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DISCUSSION PAPER SERIES

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Labor Demand Responses to Changing Gas Prices

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ABSTRACT

Labor Demand Responses to Changing Gas Prices*

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 2012–2020, 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.

JEL Classification: J23, Q31

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

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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 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, Peichl, Pestel, and Siegloch (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.

[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)

2. Data

We combine establishment-level employment data from the Establishment History Panel of the Institute of Employment Research (IAB), gas price data from Eurostat, and data on energy consumption from the German Statistical Office for the period from 2012 to 2020. The Establishment History Panel 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 Establishment History Panel, see Ganzer, Schmucker, Stegmaier, Stüber, 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- and/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 1–7 and t the years 2012–2020. We map this price data to establishments by their respective industry's j gas consumption band in 2005, i.e., $p_{jt} = \sum_k I[\text{consumption band } 2005_j = k] * p_{kt}$, where I is an indicator function equal to one if the statement in brackets is true (and zero otherwise).

3. Empirical analysis

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

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

$\eta_{cross-price}$ 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

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: BHP, all establishments in Germany.

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.

As expected, the gas price elasticity of labor demand rises with gas intensity when we split the sample by industries with low, medium and high gas intensity. Moreover, with find no impact for establishments with a low intensity (see Appendix Table A1). Further, we have conducted several robustness checks.[2] Compared to the baseline, results are robust across establishment size and qualification. 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 neg-

[2]Detailed results are reported in the Online Appendix, Tables A2–A8.

ative gas price elasticity remains 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.

Table 2: 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: BHP, all establishments in manufacturing.

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 2, doubling the gas price increases 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.

Table 3: 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: BHP, all establishments in manufacturing.

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 3). Given a cost share of gas of 3.5 percent (as of 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 for wages in the employment

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

regression (see Appendix Table A9). This implies that the baseline employment effect which is conditional on wages does not account for a downward adjustment in costs.

4. Conclusion

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.

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, the evaluation of the 2022 price hike.

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Online Appendix for
Labor demand responses to changing gas prices

NOT FOR PRINT

by
Mario Bossler, Alexander Moog, and Thorsten Schank

Appendix A Heterogeneities and robustness checks

Table A1: Labor demand elasticities by industries' gas intensity

	ln full-time employment			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, O. (2022), Aktuelle Trends: Hohe Umsätze in gasintensiven Industrien – aber niedrige Produktion, *IWH, Wirtschaft im Wandel*, 28(4), 72. 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: BHP, all establishments in manufacturing.

Table A2: Labor demand elasticities by establishment size

	size ≤ 10	$10 < $ size ≤ 100	size > 100
Δ ln wage, full-timers	-0.1227***	-0.5166***	-1.0576***
	(0.0190)	(0.0299)	(0.1974)
Δ ln gas price	-0.0198**	-0.0281*	-0.0265
	(0.0088)	(0.0137)	(0.0257)
Clusters	24	24	24
Observations	594,148	493,635	98,565

Notes: Regression coefficients from specifications in first-differences. Dependent variable ist the change in log full-time employment. Regressions by establishment size as indicated by column titles, where size is measured as the median (yearly) employment of each establishment. 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: BHP, all establishments in manufacturing.

Table A3: Labor demand elasticities by qualification

	ln low-qualified	ln medium-qualified	ln high-qualified
Δ ln wage of low-qual.	-0.3834***		
	(0.0235)		
Δ ln wage of med-qual.		-0.2474***	
		(0.0073)	
Δ ln wage of high-qual.			-0.1162***
			(0.0088)
Δ ln gas price	-0.0294*	-0.0185	-0.0219*
	(0.0170)	(0.0122)	(0.0111)
Clusters	24	24	24
Observations	376,831	1,130,886	462,629

Notes: Regression coefficients from specifications in first-differences. The dependent variable is the log full-time employment by qualification level, as indicated by column titles. Wages refer to full-time workers. 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: BHP, all establishments in manufacturing.

Table A4: Labor demand elasticities by qualification, allowing for cross-wage elasticities

	ln low-qualified	ln medium-qualified	ln high-qualified
Δ ln wage of low-qual.	-0.4521***	0.0241***	0.0065*
	(0.0282)	(0.0043)	(0.0034)
Δ ln wage of med-qual.	-0.0372	-0.5483***	-0.0058
	(0.0451)	(0.0363)	(0.0178)
Δ ln wage of high-qual.	-0.0148***	0.0047	-0.2087***
	(0.0047)	(0.0039)	(0.0079)
Δ ln gas price	-0.0263	-0.0172	-0.0313**
	(0.0201)	(0.0104)	(0.0129)
Clusters	24	24	24
Observations	232,506	232,506	232,506

Notes: Regression coefficients from specifications in first-differences. The dependent variable is the log of full-time employment by qualification level, as indicated by column titles. Wages refer to full-time workers. Standard errors clustered at the 2-digit industry level reported in parentheses. Number of observations is lower than in Table A3 since establishments which have no employees in any of the three qualification categories are not included. Asterisks indicate significance levels: * p<0.1, ** p<0.05, *** p<0.01. Data: BHP, all establishments in manufacturing.

Table A5: Labor demand elasticities with control variables

	Baseline	Controlling for empl. composition	Adding trends by region and size
Δ ln gas price	-0.0211**	-0.0190**	-0.0197**
	(0.0101)	(0.0084)	(0.0085)
Clusters	24	24	24
Observations	1,184,171	1,184,171	1,184,171

Notes: Regression coefficients from specifications in first-differences. Dependent variable is the change in log full-time employment. The second specification additionally includes as covariates the average age of employees, the total daily wage bill of an establishment as well as the shares of females, social security employees, full-time employees, apprentices, low-qualified employees, and high-qualified employees. The third specification includes dummies for federal states and lagged establishment which implies that before taking differences the employment equation includes trends by federal state and establishment size. 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: BHP, all establishments in manufacturing.

Table A6: Dynamics of labor demand elasticity, full-time workers

	Δ^{t-1} ln empl.	Δ^{t-2} ln empl.	Δ^{t-3} ln empl.
Δ^{t-1} ln gas price	-0.0211**		
	(0.0101)		
Δ^{t-2} ln gas price		-0.0181	
		(0.0176)	
Δ^{t-3} ln gas price			0.0048
			(0.0200)
Δ^{t-1} ln wage, full-timers	-0.2220***		
	(0.0125)		
Δ^{t-2} ln wage full-timers		-0.1983***	
		(0.0147)	
Δ^{t-3} ln wage, full-timers			-0.1774***
			(0.0184)
Clusters	24	24	24
Observations	1,184,171	986,265	808,721

Notes: Regression coefficients from specifications in differences. Dependent variables are employment changes with varying length of differences as indicated by column titles. 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: BHP, all establishments in services.

Table A7: Dynamics of labor demand elasticity, total employment

	Δ^{t-1} ln empl.	Δ^{t-2} ln empl.	Δ^{t-3} ln empl.
Δ^{t-1} ln gas price	-0.0251**		
	(0.0099)		
Δ^{t-2} ln gas price		-0.0329	
		(0.0224)	
Δ^{t-3} ln gas price			-0.0196
			(0.0283)
Δ^{t-1} ln wage, all workers	-0.3531***		
	(0.0153)		
Δ^{t-2} ln wage, all workers		-0.3117***	
		(0.0148)	
Δ^{t-3} ln wage, all workers			-0.2808***
			(0.0145)
Clusters	24	24	24
Observations	1,308,009	1,089,103	892,630

Notes: Regression coefficients from specifications in differences. Dependent variables are employment changes with varying length of differences as indicated by column titles. 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: BHP, all establishments in services.

Table A8: Baseline labor demand elasticities with industry level wages

	ln full-time empl.	ln total empl.
Δ ln industry wage, full-timers	-0.0068	
	(0.0525)	
Δ ln industry wage, all workers		-0.0168
		(0.0371)
Δ ln gas price	-0.0172*	-0.0178**
	(0.0090)	(0.0077)
Clusters	24	24
Observations	1,184,171	1,308,009

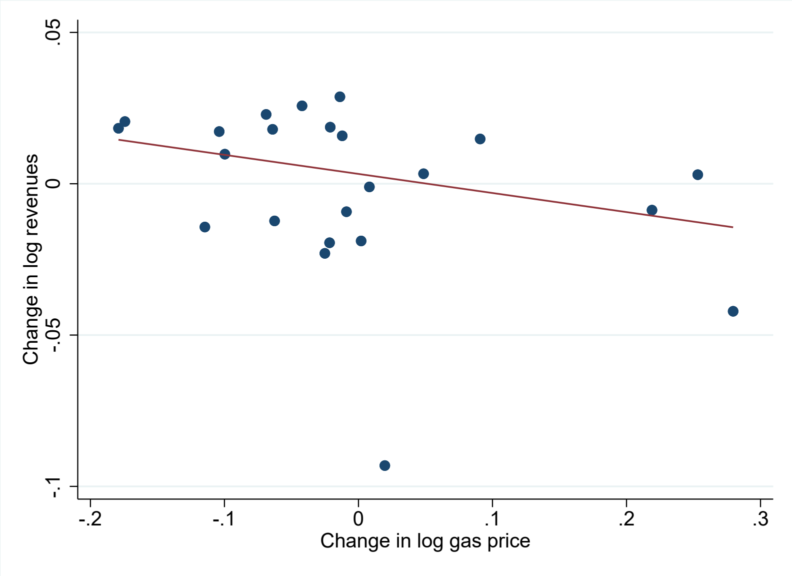
Notes: Regression coefficients from specifications in first-differences. Dependent variables are employment changes as indicated by column titles. Standard errors clustered at the 2-digit industry level reported in parentheses. Asterisks indicate significance levels: * p<0.1, ** p<0.05, *** p<0.01. Data: BHP, all establishments in manufacturing.

Table A9: Cross-price labor demand elasticity without wages

	ln full-time empl.	ln total empl.
Δ ln gas price	-0.0171*	-0.0175**
	(0.0091)	(0.0078)
Clusters	24	24
Observations	1,184,171	1,308,009

Notes: Regression coefficients from specifications in first-differences. Dependent variables are employment changes as indicated by column titles. 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: BHP, all establishments in manufacturing.

Figure A1: Correlation between revenues and gas prices



Notes: Revenue data obtained from IAB Establishment Panel, 2012 – 2020. See Section 2 for mapping of gas prices to establishments. Points refer averages within 40 equally-sized bins along the x-axis.