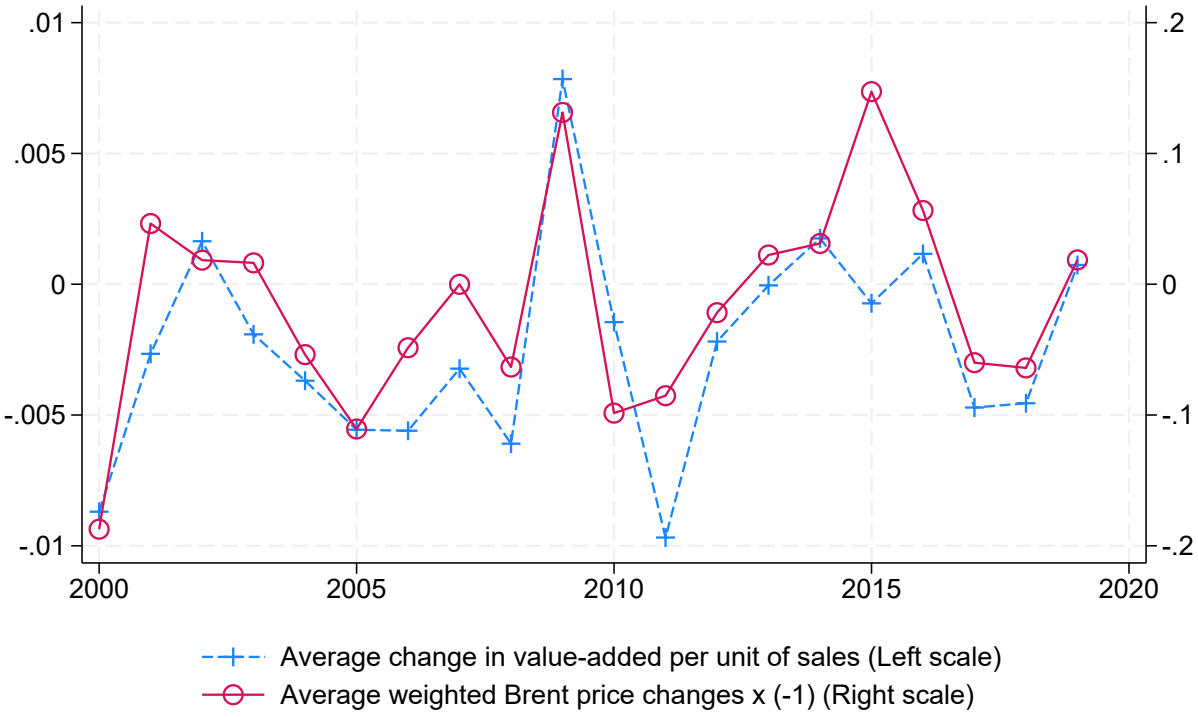
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5 Figure

Figure 1: Yearly average Bartik instrument and change in firm value added over the 2000-2019 period. The Bartik instrument is reported with a "times-minus-one" transformation in order to highlight the negative correlation between both measures.



6 Tables

Table 1: Descriptive Statistics (all prices are in 2000 euros)

Panel A	p10	p25	p50	Mean	p75	p90	SD	N
Sales (M€)	1.1	1.7	3.7	13.3	10.5	31.4	31.2	128,805
Employees	9	15	29	73.3	66	172	144.9	128,805
Raw material costs / Sales	9.6%	19.8%	32.1%	33.0%	45.3%	56.9%	17.8%	128,805
Wage bill / Sales	12.7%	18.8%	26.7%	28.0%	36.0%	45.0%	12.3%	128,805
External staff and outsourcing costs/ Sales	0.3%	1.7%	5.1%	7.9%	11.2%	19.6%	8.3%	128,805
Value added / Sales	17.6%	24.8%	33.6%	34.4%	43.2%	52.2%	13.2%	128,805
Labor share (=Wage bill/VA)	56.9%	69.5%	81.9%	81.6%	92.1%	102.4%	20.9%	128,805
Gross average wage (K€)	21.5	24.8	29.0	30.2	34.3	40.3	7.7	128,805
Productivity (K€/capita)	23.7	29.0	36.1	39.8	46.3	59.8	16.9	128,805
Profit margin	-0.8%	2.4%	5.7%	6.4%	9.9%	14.9%	6.7%	128,805
Change in raw material costs /Sales (p.p.)	-3.8%	-1.4%	0.3%	0.4%	2.3%	4.8%	3.8%	128,805
Change in value added /Sales (p.p.)	-5.2%	-2.7%	-0.4%	-0.5%	1.8%	4.2%	4.0%	128,805
Change in wage bill/Sales (p.p.)	-4.3%	-2.0%	-0.2%	-0.3%	1.4%	3.5%	3.4%	128,805
Change in profit margin (p.p.)	-5.2%	-2.4%	-0.1%	-0.2%	2.1%	4.9%	4.4%	128,805
Change in cash flow/Sales (p.p.)	-5.4%	-2.4%	-0.1%	-0.2%	2.1%	5.0%	4.6%	128,805
Change in dividend payment/Sales (p.p.)	-1.7%	-0.1%	0.0%	0.0%	0.0%	1.6%	2.2%	128,805
Lag(Cash holdings/Total assets)	0.2%	1.9%	8.1%	13.3%	20.6%	34.8%	14.2%	128,805
Lag(Equity/TA)	14.7%	27.3%	41.6%	41.1%	56.2%	67.9%	20.9%	128,805
Lag(Log(TA))	6.5	7.0	7.8	8.1	8.9	10.0	1.4	128,805
Weighted Brent price increase	0.0%	2.4%	5.7%	7.0%	9.7%	14.8%	6.4%	128,805
Payment default (2000-2019)	0	0	0	3.1%	0	0	17.4%	128,805

Panel B: Average values by firm size (quantile of sales)	[p0-p25)	[p25-p50)	[p50-p75)	[p75-p90)	[p90-p100]
Sales (M€)	1.2	2.4	6.0	17.5	79.9
Employees	12.6	22.0	43.8	107.7	361.2
Raw material costs / Sales	26.1%	30.1%	34.6%	39.1%	42.5%
Wage bill / Sales	35.7%	30.7%	25.5%	22.1%	19.0%
External staff and outsourcing costs / Sales	6.7%	8.1%	8.8%	8.2%	7.0%
Value added / Sales	42.1%	37.0%	32.0%	28.4%	25.3%
Labor share (=Wage bill/ Value added)	85.2%	83.3%	80.3%	78.8%	77.0%
Gross average wage (K€)	29.3	29.4	29.9	30.9	33.8
Productivity (K€/capita)	36.0	37.7	40.2	43.0	48.3
Profit margin	6.4%	6.3%	6.5%	6.3%	6.3%

Table 2: Impact of weighted Brent price increase on raw material costs, value-added allocation and labor share

$$\Delta y_{f,t} = \beta \times Z_{f,t} + X_{t-1} + \alpha_f + \alpha_{s,t} + \epsilon_{f,t} \quad (1)$$

- with $y_{f,t} \in \left\{ \left(\frac{RM}{SA}\right)_{f,t}; \left(\frac{VA}{SA}\right)_{f,t}; \left(\frac{W}{SA}\right)_{f,t}; \left(\frac{P}{SA}\right)_{f,t}; \left(\frac{CF}{SA}\right)_{f,t}; \left(\frac{D}{SA}\right)_{f,t}; \left(\frac{W}{VA}\right)_{f,t}; \left(\frac{VA}{N}\right)_{f,t} \right\}$, and $X_{f,t-1}$ a set of controls

	Raw material costs/Sales	Value-added/Sales and its breakdown					Labor share		Productivity		Ext. staff & outs.
Dependent	$\Delta(RM/SA)$	$\Delta(VA/SA)$	$\Delta(W/SA)$	$\Delta(P/SA)$	$\Delta(CF/SA)$	$\Delta(D/SA)$	$\Delta(W/VA)$	$\Delta(W/VA)$	$\Delta(VA/N)$	$\Delta(VA/N)$	$\Delta(OW/SA)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Weighted Brent price changes	0.086***	-0.037***	0.001	-0.038***	-0.030***	-0.008***	0.082***	0.112**	-4.761***	-6.589**	-0.009***
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.003)	(0.019)	(0.046)	(1.037)	(2.777)	(0.003)
lag(Cash holdings/TA)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
lag(Leverage)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
lag(log(TA))	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805
No firms	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commodity price change	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0
Firm level cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weighted est. (sales in $t-1$)	.	.	.	.	.	.	.	Yes	.	Yes	.
R-squared	0.175	0.164	0.196	0.186	0.164	0.129	0.188	0.199	0.188	0.223	0.162

This table reports the same analysis as Table (2) but now the sample is restricted to strictly positive increases in Brent crude oil prices. The identification strategy is detailed in Section 7.1. Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

Table 3: Impact of positive Brent shocks on value-added allocation by firm size

	Raw m. costs/Sales	Value-added/Sales and its breakdown					Labor share	Productivity	Ext. staff & o.	Sales (g.r.)	Real wage (g.r.)	Headcount (g.r.)
Dependent	$\Delta(RM/SA)$	$\Delta(VA/SA)$	$\Delta(W/SA)$	$\Delta(P/SA)$	$\Delta(CF/SA)$	$\Delta(D/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$	$\Delta(OW/SA)$	$gr(SA)$	$gr(w)$	$gr(L)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Weighted oil shocks×Lagged-Size[p0-p25)	0.083***	-0.019**	0.025***	-0.044***	-0.040***	-0.003	0.081***	-2.131	-0.024***	0.001	0.042*	-0.009
	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.004)	(0.028)	(1.471)	(0.005)	(0.025)	(0.024)	(0.024)
Weighted oil shocks×Lagged-Size[p25-p50)	0.068***	-0.019***	0.011**	-0.031***	-0.025***	-0.005	0.058**	-2.001	-0.014***	0.037*	0.019	0.029
	(0.007)	(0.006)	(0.005)	(0.007)	(0.007)	(0.003)	(0.024)	(1.333)	(0.004)	(0.022)	(0.019)	(0.020)
Weighted oil shocks×Lagged-Size[p50-p75)	0.081***	-0.036***	0.002	-0.038***	-0.030***	-0.008**	0.088***	-4.109***	-0.009**	0.069***	-0.003	0.049***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.003)	(0.024)	(1.247)	(0.004)	(0.019)	(0.016)	(0.017)
Weighted oil shocks×Lagged-Size[p75-p90)	0.095***	-0.046***	-0.005	-0.042***	-0.033***	-0.008***	0.080***	-6.606***	-0.004	0.075***	-0.023	0.040**
	(0.006)	(0.006)	(0.004)	(0.006)	(0.006)	(0.003)	(0.026)	(1.334)	(0.004)	(0.020)	(0.015)	(0.017)
Weighted oil shocks×Lagged-Size[p90-p100]	0.097***	-0.048***	-0.011**	-0.037***	-0.027***	-0.011***	0.096***	-6.402***	-0.005	0.126***	-0.003	0.042**
	(0.007)	(0.006)	(0.004)	(0.006)	(0.007)	(0.003)	(0.028)	(1.446)	(0.004)	(0.021)	(0.014)	(0.017)
lag(Cash holdings/TA)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
lag(Leverage)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
lag(log(TA))	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
dummy on firm size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,805	128,408	128,805
No firms	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,297	23,238	23,297
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commodity price change	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0
Firm level cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.176	0.167	0.207	0.188	0.165	0.129	0.189	0.191	0.163	0.302	0.151	0.252

This table reports the same analysis as Table (2) but now the sample is restricted to strictly positive increases in Brent crude oil prices. The identification strategy is detailed in Section 7.1. Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

Table 4: Impact of positive Brent shocks on value-added allocation by time horizon

Shock impact at the ...	Contemporaneous			One-year after the shock			Two-year after the shock			Three-year after the shock			Four-year after the shock		
Dependent	$\Delta(VA/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$	$\Delta(VA/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$	$\Delta(VA/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$	$\Delta(VA/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$	$\Delta(VA/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Weight. Brent price change	-0.037***	0.082***	-4.761***	-0.038***	0.093***	-5.991***	-0.040***	0.127***	-3.382**	-0.024***	0.082***	-3.957**	0.007	-0.051*	1.321
	(0.005)	(0.019)	(1.037)	(0.006)	(0.024)	(1.301)	(0.007)	(0.028)	(1.495)	(0.008)	(0.030)	(1.687)	(0.008)	(0.029)	(1.669)
lag(Cash holdings/TA)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
lag(Leverage)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
lag(log(TA))	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128,805	128,805	128,805	127,922	127,645	128,085	118,771	118,462	118,982	112,583	112,216	112,772	107,816	107,441	108,007
No firms	23,297	23,297	23,297	23,151	23,115	23,155	21,457	21,412	21,453	20,238	20,188	20,238	19,225	19,182	19,235
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commodity price change	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0
Firm level cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.164	0.188	0.188	0.250	0.279	0.285	0.299	0.309	0.329	0.325	0.331	0.355	0.352	0.359	0.378

This table reports the same analysis as Table (2) but now the sample is restricted to strictly positive increase in Brent crude oil prices. The identification strategy is detailed in Section 7.1. Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

Table 5: Impact of commodity costs increases on firms' payment default

$$Default_{f,t} = \beta \times \Delta\Big(\frac{CC}{SA}\Big)_{f,t-1} + X_{t-2} + \alpha_f + \gamma_{s,t} + \epsilon_{f,t} \quad (3)$$

where $X_{f,t-2}$ is a set of controls.

Dependent	Payment Default			
	(1)	(2)	(3)	(4)
lag(Change in RM/SA)	-0.041*	-0.016	-0.022	-0.001
	(0.021)	(0.021)	(0.019)	(0.022)
lag(Change in RM/SA) × Dummy increase in RM/SA	0.134***	0.115***	0.092***	0.065*
	(0.033)	(0.033)	(0.030)	(0.035)
Dummy Increase in CC/SA	Yes	Yes	Yes	Yes
Two-year lag(Cash holdings/TA)		Yes	Yes	Yes
Two-year lag(Leverage)		Yes	Yes	Yes
Two-year lag(log(TA))		Yes	Yes	Yes
Two-year lag(Low Credit Rating)				Yes
Constant	Yes	Yes	Yes	Yes
Observations	233,106	230,505	223,106	148,421
No firms	26,499	26,302	25,865	20,376
Industry-Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Starting from	2000	2000	2000	2006
Firm level cluster	Yes	Yes	Yes	Yes
No default in the previous year			Yes	Yes
R-squared	0.272	0.273	0.202	0.238

I test to what extent the increase in a firm's commodity costs impact its default risk, relying on a linear probability model: the dependent variable is the firm's payment default. The dependent variable $Default_{f,t}$ is a dummy set to one if the firm defaults on its suppliers in year t and zero otherwise. Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

Table 6: Impact of positive oil price shocks by energy intensity

	Raw m. costs/Sales	Value-added/Sales and its breakdown			Labor share	Productivity
Dependent	$\Delta(RM/SA)$	$\Delta(VA/SA)$	$\Delta(W/SA)$	$\Delta(P/SA)$	$\Delta(W/VA)$	$\Delta(VA/N)$
	(1)	(2)	(3)	(4)	(5)	(6)
Weighted Brent price shocks ×"energy intensive"	0.093***	-0.055***	0.010	-0.065***	0.163***	-9.121***
	(0.011)	(0.011)	(0.008)	(0.012)	(0.050)	(3.239)
Weighted Brent price shocks ×"non-energy intensive"	0.085***	-0.034***	-0.001	-0.033***	0.067***	-3.965***
	(0.005)	(0.005)	(0.004)	(0.005)	(0.021)	(1.061)
lag(Cash holdings/TA)	Yes	Yes	Yes	Ye	Yes	Yes
lag(Leverage)	Yes	Yes	Yes	Yes	Yes	Yes
lag(log(TA))	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128,805	128,805	128,805	128,805	128,805	128,805
No firms	23297	23297	23297	23297	23297	23297
Commodity price change	> 0	> 0	> 0	> 0	> 0	> 0
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm level cluster	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.175	0.164	0.196	0.186	0.188	0.188

This table reports the same analysis as Table (2) but now the sample is restricted to strictly positive increase in Brent crude oil prices. The identification strategy is detailed in Section 7.1. Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

Table 7: Challenging the instrument variable

	Food raw materials		Mineral raw materials		Fossil raw materials	
Dependent	$\Delta(RM/SA)$	$\Delta(RM/SA)$	$\Delta(RM/SA)$	$\Delta(RM/SA)$	$\Delta(RM/SA)$	$\Delta(RM/SA)$
	(1)	(2)	(3)	(4)	(5)	(6)
Weighted corn price changes	0.042***					
	(0.008)					
Weighted oilseeds price changes		0.098***				
		(0.012)				
Weighted minerals price changes			-0.013			
			(0.012)			
Weighted ferrous metals price changes				0.001		
				(0.006)		
Weighted diesel-domestic heating oil price changes					0.059***	
					(0.006)	
Weighted Brent oil (dollar) price changes						0.080***
						(0.011)
lag(Cash holdings/TA)	Yes	Yes	Yes	Yes	Yes	Yes
lag(Leverage)	Yes	Yes	Yes	Yes	Yes	Yes
lag(log(TA))	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,557	15,358	12,433	16,587	15,607	15,440
No firms	2,799	2,841	2,648	2,745	2,869	2,832
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Commodity price change	> 0	> 0	> 0	> 0	> 0	> 0
Firm level cluster	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.197	0.204	0.211	0.174	0.189	0.183

This table reports the same analysis as Table (2) but now the sample is restricted to strictly positive increase in Brent crude oil prices. The identification strategy is detailed in Section 7.1. Standard errors, reported in parentheses, are clustered at firm level. ***, **, * indicate significance levels at 1%, 5% and 10%.

7 Appendix

7.1 Conceptual framework

Based on an accounting identity, the value added of firm f in the year t, noted $VA_{f,t}$, can be defined as the firm's sales $SA_{f,t}$ net of its raw material costs, $RM_{f,t}$, and other costs $OC_{f,t}$.

$$VA_{f,t} \equiv SA_{f,t} - RM_{f,t} - OC_{f,t} \tag{4}$$

Dividing by sales and taking the first difference enables us to explain changes in the value added with changes in the raw materials costs. Equation (5) is then derived to relate shocks to the weight of raw materials in the production process to changes in value added per unit of sales:

$$\Delta\Big(\frac{VA}{SA}\Big)_{f,t} = \alpha_{VA} + \beta_{VA} \times \Delta\Big(\frac{RM}{SA}\Big)_{f,t} + \epsilon_{f,t} \tag{5}$$

Since (i) the value added is allocated between wage bill $W_{f,t}$ and profit $P_{f,t}$; and (ii) profit can be broken down into the dividend $D_{f,t}$ and a residual part, hereafter called *net cash flow* $CF_{f,t}$, so a set of equations relating shocks to raw material costs to changes in the value-added components can be written as:

$$\begin{cases} \Delta\Big(\frac{W}{SA}\Big)_{f,t} = \alpha_W + \beta_W \times \Delta\Big(\frac{RM}{SA}\Big)_{f,t} + \epsilon_{W,f,t} & \text{(6a)} \\ \Delta\Big(\frac{CF}{SA}\Big)_{f,t} = \alpha_{CF} + \beta_{CF} \times \Delta\Big(\frac{RM}{SA}\Big)_{f,t} + \epsilon_{CF,f,t} & \text{(6b)} \\ \Delta\Big(\frac{D}{SA}\Big)_{f,t} = \alpha_D + \beta_D \times \Delta\Big(\frac{RM}{SA}\Big)_{f,t} + \epsilon_{D,f,t} & \text{(6c)} \end{cases}$$

So far, this framework measures the sensitivities of value-added components to raw material shocks. But the framework is not causal.

To tackle the endogeneity issue, I rely on a shift-share (Bartik) instrument. To build that instrument, I first write the ratio $\left(\frac{RM}{SA}\right)_{f,t}$ as the sum of costs related to each raw material input of the firm, scaled by sales:

$$\Big(\frac{RM}{SA}\Big)_{f,t} = \frac{\sum_c^C [p_{c,f,t} \times q_{c,f,t}]}{SA_{f,t}} \tag{7}$$

Where $p_{c,f,t}$ is the price and $q_{c,f,t}$ the quantity of input c purchased by the firm f at time t, and C is the set of inputs.

Then the change in raw material costs per unit of sales between $t-1$ and t can be written as:

$$\Delta\Big(\frac{RM}{SA}\Big)_{f,t} = \sum_c^C \Big[\Big(\frac{p_{c,f,t-1} \times q_{c,f,t-1}}{SA_{f,t-1}}\Big) \times gr(p_{c,f,t})\Big] + \sum_c^C \Big[p_{c,f,t-1} \times \Delta\Big(\frac{q_{c,f,t}}{SA_{f,t}}\Big)\Big] \tag{8}$$

On the right hand side of Equation (8), the ratio $\frac{p_{c,f,t-1} \times q_{c,f,t-1}}{SA_{f,t-1}}$ is the raw material costs per unit of sales paid by firm f for a given raw material c at time $t-1$ (that is, prior to the change in the price of raw material c), and $gr(p_{c,f,t})$ is the price change that firm f faces for raw material c between $t-1$ and t. The second term

of Equation (8) represents the firm's adjustments via input quantities and output prices and quantities.

The price change of the input c, namely $gr(p_{c,f,t})$, might be idiosyncratic (e.g. related to firm's bargaining power) or exogenous, e.g. a supply side shock due to a shock on the supplier process like an increase in energy prices. Since the raw material production is highly dependent on fossil resources, whatever the raw material (fossil, agricultural or mineral products, see below), to focus on exogenous shocks, I concentrate the study on raw material shocks originating from the oil market.

That is, I assume there is a commodity, noted B (for Brent crude oil), whose price impacts the price of all other raw materials (this is documented in the literature metioned below), so, without loss of generality, Equation (8) is rewritten as:

$$\Delta\Big(\frac{RM}{SA}\Big)_{f,t} = \sum_{c}^{C} \Big[\Big(\frac{p_{c,f,t-1} \times q_{c,f,t-1}}{SA_{f,t-1}}\Big) \times \rho_{c,B}\Big] \times gr(p_{B,t}) + e_{f,t} \tag{9}$$

where $\rho_{c,B}$ is the market price correlation between a given raw material c and commodity B, and $gr(p_{B,t})$ is the change in the spot price of that commodity between $t-1$ and t. Thus, $\rho_{c,B} \times gr(p_{B,t})$ is the change in raw material price c caused by the change in commodity B. Commodity B is assumed to be a global product whose price is independent of firm f.

The intuition behind this instrument is that, since the advent of the industrial revolution, fossil fuels have played an increasingly role in industrial production processes, causing the energy dependence to exceed direct energy consumption. For example in France, the three main energy-intensive industries are metallurgy, the

chemical industry, and the paper & board industries (INSEE, 2023b). This ranking of energy-intensive sectors is based on *direct* energy consumption, but says nothing about *indirect* dependence on energy. In practical terms, sectors with low energy consumption may still be highly dependent on energy prices if the price of their non-fossil inputs is highly sensitive to energy prices.

The production of non-fossil raw materials is indeed highly dependent on fossil resources. For example, growing corn, the most widely produced cereal in the world (FAO, 2023), requires a lot of energy and fossil resources (through fertilizers, machinery fuel, pesticides, irrigation etc.), and these rely mostly on oil and natural gas (Pimentel, Patzek, and Cecil, 2007). The same dependence exists for mineral production (see (Kim et al., 2021, p.198) for the case of copper).

To this end, I construct a shift-share instrument, $Z_{f,t}$, whose "share" part is the weight of raw materials in a firm's production process, measured as its raw material costs per unit of sales before the price change. Following the convention in that literature (Goldsmith-Pinkham, Sorkin, and Swift, 2020), the firm's exposure to the shock is the first value observed in the dataset (t_0). The "shift" part is the change in the spot price of crude oil, calculated *à la* Davis and Haltiwanger (1992) to take into account the fossil dependence of raw materials. The oil price considered is Brent crude oil, as this is the reference price in Western Europe. In this way, I do not consider all shocks affecting raw materials, but those originating from the oil market. So the shift-share instrument is:

$$Z_{f,t} = \left(\frac{RM}{SA}\right)_{f,t_0} \times gr\left(\text{Brent Spot Price}\right)_{c,t} \tag{2}$$