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Pass-through of rising production costs to the selling prices of non-financial corporations in 2022

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Rationale

The surge in energy and other commodity prices in 2021 H2 and a significant part of 2022 has led to firms' costs increasing considerably. This article analyses how this rise in costs has been passed through to selling prices and what impact it has had on firms' output, wages, employment and unit labour costs.

Takeaways

- On average, firms passed through a significant proportion of production cost increases to selling prices in 2022, albeit with a high degree of heterogeneity across sectors.
- In sectors that have historically seen more rigid pricing (proxied by lower price volatility), pass-through of rising costs to selling prices has been slower.
- Rising input prices directly cause selling prices and unit labour costs to grow. The latter is a consequence of the negative effect on labour productivity, owing to the adverse impact on output and the lack of an impact on personnel costs.
- In any case, these direct effects, which are stronger in the sectors most exposed to this shock, do not account for the indirect (general equilibrium) effects that influence all sectors.

Keywords

Production costs, selling prices, price rigidity, energy cost.

Códigos JEL

L11, D22, D24, Q43.

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PASS-THROUGH OF RISING PRODUCTION COSTS TO THE SELLING PRICES OF NON-FINANCIAL CORPORATIONS IN 2022

Introduction

In 2021 H2 tensions began to be felt as a result of commodity supply chain issues, which caused commodity prices to surge, particularly so for energy (oil and gas). These tensions continued and worsened in 2022 with the outbreak of the war in Ukraine, although they have recently begun to ease. This has driven up firms' production costs significantly, especially in terms of energy expenditure.

This article analyses the degree to which firms' mounting production prices have been passed through to their selling prices in recent years. The direct effects of rising input costs on production, wages, employment and labour productivity in Spanish firms are also explored.

Following this introduction, this article comprises three further sections. The first analyses the pass-through of unit production costs to selling prices in recent years for the most important sectors in the Spanish economy.[1] The second looks in greater detail at this pass-through in the industrial sector,[2] using data disaggregated by industrial sub-sector, allowing some of the heterogeneous effects to be identified. The final section quantifies the direct effects of rising input prices on other variables (turnover, productivity, employment, wages and unit labour cost, in particular), again using data disaggregated by industrial sub-sector.

It should be noted that the methodology used in this article rests on exploring changes across sub-sectors. This allows the estimation of the direct effects of rising production costs on, for example, selling prices and wages. However, the direct effects do not capture the indirect general equilibrium effects, which influence all economic sectors, regardless of how much they have been affected by rising production costs. Thus, for example, more expensive energy and other inputs drive up goods and services inflation, which generally exerts upward pressure on workers' wage demands as they attempt to mitigate loss of purchasing power, which can ultimately lead to widespread wage rises.

Pass-through of rising costs to selling prices: main sectors

According to the economic literature, the degree of pass-through of rising unit production costs (production costs per unit produced or sold) to selling prices depends on several factors, such as the sensitivity of supply (marginal costs) and demand to price fluctuations and the level of

1 A total of 14 sectors are analysed, disaggregated at section or division level, as set out in NACE Rev. 2.

2 The industrial sector has been used to analyse the heterogeneous effects, given that data are available for a high number of sub-sectors and equally detailed price data are also available.

competition in the final product market of the sector in question.[3] Pass-through can be measured either in absolute terms, by observing the extent to which a change in unit costs in euro has been passed through to selling prices in euro, or in relative terms, by comparing the rate of change of unit costs and selling prices (in other words, selling price elasticity with respect to unit costs). In both cases, complete pass-through is deemed to have occurred when the (absolute or relative) change in unit selling prices is equal to the change in costs, while a lower rate of change signifies partial or incomplete pass-through.

The concepts of absolute and relative pass-through are interrelated. Whenever the selling price is greater than the unit cost, which it normally is, complete relative pass-through means that selling prices in euro increase faster than unit costs in euro.[4] It therefore follows that if absolute pass-through is complete, relative pass-through will be incomplete, since selling prices rise by exactly the same amount as unit costs. If, in turn, relative pass-through is complete, absolute pass-through will be more than 100% (the price in euro rises more than the unit cost in euro).

Similarly, there is a direct connection between relative pass-through and profit margins. Complete relative pass-through entails the margin on sales (the ratio between gross ordinary profit[5] and net turnover) remaining constant,[6] while incomplete relative pass-through will see it fall. However, as long as the margin on sales remains positive and selling prices are rising, complete absolute pass-through means that the margin on sales shrinks.[7]

As noted earlier, looking at the margin on sales allows the degree of relative cost pass-through to be inferred, but such a method is insufficient for measuring absolute pass-through. Given that profit margins have been analysed in recent publications by the Banco de España and other analysts, this article's exploration of cost pass-through focuses on the concept of absolute pass-through, although some results are also discussed in terms of relative pass-through. Two periods are considered: the change between 2021 and 2022 and the change between 2019 and 2022.[8] In both cases, these

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3 In a final product market with perfect competition, a sector-level cost shock is passed through to selling prices to a greater degree if demand is less elastic and supply is more elastic. In less competitive markets, pass-through is also higher if demand sensitivity falls with declining demand. In theory, pass-through over 100% (more than complete) is possible if, against a backdrop of falling production, the sensitivity of demand to price fluctuations drops far enough and large economies of scale are in play (in this case, marginal costs rise if production declines). Lastly, there are many theoretical models that predict that the degree of pass-through rises with greater competition, since firms are then unable to absorb the cost increase entirely with margins. The exact degree to which the pass-through occurs will depend on the nature of strategic interactions between firms. See Ganapati, Shapiro and Walker (2020), Amiti, Itskhoki and Konings (2019) and Alvim et al. (2014) for more details.

4 This is because complete relative pass-through is the result of increases that are equal in percentage terms. When the same percentage change is applied to prices, the resulting increase is greater than that in the unit cost, since the latter are initially lower.

5 Gross ordinary profit is calculated as the difference between turnover and production costs.

6 The margin on sales, $m_{i,t}$, in sector i and period t can be expressed as $m_{i,t} = P_{i,t} / V_{i,t} = (P_{i,t} - C_{i,t}) / P_{i,t}$, where $P_{i,t}$ is the sector's gross operating profit, $V_{i,t}$ is turnover and $P_{i,t}$ and $C_{i,t}$ are the selling price and unit cost, respectively. If unit costs vary by a factor k in the period t + 1, $C_{i,t+1} = kC_{i,t}$, and there is complete relative pass-through to selling prices, then $P_{i,t+1} = kP_{i,t}$, which means that the margin on sales does not change:

$$m_{i,t+1} = (P_{i,t+1} - C_{i,t+1}) / P_{i,t+1} = (kP_{i,t} - kC_{i,t}) / kP_{i,t} = (P_{i,t} - C_{i,t}) / P_{i,t} = m_{i,t}$$

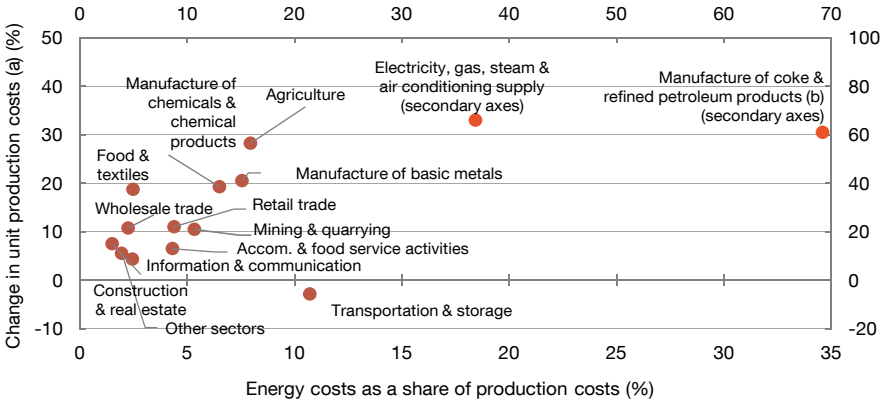
7 There is complete absolute pass-through to prices if $P_{i,t+1} - P_{i,t} = C_{i,t+1} - C_{i,t}$, or, in terms of the margin on sales, $m_{i,t+1} = m_{i,t} P_{i,t} / P_{i,t+1}$. Therefore, in an environment of rising prices, $P_{i,t+1} / P_{i,t} > 1$, the complete absolute pass-through to prices results in the margin on sales shrinking ($m_{i,t+1} < m_{i,t}$), provided the margin is positive, which generally holds true at sector level.

8 The shorter period (between 2021 and 2022) was chosen because it covers the steepest increase in energy prices. The longer period (comparing 2019 with 2022) was chosen to have a longer time horizon, allowing the long-term impacts to be analysed. 2019 was selected since it was unaffected by the pandemic, which could otherwise distort the conclusions.

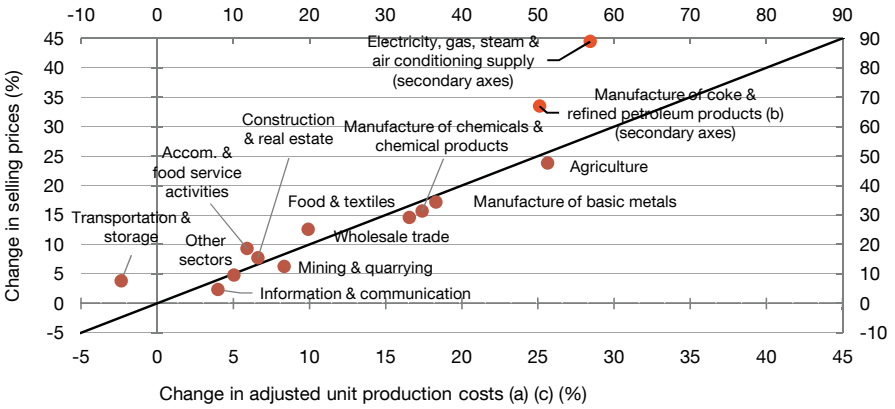
Chart 1

Pass-through of the increase in production costs to selling prices in the main sectors

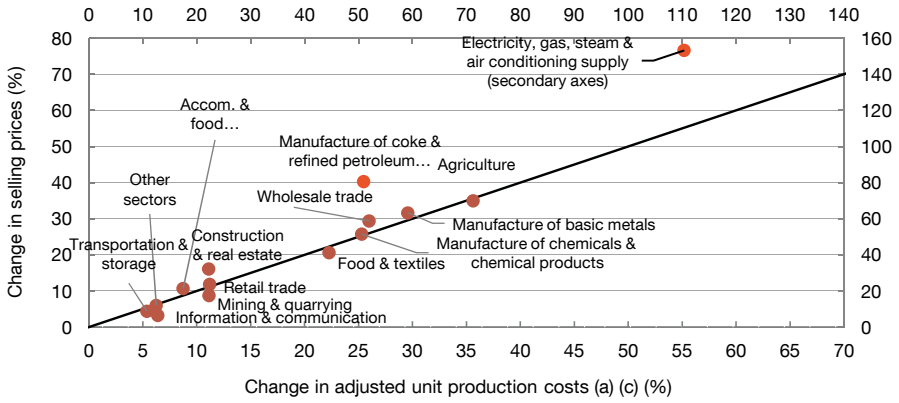
1.a Energy costs as a proportion of production costs vs. change in unit production costs between 2021 and 2022, by sector



1.b Change in selling prices relative to change in unit production costs between 2021 and 2022



1.c Change in selling prices relative to change in unit production costs between 2019 and 2022



SOURCES: AEAT and Banco de España.

a Production costs include inputs and wages.
b Including the wholesale trade of fuel.
c Adjusted for the ratio of costs to turnover in t-1.

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increases are calculated by taking an average of unit prices in the first and last years. The analysis is then performed using information on turnover, wages and employment from the Spanish tax authorities (AEAT), which contains quarterly data for more than a million firms, broken down by sector.

In order to analyse absolute cost pass-through, it was necessary to proxy unit prices both for the goods and services sold by firms and for the inputs used in the production process. Data on turnover from the tax authorities were used for unit selling prices, since these data series reflect how revenues have changed in both nominal and deflated terms. These deflated data series were used to calculate the change in unit selling prices (calculated as the gross growth rate in nominal turnover divided by the gross growth rate in deflated turnover) and unit production costs (growth rate in costs divided by growth rate in deflated turnover).

Chart 1.a compares the change in unit production costs[9] (including wages) between 2021 and 2022 with energy costs as a proportion of those production costs (proxied using input-output table data) for the main economic sectors. As expected, a positive relationship between the two variables can be seen, reflecting the sharp increase in the price of energy in this period, to such an extent that, in many cases, that increase was key in driving production costs in those more energy-intensive sectors.

For example, the manufacture of basic metals and the manufacture of chemicals and chemical products sub-sectors, both of which use vast amounts of energy in their production processes, saw a sharper increase in unit costs than other manufacturing sub-sectors. Similarly, unit production costs surged in the electricity, gas, steam and air conditioning supply and the manufacture of refined petroleum products sub-sectors since, in both cases, their main input is an energy-related commodity, which is also why such sub-sectors see these costs accounting for a larger relative share of total costs.

However, there are also some notable exceptions. The sector covering the manufacture of food products and the manufacture of textiles experienced steep increases in unit production costs in 2022, despite not being among the sectors for which energy accounts for a higher proportion of costs. This would indicate that these sectors use other commodities whose prices also rose sharply, partly as a result of more expensive energy,[10] which exerting severe upward pressure on their production costs. By contrast, it is noteworthy that the transportation and storage sector not only registered no increase in unit costs, even though its energy costs are significant, but actually saw unit costs drop somewhat between 2021 and 2022. This is partly because many transport firms with high fixed costs saw their unit fixed costs decrease – enabling them to absorb the increase in energy costs (a variable cost) in that period – as a result of their activity picking up dramatically in 2022 once the mobility restrictions were lifted. Nevertheless, it must be noted that some of the price indices used may contain measurement errors, meaning that the quantitative findings of the analysis must be treated with a degree of caution.

9 Unit production costs are calculated as the ratio between total costs (including supplies, other operating costs – both fixed and variable – and personnel costs) and the number of units produced (proxied by deflated nominal turnover).

10 In particular, the mounting price of gas has led to fertiliser price increases, which consequently cause food commodity prices to rise. For further details, see Borrallo, Cuadro-Sáez, Pacce and Sánchez (2023).

Charts 1.b and 1.c compare the rate of change of unit production costs with selling prices in two separate periods (2021-2022 and 2019-2022) in order to measure the pass-through of unit production costs to selling prices in the aforementioned sectors. Given that the pass-through is analysed in absolute terms, the percentage change in unit costs must be adjusted for their share of turnover.[11] The results show that pass-through was very high, almost complete (in absolute terms), in both the shorter (2021-2022) and longer period (2019-2022). This is because in most sectors the change in costs tracks that in selling prices very closely, such that, when plotted on a graph, the dot denoting that relationship lies very close to the 45-degree line. However, it should be noted that the electricity, gas, steam and air conditioning supply sector and the manufacture of refined petroleum products sector are above the diagonal line, indicating that in both cases and in both periods selling prices grew faster than their (adjusted) unit costs. The same phenomenon can be observed in the shorter period, although to a noticeably lesser extent (see Chart 1.b), in other sectors, such as the transportation and storage sector and the accommodation and food service activities sector. This high pass-through may be explained by the robust recovery in demand in 2022 in both sectors which, following the lifting of pandemic-related mobility restrictions, exerted pressure on selling prices. In the longer period (2019-2022, see Chart 1.c), along with the electricity, gas, steam and air conditioning supply sector and the manufacture of refined petroleum products sector, the wholesale trade and construction sectors raised selling prices relatively more than the increase in unit production costs. Nevertheless, the difference between the change in prices and costs in these two sectors is much more moderate than that seen in the electricity, gas, steam and air conditioning supply and manufacture of refined petroleum products sectors.

Pass-through of rising costs to selling prices: industrial sub-sectors

To analyse in greater detail the pass-through of costs to selling prices, we used more granular industrial sector data (at NACE Rev. 2 group level, excluding the manufacture of refined petroleum products).[12] This allows us to investigate the behaviour of the different industrial sub-sectors for which sound producer price data are also available (Industrial Price Index + Export Price Index of Industrial Products).[13] The use of more granular data also enables us to conduct an econometric analysis of the degree of cost pass-through and its determinants.

The three panels of Chart 2 replicate the same analysis as Chart 1 for the 90 industrial sub-sectors for which data are available. In this case, the cost of energy as a proportion of production

11 This is the case given that:

$$P_{i,2022} - P_{i,2021} \gtreqless C_{i,2022} - C_{i,2021} \Leftrightarrow \frac{(P_{i,2022} - P_{i,2021})}{P_{i,2021}} \gtreqless \frac{(C_{i,2022} - C_{i,2021})}{C_{i,2021}} \frac{Costs_{i,2021}}{Revenues_{i,2021}}$$

where $P_{i,t}$ and $C_{i,t}$ are unit prices and costs in sector i in period t.

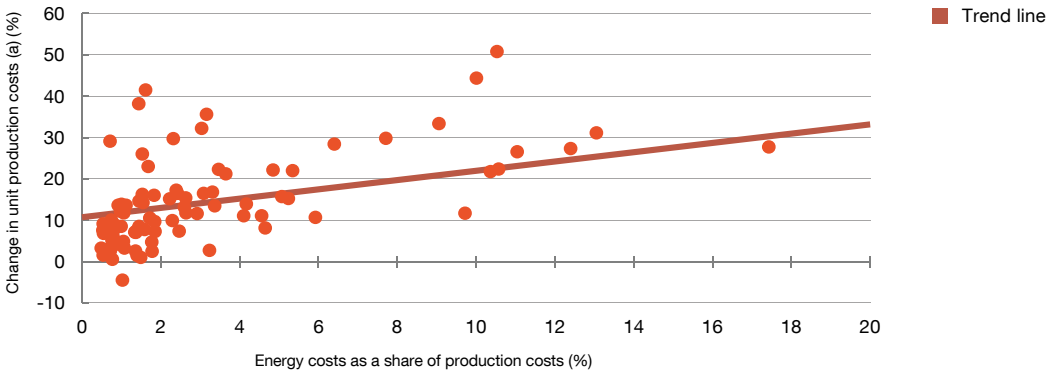
12 We excluded this sub-sector from this analysis as its activity differs greatly from that of the other industrial sub-sectors and since it has already been analysed separately above.

13 The time series Industrial Price Index + Export Price Index of Industrial Products (IPRI + IPRIX) aggregates two producer price indicators: one for the domestic market (IPRI) and another for the external market (IPRIX). The aggregate indicator thus measures the prices of industrial products manufactured in the domestic market and sold in both the domestic and the external market.

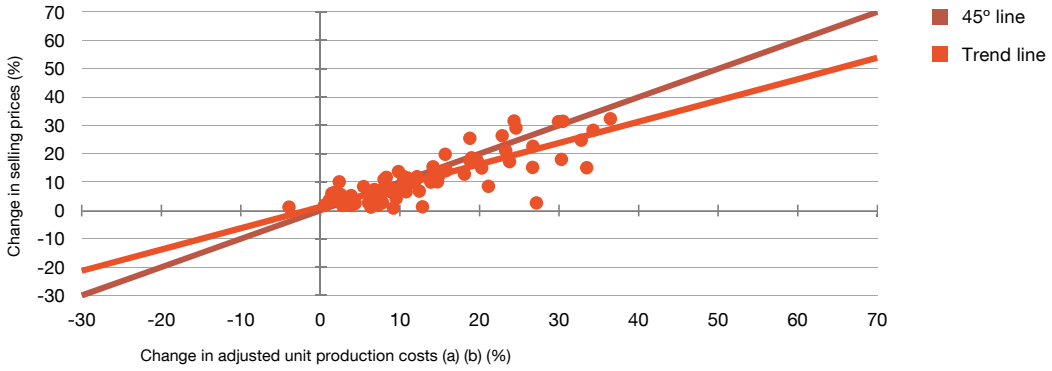
Chart 2

Pass-through of the increase in production costs to selling prices in the industrial sector

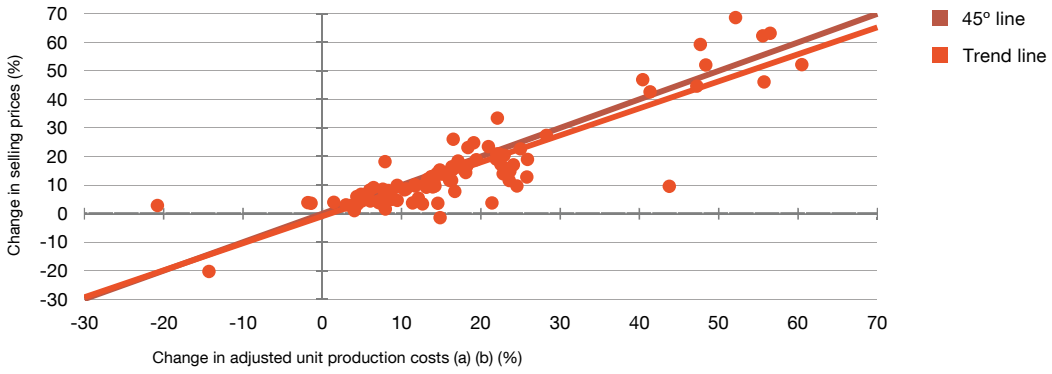
2.a Energy costs as a proportion of production costs vs. change in unit production costs between 2021 and 2022, by industrial sub-sector



2.b Change in selling prices relative to change in unit production costs between 2021 and 2022



2.c Change in selling prices relative to change in unit production costs between 2019 and 2022



SOURCES: AEAT, INE and Banco de España.

a Production costs include inputs and wages.
b Adjusted for the ratio of costs to turnover in t-1.

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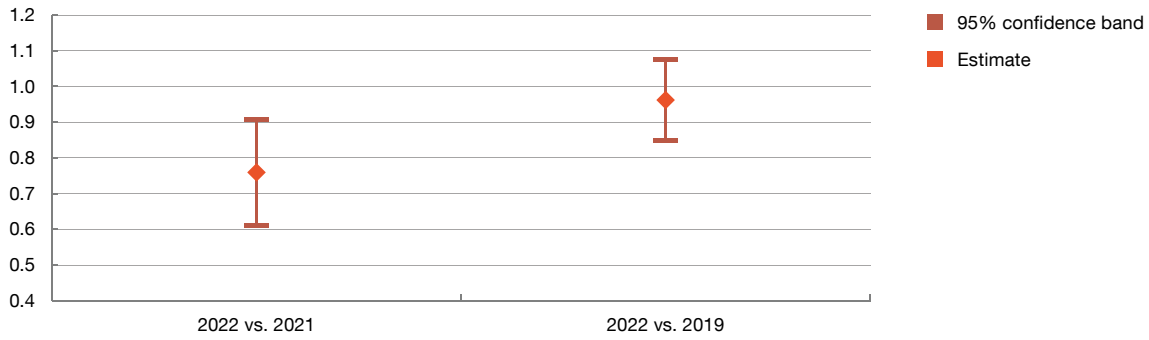
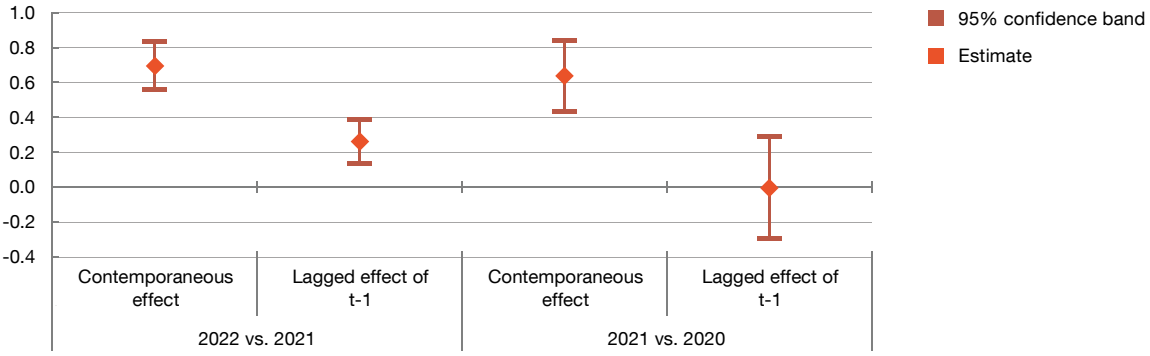
Chart 3

Pass-through of the increase in production costs to selling prices in the industrial sector: dynamic and heterogeneous effects

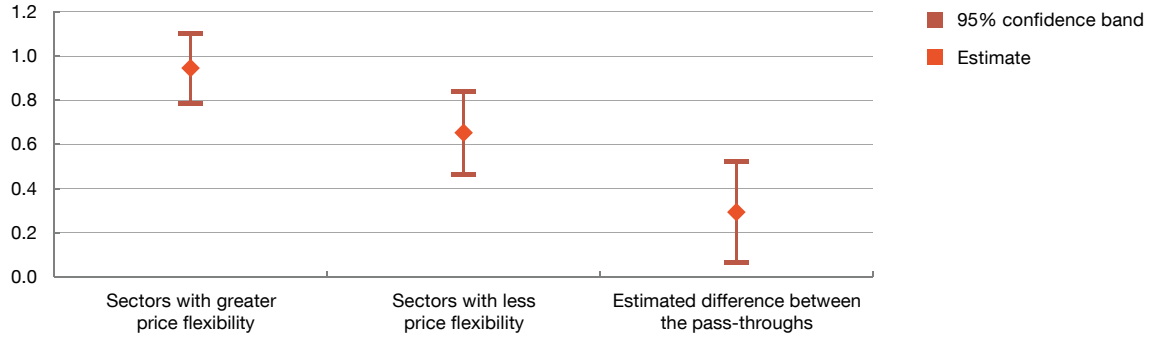
3.a Absolute pass-through of the increase in production costs to selling prices (a)



3.b Dynamic effects of the pass-through of the increase in production costs to selling prices (b)



3.c Pass-through of the increase in production costs to selling prices, by historical price flexibility (c). 2022 vs. 2021



SOURCES: AEAT, INE and Banco de España.

a Absolute pass-through is estimated as the coefficient b_1 in the regression:

$$dP_i = b_0 + b_1 dC_i + Controls_i + e_i$$

where dP_i is the rate of change of unit prices in sub-sector i; dC_i is the rate of change of unit production costs in sub-sector i adjusted for the ratio of costs to turnover in t-1. The confidence intervals were estimated using robust standard errors.

b The contemporaneous and lagged effects are estimated using a similar specification to that in Chart 3.a, but adding the change in unit costs in the prior period.

c The heterogeneous effect is estimated using a similar specification to that in Chart 3.a, but adding the interaction between the change in unit costs and an indicator of the sub-sector belonging to a group of sub-sectors with greater historical price flexibility. Such sub-sectors are defined as those with above-average historical price flexibility. The sector's historical price flexibility is defined as the standard deviation of the monthly series of rates of change of prices (IPRI + IPRIX) over the period 2005-2018.

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costs is measured drawing on the Energy Consumption Survey[14] conducted by the INE. Chart 2.a shows a positive relationship between rising unit production costs and spending on energy as a proportion of the former. Yet, as with the analysis based on the main economic sectors, for similar levels of energy spending as a proportion of unit production costs we observe a large dispersion in the change in unit production costs, suggesting that other factors, not just energy intensity, were behind unit production cost dynamics in 2022.

Chart 2.b shows that, on average, the absolute pass-through of the increase in unit production costs to selling prices in the industrial sector between 2021 and 2022 was high, albeit incomplete. This is because the trend line's slope is shallower than the 45-degree line. However, we observe high heterogeneity, illustrated by the dispersion of the dots around the trend line. This heterogeneity is also observed when analysing pass-through over a longer period (between 2019 and 2022). However, in this case the trend line is closer to the diagonal line, showing that, on average, absolute pass-through was almost complete and greater than in the short term (see Chart 2.c). This may be due to firms being slow to adjust their selling prices in response to changes in their costs.

These results are confirmed by a regression estimated at the most detailed level of breakdown available (203 sub-sectors, at NACE Rev. 2 class level)[15] (see Chart 3.a). In particular, if we analyse the change versus 2021, the coefficient measuring this effect is less than one (the point estimate is 0.76, with 95% confidence bands ranging from 0.61 to 0.91). This can be interpreted as evidence that, on average, absolute pass-through between 2021 and 2022 in the industrial sector was incomplete. However, in the longer period (2022 versus 2019) the coefficient being statistically different from one cannot be rejected (with a 95% confidence band, it ranges from 0.85 to 1.08). This evidence indicates that, for the longer period, absolute pass-through to selling prices was, on average, complete and, therefore, stronger than in the shorter period.[16]

This result could be due to the existence of dynamic effects; in other words, that a change in unit costs would impact prices not only in the same period, but also in subsequent periods. To quantify these dynamic effects, we perform another regression for two sub-periods (from 2020 to 2021 and

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14 Banco de España (2023).

15 Absolute pass-through is estimated as the coefficient b_1 in the regression:

$$dP_i = b_0 + b_1 dC_1 + Controls_i + e_i$$

where dP_i is the rate of change of unit prices in sub-sector i and dC_1 is the rate of change of the unit production cost in sub-sector i adjusted for the ratio of costs to turnover in t-1. The regression is estimated at the most detailed level of breakdown available (203 sub-sectors, at NACE Rev. 2 class level). An extensive group of control variables is used, including the share of exports, the share of firms with fewer than ten employees, intermediate demand and gross fixed capital formation as a proportion of total demand (drawn from the 2019 input-output tables), the sector's historical price flexibility (in logs), services turnover as a proportion of total turnover (drawn from the INE's Structural Business Statistics for the Industrial sector) and the number of firms in each sub-sector (in logs). All the controls are for the period t-1. To control for a possible measurement error in turnover, the regression includes the difference between the changes in output in the industrial production index and changes in output implied by data from the tax authorities. To account for the persistent part of a possible measurement error in the changes in unit costs, the regression includes the difference between changes in unit costs in the period 2019-2021 according to the tax authorities and the integrated CBSO database. The above-mentioned equation is estimated using least squares weighted by the number of firms in each sector. Similar results are obtained if the equation is estimated without using unweighted (ordinary) least squares. Quantitatively similar results are obtained if the change in unit costs is instrumented with the sector's exposure to energy.

16 Similar regressions were performed to estimate relative pass-through. The results point to relative pass-through being stronger in the longer period (0.84, with a 95% confidence interval of 0.77 to 0.92) than in the short period (0.67, with a 95% confidence interval of 0.54 to 0.80). In both periods, relative pass-through was incomplete.

from 2021 to 2022) that includes as the explanatory variable of the change in selling prices both the contemporaneous change in unit costs and the change in the previous period. The results suggest that, in both sub-periods, the contemporaneous effects associated with the changes in unit costs are very significant and of a similar size (see Chart 3.b). Meanwhile, the lagged effects are not significant in the period 2020-2021. Conversely, they are significant in the most recent period. However, their impact is much (around three times) smaller than that of the contemporaneous effects in the same year. The existence of dynamic effects between 2021 and 2022 would suggest that the changes in costs recorded in 2021 had a longer-lasting impact than the changes in the previous year. This could be due to the steeper rise in production costs in that year, which meant that some firms had greater need to pass them on (in 2021 and 2022 alike) to prevent their profit margins from narrowing.

A possible explanation for the cross-sub-sector heterogeneity in cost pass-through is price flexibility in each sub-sector. To assess this hypothesis, we replicate the same regression, the results of which are depicted in Chart 3.a, but allow the coefficient measuring pass-through to change according to the sub-sector's price rigidity. As expected, the results indicate that pass-through was slower in 2022 in the sub-sectors in which prices have historically been more rigid (see Chart 3.c).[17] Thus, pass-through was complete in the sub-sectors with greater price flexibility, as the hypothesis that the coefficient measuring pass-through is statistically different from one cannot be rejected. By contrast, pass-through was incomplete (coefficient less than one) in those sub-sectors with more rigid prices. In addition, the difference between the two coefficients is statistically significant at the typical levels.

Impact of higher input costs on different business variables

The first column of Chart 4.a shows the results of a regression estimating the relationship between changes in unit input cost (excluding wages) between 2021 and 2022 (the dependent variable) and exposure to the energy price shock (measured as energy inputs as a percentage of purchases of goods and services).[18] As in the previous section, we use the sample of 203 industrial sub-sectors. The results show that there is a positive and significant relationship between the two variables, such that those sub-sectors more exposed to the energy price shock saw a more marked change in input costs in 2022.[19]

Lastly, we analyse the effect of the change in unit input costs (excluding wages) on different business variables (unit selling price, deflated turnover, employment, average wage, productivity

17 The heterogeneous effect is estimated with a similar specification to Chart 3.a, but factoring in the interaction between the change in unit costs and an indicator of the sub-sector belonging to a group of sub-sectors with greater historical price flexibility (those which are above the historical average). The sector's historical price flexibility is defined as the standard deviation of the monthly series of rates of change of prices (IPRI + IPRIX) over the period 2005-2018.

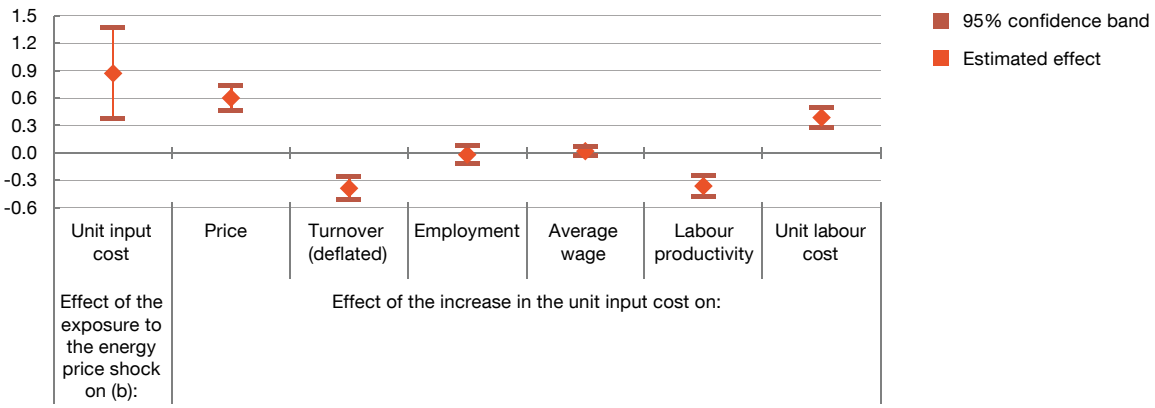
18 This relationship is estimated by factoring in controls similar to those discussed in footnote 7.

19 In partial R^2 terms, exposure to the energy price shock explains at least 6.5% of the change in unit input costs and is one of the most important explanatory variables included in the regression. However, this estimate is probably biased downward, given that data on the share of energy consumption are only available at NACE Rev. 2 group level, while data on inputs are available at a more disaggregated level.

Chart 4

Increase in unit input costs between 2021 and 2022 in the industrial sector and its effect on different variables

4.a Estimated coefficients (a)



SOURCES: AEAT, INE and Banco de España.

a The effect of the change in the unit cost is estimated as the coefficient b_1 in the regression:

$$dY_i = b_0 + b_1 dC_i + Controls_i + e_i$$

where dC_i is the rate of change of the unit production cost (excluding wages) in sub-sector i, and dY_i is the rate of change of the dependent variable in sub-sector i. The dependent variables include selling prices, turnover, employment, average wage, labour productivity and unit labour cost. The confidence intervals were estimated using robust standard errors.

b The effect of exposure to the energy price shock is estimated using a specification similar to that mentioned above, but with the change in unit production costs excluding wages as the dependent variable and exposure to the energy price shock as the explanatory variable. Exposure to the energy price shock is measured as energy purchases (natural gas, electricity and other fuels) as a percentage of total goods and services purchases.

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and unit labour cost)[20] between 2021 and 2022. Specifically, we perform various regressions, similar to those estimated above, in which the dependent variables are each of these business variables and the coefficient of interest is that associated with the increase in the unit input cost. To facilitate their comparison, the estimated effects are depicted in terms of elasticities.[21] The results in the second to seventh columns of Chart 4.a show that the increase in input cost has a positive impact on selling prices and a negative impact on real turnover. The latter reflects the drop in demand as a result of higher prices. However, the direct impact on employment and the average wage is zero, perhaps capturing the rigidity of these variables in the short term. As the increase in prices prompts a fall in production with the same level of employment, this translates into a decline in labour productivity. Meanwhile, as there are no effects on employment and the average wage, the wage bill is unaffected; however, the fall in productivity triggers an increase in unit labour costs in the short term. As discussed above, these impacts do not take into account the indirect general equilibrium effects.

20 Unit labour costs are defined as the ratio of labour compensation to output (proxied by deflated nominal turnover).

21 In the case of the regression in which the dependent variable is the change in selling prices, the coefficient of the change in input cost represents relative pass-through.

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