Letter

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Labor Demand Responses to Changing Gas Prices

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Abstract: In course of the current energy crisis, the consequences of increasing gas prices are heavily discussed. To date, however, there is no evidence of the impact of gas prices on the labor market. Using administrative employment data from 2012 to 2020, we find for manufacturing establishments a gas price elasticity of labor demand of −0.02, likely reflecting a scale effect. We also show that a rise in the gas price leads to an increase in establishment closure. A negative impact of the gas price on wages of 2 percent is consistent with rent-sharing.

Keywords: elasticity; establishment closure; gas price; labor demand; wages

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1 Introduction

In course of the Russian invasion of Ukraine, energy prices heavily increased in Western Europe. In particular, the price of natural gas, of which Russia is a major

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supplier, has risen. This price increase initiated a policy debate on how the respective increase in costs affects the economy and firms in particular. In our empirical analyses, we contribute to this debate by examining how changes in gas prices affected establishments' labor demand in the past.

To the best of our knowledge, other studies do not focus on the effect of gas prices on the labor market. Previous research focused mainly on estimating the effect of aggregated energy- or electricity prices on labor demand. Regarding energy prices, Marin and Vona (2021) found a (modest) negative employment effect, whereas Hille and Möbius (2019) did obtain no impact of energy on employment within manufacturing. Regarding the electricity price, Cox et al. (2014) estimated a negative effect on labor demand within the manufacturing sector in Germany. Bijnens, Konings, and Vanormelingen (2022) reported similar findings for whole Europe and included the gas price to control for potential omitted variable bias but found that on average employment is not affected by the gas price. We contribute to this literature by presenting first evidence of gas price changes on establishment-level employment growth, establishment closure, and wage growth.

From a theoretical perspective, the gas price is likely to affect labor demand through a scale effect. Specifically, in certain industries, gas is a critical input for production. As a result, if gas prices rise, firms may decrease their gas consumption, leading to a reduction in production levels and a corresponding decrease in labor demand. The scale effect is particularly pronounced when gas is difficult to substitute with other factor inputs, such as alternative energy sources.[1]

We use administrative social security data covering the universe of establishments in Germany to which we assign the gas price based on past industry-level gas consumption bands. Estimating an establishment-level employment equation in first differences, we find a statistically significant gas price elasticity of −0.02. The negative effect remains robust across establishment sizes and qualification. In line with that, we find evidence of an increasing probability for establishment closure in the next period as well as a negative effect on an establishment's remaining survival time. Further, our results suggest a negative cost-sharing effect on wages of 2 percent.

2 Data

We combine establishment-level employment data from the Establishment History Panel (BHP) of the Institute of Employment Research (IAB), gas price data from

1 See, e.g. IW-Kurzbericht 40/2022 "Substitutionspotentiale von Gas in der deutschen Industrie" (https://www.iwkoeln.de/fileadmin/user_upload/Studien/Kurzberichte/PDF/2022/IW-Kurzbericht_2022-Gas-Substitutionen.pdf).

Eurostat, and data on energy consumption from the German Statistical Office for the period from 2012 to 2020. The BHP aggregates the population of all social security employees at the establishment level. For the main analysis, we use the subset for all establishments in manufacturing. The establishment data covers information on total employment and full-time employment both by education and task, as well as establishment-level average wages. The data also includes the date of an establishments' last social security notification which allows the analysis of establishment closure. For more information on the BHP, see Ganzer et al. (2022).

The variation of gas and electricity prices mainly depends on their consumption level (Cox et al. 2014). Typically, the more a firm consumes the lower the price, i.e. a firm with high consumption levels has higher bargaining power in negotiating their energy contracts and vice versa. However, we lack consumption or price data at the firm level. To exploit price variation in the cross-section and over time, we use Eurostat data on average end of year gas prices p_{kt}, where k indexes consumption bands 1 to 7 and t the years 2012 to 2020. We map this price data to establishments by their respective industry's j gas consumption band in 2005, i.e. $p_{jt} = \sum_k I[\text{consumption band } 2005_j = k] \times p_{kt}$, where I is an indicator function equal to one if the statement in brackets is true (and zero otherwise). Taking consumption bands from 2005 (instead of the current year) ensures that the assignment of the gas price is based on predetermined consumption. Hence, it is not endogenously influenced by contemporary industry-level shocks. This procedure yields at the establishment level for our regression sample an average (absolute) yearly change in the log gas price of 0.057 and a standard deviation of the yearly change in the log gas price of 0.084.

3 Empirical Analysis

We estimate the following first-differenced (log) employment equation of establishment i in industry j at year t:

$$\Delta \ln \text{employment}_{it} = \alpha + \eta_{\text{cross-price}} * \Delta \ln \text{gas price}_{jt} + \eta_{\text{own-price}} * \Delta \ln \text{wage}_{it} + X_{it}\beta + \epsilon_{it}$$

$\eta_{\text{cross-price}}$ measures the (unconditional) cross-price elasticity of labor demand with respect to the industry-level gas price. $\eta_{\text{own-price}}$ identifies the own-wage elasticity of labor demand. X includes time dummies and the price of electricity – a potential substitute for gas. We estimate the equation separately for full-time employment and total employment.

Columns (1) and (2) of Table 1 report estimates for full-time employment in manufacturing. We observe a negative wage elasticity, and most interestingly, we identify a statistically significant negative gas price elasticity of labor demand of −0.02. This result also holds when controlling for the electricity price, i.e. ruling out that the measured employment effect picks up price changes of electricity. Since it is implausible to substitute gas with employees, we consider our finding as a scale effect such that establishments in the manufacturing sector are likely to downward-adjust employment when encountering increasing gas costs (and vice versa). This argument is further supported by descriptive evidence of a negative relationship between gas prices and revenues, see Online Appendix, Figure A1.

An effect of increasing gas prices should be unlikely for establishments in the service sector which is considerably less gas-intensive. In fact, our data shows that the cost share of gas as of total costs is 3.5 percent in manufacturing and only 0.4 percent in services. In column (3), we report estimates of employment growth in the service sector, i.e. a sort-of placebo test. Our expectations are corroborated by a gas price elasticity which is insignificant and close to zero. Columns (4) to (6) show estimates on total employment including part-timers, for which the (daily) wage information is a less accurate approximation of hourly wages. Nevertheless, the wage elasticities are still negative and in a plausible range. Moreover, the gas price elasticity is −0.025 and thereby largely in line with the effect on full-time employment. Again, the placebo test yields no gas price effect in the service sector.

In Table 2, we examine whether the impact of the gas price varies by gas intensity and therefore split the manufacturing industries in low, medium, and high gas intensity. As expected, the gas price elasticity of labor demand rises with gas intensity. The elasticity is notably large in high-intensity industries (between −0.21 and −0.25) and it is still economically significant in medium-intensity industries (−0.05). However, the gas price elasticity is virtually zero for establishments in industries with low gas intensity.

Further, we have conducted several robustness checks.[2] Compared to the baseline, results are robust across establishment size and qualification. The latter indicates a slightly higher gas price elasticity of −0.03 for low-qualified employees while for medium- and high-skilled employees the gas price elasticity remains robust at −0.02. Moreover, robust gas price elasticities can be observed when additionally controlling for employment composition and trends by region and size. When checking for effect dynamics across time, the negative gas price elasticity remains

2 Detailed results are reported in the Online Appendix, Tables A1–A7.

Table 1: Baseline labor demand elasticities.

	Δ ln full-time employment			Δ ln total employment		
	Baseline: manufact.	**Controlling for electr. price**	**Placebo: services**	**Baseline: manufact.**	**Controlling for electr. price**	**Placebo: services**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Δ ln wage full-timers	−0.222***	−0.222***	−0.195***			
	(0.013)	(0.013)	(0.027)			
Δ ln wage all workers				−0.353***	−0.353***	−0.347***
				(0.015)	(0.015)	(0.024)
Δ ln gas price	−0.021**	−0.021**	0.001	−0.025**	−0.025**	−0.007
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.019)
Δ ln electricity price		−0.029			0.006	
		(0.038)			(0.051)	
Clusters	24	24	28	24	24	28
Observations	1,184,171	1,184,171	4,271,674	1,308,009	1,308,009	5,938,793

Notes: Regression coefficients from specifications in first-differences. Standard errors clustered at the 2-digit industry level reported in parentheses. Asterisks indicate significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data: Destatis, Eurostat and BHP, all establishments in Germany.

Table 2: Labor demand elasticities by industries' gas intensity.

	Δ ln full-time employment			Δ ln total employment		
Gas intensity:	**High**	**Medium**	**Low**	**High**	**Medium**	**Low**
Δ ln wage full-timers	−0.197***	−0.272***	−0.211***			
	(0.016)	(0.020)	(0.017)			
Δ ln wage all workers				−0.377***	−0.412***	−0.329***
				(0.025)	(0.026)	(0.015)
Δ ln gas price	−0.208*	−0.055***	0.004	−0.247**	−0.052**	−0.003
	(0.086)	(0.009)	(0.019)	(0.084)	(0.015)	(0.015)
Clusters	5	5	14	5	5	14
Observations	143,544	281,055	759,572	160,338	315,266	832,405

Notes: Regression coefficients from specifications in first-differences. Dependent variables are employment changes as indicated by column titles. Classification of industries' gas intensity based on Holtemöller (2022). Standard errors clustered at the 2-digit industry level reported in parentheses. Asterisks indicate significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data: Destatis, Eurostat and BHP, all establishments in manufacturing.

robust and significant in the short-run (within a year), while indicating diminishing long-run effects. When using industry-level wages instead of establishment-level wages, the own-wage elasticity shrinks but the gas price elasticity remains unchanged.

So far, all estimates are identified from existing establishments. However, gas prices may affect employment also through establishment closures. To examine this issue, we estimate a linear probability model with the dependent variable indicating establishment closure between t and $t + 1$. As reported in Table 3, an increase in the gas price by 100 log points rises the likelihood of establishment closure by 1.3 percentage points (with an average closure rate of 5.8 percent). Correspondingly, OLS and Tobit regressions show that the gas price negatively affects establishment survival in days.

Ceteris paribus, a shock in gas prices should lead firms' costs to increase. We estimate a wage regression to see how much of the cost increase is passed on to employees and obtain a gas price elasticity of wages of −0.018 for full-time employees and of −0.021 for all employees (see Table 4). Given a cost share of gas of 3.5 percent (as of total costs), the wage effects imply that about half of a the cost share increase is passed on to employees' wages.[3] Correspondingly, the gas price elasticity of labor demand is slightly reduced (from −0.022 to −0.017) when we do not control

3 This is only a valid approximation if the cost share of gas is small.

Table 3: Establishment closure.

	Closure in $t+1$	Establishment survival (in days)	
	OLS	OLS	Tobit, $\partial y^{star}/\partial x$
Δ ln gas price	0.013*	−94.6*	−331.3**
	(0.007)	(45.7)	(142.7)
Clusters	24	24	24
Observations	1,151,908	1,308,009	1,308,009

Notes: Column (1) presents an OLS-estimation with the dependent variable being equal to one if the establishment is not in the data in $t+1$. The dependent variable of the specifications in columns (2) and (3) is constructed based on the last date of each establishment in the data, which is right-censored at 31 December 2020. Column (2) shows the OLS regression coefficient and column (3) shows the marginal effect on the latent (uncensored normally-distributed) variable y-star of a Tobit regression. Standard errors clustered at the 2-digit industry level reported in parentheses. Asterisks indicate significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data: Destatis, Eurostat and BHP, all establishments in manufacturing.

Table 4: Wage effect.

	Δ ln wage, full timers	Δ ln wage, all workers
Δ ln gas price	−0.018**	−0.021**
	(0.007)	(0.008)
Clusters	24	24
Observations	1,184,171	1,308,009

Notes: Regression coefficients from specifications in first-differences. Standard errors clustered at the 2-digit industry level reported in parentheses. Asterisks indicate significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data: Destatis, Eurostat and BHP, all establishments in manufacturing.

for wages in the employment regression (see Appendix Table A8). This implies that the baseline employment effect which is conditional on wages does not account for a downward adjustment in costs. Our negative wage response to a gas price increase is in line with the rent-sharing literature, e.g. Mertens, Müller, and Neuschäffer (2022) use energy costs as an instrument to estimate the effect of value added on wages for German manufacturing firms.

4 Conclusions

This paper provides first evidence of the gas price effects on employment within the German manufacturing sector by finding a negative gas price elasticity of −0.02, likely indicating a scale effect. In line with that, the semi-elasticity on establishment closures is −0.013. Moreover, wages are negatively affected by increasing gas prices, where about half of the cost increase is passed on to employees. In sum, these findings contribute to an important policy discussion that has been lacking hard evidence. Applying our estimated gas price elasticity to the average rise in the gas price of 125 % between 2021 and 2022 (which is equivalent to a change in the log gas price of 0.8) implies an employment reduction of approximately 1.6 percent in the manufacturing sector, i.e. a reduction of about 100,000 jobs given a total of 6.7 million employees in manufacturing. However, this is an out-of-sample prediction and therefore needs to be re-evaluated with actual data from 2022.

We would like to note that several interesting extensions are infeasible due to data availability: first, the isolation of a substitution effect through conditional labor demand equations; second, the effect of gas price changes on all factor inputs; third (as noted above), the evaluation of the 2022 price hike.

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