The Influence of Public Employment on Private Employment, Wages and Housing Costs in German Districts – An empirical analysis of Public Sector Employment and Local Multipliers

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1 Introduction

Public employment is a prominent policy tool to support the economy and reduce regional imbalances. Multiple governments have influenced the number and location of public sector workers to counteract unemployment, economic shocks or strengthen lagging regions (Faggio et al. 2019; Faggio 2019; Frei & Thum 2019). This trend is bound to continue. Estimates suggest that the German federal government's Corona stimulus package alone will create about 60 000 new public sector jobs (Feld et al. 2020; Wolter et al. 2020). Public employment is also intended to be a measure towards equal living conditions and the strengthening of the former coal mining regions (Bundesministerium des Innern, für Bau und Heimat (BMI) 2019, Kommission Wachstum Strukturwandel und Beschäftigung 2019; Deutscher Bundestag 2020, §18). It is expected that public employment will positively affect regional development through employment- and purchasing power effects.

Evidence on the impact of public employment changes on regional development, especially on private employment, is, however, scarce (Faggio & Overman 2014; Becker et al. 2021). To the best of my knowledge, only one discussion paper examines the effect of public employment changes on a national level for Germany. In this paper, Senftleben-König (2014) identifies a substantial crowding-out effect of public on private employment for a period of public sector shrinking. If these results are also applicable for public sector expansion, public employment would be a counterproductive measure for improving regional development. There is, however, a lack of knowledge on the symmetry of the multiplier effect. Evidence on the subject is scarce and it lacks a conclusive theoretical explanation but studies on public sector expansion tend to find deviating effects from those on its reduction (Faggio & Overman 2014; Senftleben-König 2014; Auricchio et al. 2020; Jofre-Monseny et al. 2020; Fallah 2021). It cannot be ruled out that the crowding-out effects in Italy and Germany are country-specific, e.g., following their specific social security systems, as there do not exist multiple studies with a comparable framework on a single country.

This paper addresses two crucial questions in regional multiplier research. First, particularly relevant from a German policy perspective, I investigate the effects of public employment expansion on private employment, wages, and rents. Second, my work contributes to resolving the debate on asymmetric multipliers. As the first follow-up study on public-private multipliers in a single country, I show that the theory of asymmetric effects is superior to that of country-specific effects. In addition, I present a coherent theoretical derivation of the causes of the asymmetric public-private employment multiplier effect.

2 Literature Overview

There is a long history of research into regional multiplier effects. This paper will contribute to the recent, growing subfield of regional public-private multipliers within a general equilibrium framework.

Historically, research on regional multipliers was based on input-output models. This came with several limitations, the most major being the assumption of fixed input costs and output prices (Richardson 1985). Moretti (2010) overcame this limitation with a general equilibrium model. It allows to account for potential wage- and price changes and their impact on local employment following exogenous employment changes. He developed the framework to investigate the effect of manufacturing jobs on the tradable (mostly services) and non-tradable (mostly manufacturing) sectors.

The theoretic model is presented in more detail in Moretti (2011). In his empirical paper, Moretti (2010) finds that from 1980 to 1990 and 1990 to 2000, one additional job in manufacturing in a city in the US comes with 1.6 jobs in the local non-tradable sector while leaving other parts of the tradable sector unaffected. Moretti's influential work made another vital contribution to the field by introducing the shift-share approach to regional labor market research. This approach isolates exogenous variations in the data and, therefore, detects and overcomes potential biases (Moretti 2010).

Faggio & Overman (2014) developed the framework further to investigate public-private multipliers. They augment a model frequently used in migration research to investigate potential displacement effects and control for biases with an instrumental variable regression based on Moretti's shift-share approach (2010). Invatigating Local Authorities in England within a period of public employment expansion (2003-2007), Faggio and Overman find a small positive effect on private employment in the short run. They calculate that 100 additional public sector jobs create about 50 jobs in the non-tradable sector while destroying 40 in the tradable sector. Using an instrumental variable regression, they detect that the estimators for the untradable sector are significantly biased downwards (Faggio & Overman 2014). The authors do not test for potential effects on prices or wages.

Senftleben-König (2014) uses the framework of Faggio & Overman (2014) to analyse public-private multipliers in Germany. She extends the model by including wages in addition to the employment effect. In the chosen timeframe from 2003 to 2007 public jobs in Germany were reduced overall. Senftleben-König finds that 100 additional public jobs crowd out 74 jobs in the private sector and increase local wages significantly. On a sectoral scale, she finds a negative effect on the tradable sector but no impact on the non-tradable sector. Senftleben-König explains the difference from the results of Faggio & Overman (2014) through the elasticity of labor based on the countries specific social security systems (Senftleben-König 2014).

Auricchio et al. (2020) use a similar approach to Faggio & Overman (2014) to analyze public sector shrinking in Italy from 2001 to 2011. Contrary to Faggio & Overman (2014) and most other studies but in line with Senftleben-König (2014), they find a significant and strong crowding-out effect of public employment. In the context of a public job reduction, this means that 100 jobs less in the public sector led to 60-80 jobs more in the private sector, an increase driven by the tradable sector. The authors argue that public sector contraction might have a different effect on private employment than its expansion, that the effect is asymmetrical. They also investigate the price effect modeled by housing costs and

detect a significant decline in prices in areas where public employment was reduced (Auricchio et al. 2020).

Recent studies from Turkey (Aldan 2021) and the West Bank (Fallah 2021), both using the framework developed by Faggio & Overman (2014), find evidence of a strong multiplier effect on regional private employment. These results might be influenced by the specific political and economic situations in these countries (e.g., informal work) (Aldan 2021; Fallah 2021).
My research is also closely related to studies investigating the public-private multiplier on a subnational level. Given the smaller geographical scale, these investigations provide a valuable contribution to understanding the inner works of the multiplier effect.

Jofre-Monseny et al. (2020) analyze the effect of the rapid public sector expansion in 83 Spanish cities. Using a search and matching model and a regression they find that public employment crowds in private employment in the non-tradable sector but leaves the tradable sector and unemployment unchanged. Instead, the local workforce increases through migration. In their baseline model, ten additional public sector jobs increase non-tradable employment by nine positions (Jofre-Monseny et al. 2020).

Becker et al. (2021) investigate the impact of the public employment expansion connected with the capital status of Bonn after the second world war. They compare Bonn to a control group of similar cities as well as to a synthetic control city for the period 1925-1987. They find that 100 additional public sector jobs create about 100 jobs in the non-tradable sector while crowding out 20 jobs in the tradable sector. They argue that this is likely the upper bound of the multiplier effect in Germany, given the status as the capital city (Becker et al. 2021).

3 Theory

An increase in private employment following the expansion of public employment is explained by the rise in the demand for local goods and services (Moretti 2010; Faggio & Overman 2014). This positive multiplier could be (partly) offset by general equilibrium effects. If additional public jobs are created, the regional price level is expected to rise. The increased demand for workers leads to higher wages which, especially if the demand is partly satisfied by in-migration, leads to a rise in housing costs. The magnitude is dependent on the elasticity of labor and housing supply. This weakens the competitiveness of local businesses and forces them to raise prices, reduce staff or relocate. The adjustment process on wages, prices, etc., continues until a new general equilibrium is achieved. If the price effects dominate the demand effect, public sector jobs do not create jobs in the private sector; instead, they crowd them out (Moretti 2010; Faggio & Overman 2014). Public employment increases therefore do not automatically increase aggregated employment in the region instead the overall effect is dependent on the relative size of the multiplier to the general equilibrium effect.

To better understand these effects and their potential size, it is necessary to deconstruct private employment into two different sectors: tradables and non-tradables.

The non-tradable sector consists of businesses that produce goods or services for the local market and do not face competition from outside. They determine their prices locally (Moretti 2010). If local wages and employment increase following the expansion of the public sector, the local budget constraint rises, and demand for these industries grows. This leads to more jobs in the non-tradable sector. The rising wages and housing costs non-tradable businesses face will be passed on to the consumers (Moretti 2011) as price levels are locally determined. The multiplier effect in the non-tradable sector is dependent on four factors: The preference of consumers for non-tradables, the technology in the non-tradable sector, the salary of the jobs created in the public sector and the offsetting general equilibrium effect (Moretti 2010).

Public employment is expected to crowd out tradable sector employment if local demand is neglectable (Faggio & Overman 2014). The tradable sector does not benefit from a multiplier but suffers from the general equilibrium effect. A rise in local employment and housing costs is expected to put pressure on wages in the tradable sector if labor is mobile across sectors. As prices for tradables are determined (inter)nationally, higher costs cannot be passed on. Therefore, production is expected to (partly) move to more competitive locations in the long run, decreasing local tradable employment (Moretti 2010; Faggio & Overman 2014).

4 Empirical Strategy

4.1 Public-Private Employment Model

Based on Card (2009) and Faggio & Overman (2014), total employment (E) in district d in the year t is the sum of private employment PR and public employment PB in t. Proportional employment changes between the years s (start) and e (end) in district d can therefore be expressed as:

$$\frac{E_{d,e} - E_{d,s}}{E_{d,s}} = \frac{PR_{d,e} - PR_{d,s}}{E_{d,s}} + \frac{PB_{d,e} - PB_{d,s}}{E_{d,s}} \quad (1)$$

This decomposition of total employment growth can be used to create a linear model for the causal relationship between public and private employment following Card (2009) and Faggio & Overman (2014) with adaptions by Auricchio et al. (2020):

$$\frac{PR_{d,e} - PR_{d,s}}{E_{d,s}} = \alpha + \beta \left(\frac{PB_{d,e} - PB_{d,s}}{E_{d,s}} \right) + \gamma X_{d,s} + \varepsilon \quad (2)$$

Using the change in private employment as the dependent variable removes artificial correlation and allows to test directly for displacement (Faggio & Overman 2014). X is a vector of additional district characteristics in period s that potentially influence employment growth. The error term is ε. The primary variable of interest in this equation is β. It captures the change in private employment associated with one additional public sector worker. If β is greater than zero, public employment has a multiplier effect on private employment, β<0 indicates public employment crowding out private employment (Faggio & Overman 2014; Auricchio et al. 2020). The initial district population (ln), dummies for former East and West Germany, for the districts' urbanity or rurality, and the regional qualification structure are used as control variables (Faggio & Overman 2014; Senftleben-König 2014; Jofre-Monseny et al. 2020).

4.2 Public-Employment – Rent/Wage Model

To analyse the mechanisms within the general equilibrium effect, I specify additional models for the relation of wages and housing costs with public sector employment changes (van Dijk 2018). To do so, Model (2) is adjusted. Instead of the private sector employment growth, the increase in local rents (R) and the real gross hourly wage (W) are used respectively as the dependent variable. The equation with G as a placeholder for R and W is:

$$\frac{G_{d,e} - G_{d,s}}{G_{d,s}} = \alpha + \beta \left(\frac{PB_{d,e} - PB_{d,s}}{E_{d,s}} \right) + \gamma X_{d,s} + \varepsilon \quad (3)$$

Following Auricchio et al. (2020), the same control variables as in Model (2) are used.

4.3 Instrumental Variable Approach

Unobserved factors of private employment growth might be correlated with growth in public sector employment in equation (2), violating the condition that ε must be random (Gibbons et al. 2015). In this case β would be biased upwards. If governments try to counterbalance negative shocks in a region by increasing the size of the public workforce, β would be biased downwards (Faggio & Overman 2014). To ensure causality, I apply an instrumental variable approach common public employment multiplier literature. The shift-share approach was developed by Bartik (1991). The instrument calculates regional changes in public employment based on the district's initial share - and the nationwide growth of public employment. This is based on the idea that without any local shocks, the districts would each have received a proportionate share of new public jobs. National growth is calculated excluding the respective district's growth d. This ensures independence of local economic conditions. The Bartik-Instrument should therefore be orthogonal to ε from equation (2). The final instrument is (Faggio & Overman 2014; Senftleben-König 2014; Auricchio et al. 2020; Roupakias 2021):

$$Bartik_{d,e} = \left(\frac{PB_{d,s}}{E_{d,s}}\right) \times \left(\frac{PB_{e,-d} - PB_{s,-d}}{PB_{s,-d}}\right) \qquad (4)$$

The Bartik instrument is used as an alternative in equation (2), replacing $(PB_{d,e}\text{-}PB_{d,s})/E_{d,s}$ in the two-stage least-squares regression.

5 Data

I use the *Erwerbstätigenrechnung des Bundes und der Länder* for my analysis of the private sector. It entails the yearly average workforce[1] (Destatis 2021d). To limit my sample to the private sector, I subtract the number of public employees derived from the *Personalstandsstatistik* from the total number of working people in each district and year, following the approach of Senftleben-König (2014).

The *Erwerbstätigenrechnung* includes separate counts for eight groups of economic sectors. This categorization is used for the sector-specific analysis. I follow Faggio & Overman (2014) and the subsequent literature and define the public sector as the group of the sectors O-T through to misclassification, the share of public sector workers is much higher based on the sectors (about 31 %) than its actual count in the *Personalstandsstatistik* (about 9 %). This mirrors the experiences of Faggio & Overman (2014) and Senftleben-König (2014). I exclude *Energy and water supply, disposal, and mining* from the analysis as those primarily provide public goods and are heavily regulated (Senftleben-König 2014). This leaves the private sector with classes A, C, and F-N.

The separation of the tradable and the untradable sector is derived from the WZ2008 classification (Destatis 2008). I match up the sector selection by Faggio & Overman (2014) with the German system. The untradable sector comprises of class F, G-J and K-N. The tradable sector includes class C *Manufacturing* and A *Agriculture* (Jensen et al. 2005).

1 including employees, self-employed, marginally employed and publicly employed

For wages, I rely on data provided by the *Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder"*. To separate the statistic into public- and private-, tradable and non-tradable sector wages, I use the sectoral groups described above. Total wages are transformed into real hourly gross wages of employees[2]. Thuringia did not report wages on a district level till 2014, leading to 23 districts being dropped from the analysis.

Regional asking rents represent housing costs. The data have been provided by the BBSR and are not publicly available (BBSR 2021a). The asking rents have been derived from online and print offerings of unfurnished flats and houses between 40 m^2 and 130 m^2.

Data on the control variables have been gathered from Destatis and the BBSRs Inkar-Database. The variables were checked for correlation using a Pearson-correlation test. This avoids multicollinearity (Asteriou & Hall 2021). Results are reported in Appendix C Table 5. The correlation coefficients are mostly small, with the Unemployment-East/West pair standing out with a value of 0.7. While this could be considered tolerable (Asteriou & Hall 2021), I choose to exclude the unemployment rate from my main specification. The results are, however, robust to its enclusion (Appendix C Table 8).

5.1 Timeframe

As multipliers are calculated using the differences in employment between a start and end year, their choice heavily influences the results of the analysis (Osman & Kemeny 2022). When looking at the employment multiplier of tradables, Nguyen & Soh (2017) show the influence of the business cycle on the results. To avoid the overlap of growth and recession periods, I will use the decade 2009-2019 as a timeframe. The year 2009 marks the end of a recession period in Germany, while 2019 was the last year of GDP growth before the Corona pandemic caused the next recession (Feld et al. 2020). Starting in the recession allows the results to be best applied to the expected impact of the Corona stimulus measures that have been put in place.

5.2 Descriptive Statistics

Employment

The 399 districts used in this analysis are diverse in size and composition of their workforce. I report the descriptive statistics by regional type in Appendix C Table 6 to acknowledge this variation.

In total, 3 575 354 people were employed 2009 in the public sector across the 399 districts. This number increased by 200 000 within the ten-year period (own calculations, based on Statistische Ämter des Bundes und der Länder 2021c). Public employment accounts on average for 8.9 % of total employment per district in 2009. Even though the number of public employees increases from an average of 8 961 in 2009 to 9 460 people in 2019, public employment decreased slightly in proportion to total employment. About one-third of all districts experienced a reduction in public sector jobs. In the remaining districts, the growth rate was up to 6.7 % (Table 1). Private employment accounts for over 90 % of total work in most districts. The number of private employees increased on average by 9.3 % between 2009 and 2019, compared to a 0.4 % increase in public employment. The growth is considerably more substantial for western than for eastern German districts (Appendix C Table 6).

2 for a more detailed description on the wage data see Appendix A, for regional modifications see Appendix B

Using sectoral data, public-sector employment is about three times the size of public employment, while private-sector employment captures approximately three-quarters of private employment. The growth rates are also more similar across sectors, although the private sector still outperformed the public sector (Table 1). Untradable sector employment on average is double the size of tradable sector employment. The ratio is lower for eastern and rural districts, where the tradable sector is slightly stronger (Appendix C Table 6). Untradable employment grew about three times stronger than tradable sector employment (Table 1) illustrating the general shift towards the service sector.

Wages

Wages grew faster in the untradable sector, which is a sign that increased demand indeed triggers wage growth (Table 1) The increase was stronger for eastern and rural districts but from a lower initial value.

Rents

Asking rents per square meter grew on average by 36.8 % from 2009 to 2019. The main regional distinction is again between eastern and western districts, with rents in the former growing by 22.3 % while the latter experienced a 39.7 % increase (Appendix C Table 6). Rents in urban districts developed four percentage points stronger than in rural districts.

Table 1: *Descriptive Statistics of the Regression Analysis Variables; Deltas for the period 2009-2019, the instrumental variable is defined as the public employment share of total employment in a district (2009) multiplied by the overall growth of public employment in Germany (2009-2019) excluding the respective district, Wages referring to real gross hourly wages in the respective sectors, Qualifications based on the year 2012; own calculations based on: Statistisches Bundesamt (Destatis) 2020; Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) 2021a, 2021b; Statistische Ämter des Bundes und der Länder 2021a, 2021b*

	Mean	SD	Min	1. Quartile	Median	3. Quartile	Max	N
Employment Multiplier								
Δ Public Employment	0,4%	1,2%	-5,3%	-0,2%	0,4%	1,0%	6,7%	399
Δ Private Employment	8,3%	6,5%	-9,9%	4,2%	8,7%	12,5%	28,9%	399
Instrumental Variable	0,5%	0,2%	0,2%	0,4%	0,5%	0,6%	1,4%	399
Δ Public Sector	3,2%	2,7%	-7,5%	1,8%	3,5%	4,9%	13,2%	399
Δ Private Sector	5,4%	5,5%	-7,5%	1,6%	5,4%	8,8%	23,5%	399
Δ Tradable Sector	1,3%	2,6%	-7,0%	-0,3%	0,8%	2,7%	14,1%	399
Δ Untradable Sector	4,2%	4,5%	-7,7%	1,4%	4,3%	7,0%	21,5%	399
General Equilibrium								
Δ Private Wage	14,7%	5,2%	2,4%	11,1%	13,9%	17,8%	30,5%	376
Δ Tradable Wage	10,9%	7,0%	-6,5%	6,5%	10,0%	14,9%	37,3%	376
Δ Untradable Wage	17,5%	5,5%	0,5%	14,0%	17,3%	21,0%	37,2%	376
Δ Asking Rent	35,6%	14,2%	-6,9%	25,5%	37,1%	44,8%	102,9%	399
Control Variables								
Total Population (ln)	5,20	0,28	4,53	5,02	5,17	5,38	6,54	399
Vocational Degree	63,7%	6,0%	44,4%	59,8%	64,0%	67,9%	78,8%	399
Academic Degree	9,7%	4,4%	3,3%	6,7%	8,5%	11,4%	29,7%	399

6 Analysis

The dependent and the key explanatory variable from Table 2 to Table 4, the change in private (sector) and public (sector) employment, represents the growth of their respective industries in relation to the overall employment in 2009. For example, an estimate for Public Employment Growth of 2 means that private employment increased at double the rate of public employment, expressed either in percentage points or – more intuitively – in persons. The dependent variables for the general equilibrium mechanism are wages and rents. Estimators for private, tradable, and untradable sector wages as well as rents are expressed as growth in percentage points.

Table 2: *Effect of regional public employment growth on private employment, OLS Regression and Second Stage 2SLS Regression Results of Public and Private Employment Change, own calculations*

Public Employment Growth – Private Employment Growth				
	Dependent variable:			
	Private Employment Growth			
	OLS		*2SLS*	
	(1)	(2)	(1)	(2)
Public Employment Growth	1.674***	0.699***	8.523***	7.545**
	(0.265)	(0.249)		
Total Population (ln)		0.021***		0.021**
		(0.005)		(0.008)
West		0.076***		0.007
		(0.010)		(0.036)
Urban		-0.017**		-0.005
		(0.007)		(0.014)
Share Academic Workers		0.257***		0.173
		(0.094)		(0.165)
Share Vocational Workers		-0.044		0.118
		(0.075)		(0.154)
Constant	0.076***	-0.223**	0.050***	-0.292*
	(0.003)	(0.094)	(0.012)	(0.164)
Observations	399	399	399	399
R^2	0.092	0.320		
Adjusted R^2	0.089	0.309		
Residual Std. Error	0.062	0.054	0.101	0.092
F Statistic	40.044***	30.691***		

Notes: Standard errors are reported in parentheses. R^2s and Public Employment Growth standard errors are not reported for the 2SLS Models as they are invalid for these models. The instrumental variable is defined as the public employment share of total employment in the district (2009) multiplied by the overall growth of public employment in Germany (2009-2019), excluding the respective district. Observations at the district level. Total population (ln) for the base year 2009; qualification structure for 2012. Private and public employment are expressed as contributions to total employment growth from 2009 to 2019. Public employment and private employment based on the Personalstandsstatistik (Statistische Ämter des Bundes und der Länder 2021c). For an overview of the variables, see Table 1. 2SLS Estimates were produced using the IVReg command of the Applied Econometrics with R Package (Kleiber & Zeileis 2008). First Stage estimates are reported in Appendix C Table 7. Outputs were created with stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01

6.1 The Public-Private Employment Multiplier

Public Employment - Private Employment

Public Employment Growth has a strong and significant, positive influence on Private Employment Growth (Table 2). This is the key result when I estimate equation (2). The coefficient varies between 1.7 and 0.7. All models are highly significant in their F-statistics as well as in most of their variables. Without any controls (Model 1), the addition of 10 public jobs within a district came with a 16 job increase in private employment. This value, as well as the whole model, is significant at a 1 % level.

In my preferred OLS Model, (2), all controls are included. The model explains 30 % of the observed variation, which is comparatively high (Faggio & Overman 2014; Senftleben-König 2014). The estimator for public employment is lowest in this model but still highly significant. The point estimate of 0.7 means that ten additional public jobs in one district increase private employment on average by seven positions compared to a district with the equivalent population, qualification structure, and regional characteristics. The model is significant at a 1 % level. Overall, the multiplier effect of public employment growth outweighs potential displacement effects, and more public jobs lead to more private employment.

Instrumental Variable Regression

To control for potential biases in the OLS regression model, I calculate a 2SLS model based on the shift-share approach (Table 2). The point estimates are considerably higher in this model, suggesting that β is biased in the OLS models. This effect stays constant regardless of the base years (2009-2019;2010-2019;2014-2019) or the included controls. Therefore, β is downwards biased in the linear model (Faggio & Overman 2014). With this in mind, the OLS regression results following should be interpreted as lower-end barriers of the actual effect size.

A downward biased β is associated with the targeted use of public employment to offset negative shocks and support lagging regions (Faggio & Overman 2014; Senftleben-König 2014; Auricchio et al. 2020; Roupakias 2021). This seems plausible for Germany in this timeframe and can be partially confirmed by my raw data, which show an over proportional growth of public employment in areas with shrinking private employment.

The difference between the instrumental variable regression results and the OLS results is quite large, which is not uncommon for this type of model (c.f. Faggio & Overman 2014; Senftleben-König 2014; Auricchio et al. 2020). Multiple tests confirm the plausibility of the results and the validity of the instrument. I calculated the instrument as well as the 2SLS Model for the periods 2010-2019 and 2014 to 2019. For both specifications, the 2SLS regression produced substantially larger estimates (Appendix C Table 9), and all models detect a positive public-private employment multiplier. While the effect size is dependent on the period, I do not find differences in its significance or directionality.

I test the validity of the instrument using the first stage estimates of the instrumental variable model and calculating its F statistic (Appendix C Table 7). To be reliable, the value must not be below 10 (Staiger & Stock 1997; Auer & Rottmann 2020). As all first-stage F statistics surpass 20, the model is highly significant. Additionally, it can be tested whether the instrumental variable is weak. This would be the case if it is not sufficiently correlated with the endogenous variable. To test the instrument's strength, we look at the first stage coefficients (Senftleben-König 2014; Auricchio et al. 2020). These should be significant at a 10 % level (Staiger & Stock 1997; Jaeger et al. 2018). Appendix C Table 8 shows that p is <0.01 for all models. This remains unchanged with the inclusion of control variables, suggesting that the instrument has no connection to unobserved heterogeneity (Auricchio et al. 2020) and is not violating the crucial exclusion restriction, which would make the instrument invalid (Imbens 2014). Therefore, the Bathik-Instrument is a valid, strong instrument for my analysis of public-private employment multipliers.

6.2 Sectoral Analysis

Public Employment - Private Employment

To gain a deeper understanding of the public-private employment multiplier, I disaggregate the total workforce into the tradable and untradable sectors. Doing so, I must rely on the less precise public sector as a proxy for public employment. I replicate my earlier analysis with these data to validate their use. The strong, positive effect between public and private employment remains, even though the point estimates are about half the size for all models compared to the equivalent specifications in Table 2 (Table 3 1&2).

Table 3: *Effect of regional public sector employment growth on private, tradable and untradable sector employment, OLS Regression, own calculations*

OLS Regression: Public Sector – Private/Untradable/Tradable Sector Employment Growth						
	Dependent variable:					
	Private Sector Employment		Untradable Sector Employment		Tradable Sector Employment	
	OLS					
	(1)	(2)	(1)	(2)	(1)	(2)
Public Sector Employment	0.664***	0.305***	0.665***	0.240***	-0.002	0.066
	(0.095)	(0.115)	(0.075)	(0.087)	(0.047)	(0.057)
Total population (ln)		0.019***		0.013***		0.006***
		(0.004)		(0.003)		(0.002)
West		0.049***		0.033***		0.016***
		(0.009)		(0.007)		(0.005)
Urban		-0.023***		-0.014***		-0.010***
		(0.007)		(0.005)		(0.003)
Share academic		0.153*		0.044		0.108**
		(0.086)		(0.066)		(0.043)
Share vocational		0.001		-0.169***		0.170***
		(0.072)		(0.055)		(0.036)
Constant	0.033***	-0.229***	0.021***	-0.042	0.013***	-0.188***
	(0.004)	(0.086)	(0.003)	(0.065)	(0.002)	(0.043)
Observations	399	399	399	399	399	399
R^2	0.109	0.213	0.165	0.311	0.00000	0.099
Adjusted R^2	0.107	0.201	0.162	0.301	-0.003	0.085
Residual Std. Error	0.052	0.049	0.041	0.037	0.026	0.024
F Statistic	48.507***	17.704***	78.199***	29.518***	0.001	7.163***

Note: Standard errors are reported in parentheses. Observations at the district level. Total population (ln) for the base year 2009; qualification structure for 2012. Private and Public Sector Employment are expressed as contributions to total employment growth from 2009 to 2019. Sectoral differentiation based on the WZ2008 (Statistische Ämter des Bundes und der Länder 2021d). For an overview of the variables, see Table 1. Estimates were produced using the lm command in R to calculate an Ordinary Least Squares regression, outputs were created using stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01

Untradable Sector

Public employment is expected to positively influence private employment in the untradable sector (Faggio & Overman 2014). The assumption holds true for Germany in the period 2009-2019. The point estimates are positive and highly significant. For this period of slight growth in the public sector, my preferred specification –Model 2– suggests that there is one additional job in the untradable sector for every four jobs created in the public sector. The controls are very stable across the models as well as across the different analyses performed so far. The result reveals a strong multiplier effect of public on untradable sector employment, which could be explained through an increase in the working population and wages, which boost the region's purchasing power. This assumption will be tested in a subsequent model.

Tradable Sector

The influence of the public on the tradable sector is not significantly different from zero (Table 3 1&2). The insignificantly positive coefficient found in Models 2 appears incompatible with my theoretic framework. Furthermore, it differs decisively from the significant crowding-out effect detected by Senftleben-König (2014) for Germany or Auricchio et al. (2020) for Italy. They instead resemble Jofre-Monseny et al. (2020) who find a nearly identical, insignificantly positive multiplier on the tradable sector. Fallah (2021) even detects a significantly positive multiplier.

There appear to be unobserved drivers of a multiplier effect for the tradable sector, which cancel out the price-based replacement effect. The most likely explanation is that the assumption of insignificant regional demand is violated (Jofre-Monseny et al. 2020). As no deeper disaggregated data were available, the tradable sector is defined as A-Agriculture and C-Manufacturing. These sectors include subsectors for which local demand is arguably a relevant factor. Jofre-Monseny et al. (2020) count among them, for example, parts of the food- as well as the publishing and printing or furniture industries. Nevertheless, it should also be noted that with a positive effect on untradable and no effect on tradable employment, public employment growth still changes the sectoral composition of a district in favor of the untradable sector, leading to a relative decline of the role of tradable employment (Jofre-Monseny et al. 2020).

Wages

Table 4: *Effect of regional public sector employment growth on private sector wages and asking rents, OLS Regression, own calculations*

OLS Regression: Public (Sector) Employment – Private Sector Wage Growth/Asking Rents				
	Dependent variable:			
	Private Sector Wages		Asking Rents	
	OLS			
	(1)	(2)	(1)	(2)
Public Sector Employment	-0.419***	0.240**		
	(0.102)	(0.098)		
Public employment			4.894***	2.820***
			(0.559)	(0.530)
Total population (ln)		0.002		0.001
		(0.004)		(0.010)
West		-0.077***		0.179***
		(0.008)		(0.021)
Urban		-0.015***		-0.051***
		(0.006)		(0.015)
Share academic		0.240***		0.995***
		(0.074)		(0.200)
Share vocational		0.182***		-0.039
		(0.062)		(0.168)
Constant	0.162***	0.050	0.337***	0.145
	(0.004)	(0.073)	(0.007)	(0.200)
Observations	376	376	399	399
R^2	0.044	0.397	0.162	0.364
Adjusted R^2	0.041	0.387	0.160	0.354
Residual Std. Error	0.051	0.041	0.130	0.114
F Statistic	17.019***	40.485***	76.714***	37.359***

Note:

Standard errors are reported in parentheses. Observations at the district level. Total population (ln) for the base year 2009; qualification structure for 2012. Public sector employment and Public employment are expressed as contributions to total employment growth from 2009 to 2019. Private sector wages are reported as growth of real, hourly wages, based on Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder" (2021). Sectoral differentiation based on the WZ2008 sectors (Statistische Ämter des Bundes und der Länder 2021d). Asking rents are expressed as growth of average net asking rents (cold) (Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) 2021a). For an overview of the variables, see Table 1. Estimates were produced using the lm command in R to calculate an Ordinary Least Squares regression, outputs were created using stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01

The development of local wages plays a vital role in the discussion around public-private employment multipliers (Jofre-Monseny et al. 2020). Changes in local price levels are seen as the key mechanism to the understanding of multiplier and crowding-out effects.

Contrary to expectations, in Model 1, without any controls, the effect of public sector expansions on local wages is negative (Table 4). The estimate is -0.419, therefore in districts with a 1 pp higher increase in public sector employment, wages grew about 0.42 pp less. This changes with the introduction of regional controls. Applied separately both West and Urban have a strong, negative correlation with wage development, with wages growing about 9.3 pp less in western and 1.4 pp less in urban districts. This reflects the catching-up process of the eastern and rural districts. As public sector growth was considerably up in Western and Urban districts, this effect internalizes into the Public Sector Change in Model 1. Once controlling for the regional types, the estimator for the public sector influence on private wages turns positive (***). In districts with the same regional specifics, private wages grew on average one quarter percentage point more if public employment increased by 1 pp (Model 2).

Senftleben-König (2014) finds a very similar positive effect of public employment increases on local wages, which is interesting, given the different effects of public employment on total and sectoral employment in these periods. Therefore, this observation can be used to derive a better understanding of the much-described asymmetric effect of public employment in- and decreases on private employment.

Disaggregating the results by sector (Appendix C Table 10) shows an insignificant effect on tradable and a significantly positive effect on untradable sector wages. This hints that workers are not perfectly mobile across sectors, as is commonly assumed in economic theory (Faggio & Overman 2014). As public employment is mainly considered to be in the untradable sector (Faggio & Overman 2014), its increase appears to only put upwards pressure on untradable sector wages. This helps to understand the insignificant effect of public on tradable sector employment. As tradable sector wages are unaffected, the leading cause of the crowding-out effect does not apply. Therefore, the assumption that public sector expansion would harm tradable employment by increasing local wage levels does not hold up. To explain the insignificant effect of public on tradable sector employment, as discussed above, demand for regional tradables must therefore only level out price and not wage effects.

Rents

Finally, I look into the effect of public employment on regional asking rents, which are the main factor in regional price levels and influence the general equilibrium (Kosfeld et al. 2009). Their variance is greater than that of regional price levels in general. Nevertheless, rents are the best approximation available over the timeframe (Kosfeld et al. 2009).

Public employment increases regional asking rents considerably in all models. The coefficient remains highly significant for all of them. In my preferred specification (Table 4, Model 2), a one percentage point increase in public employment comes with 2.8 pp higher asking rents in the district. As expected, public employment increases lead to higher regional price levels, expressed in asking rents. These are increasing the pressure of crowding out. Therefore, the detected positive influence of public employment on total employment (Tables 2&3) can be read as an indicator that local purchasing power effects of public employment are strong.

6.3 The Asymmetric Multiplier Effect

Public employment has a positive multiplier effect on private employment in Germany from 2009 to 2019. This holds true regardless of the specifics of the sectoral split or the regression method used. The multiplier is driven by the positive effect of public- on untradable sector employment while the tradable sector remains unaffected. Private sector wages increase significantly with more public sector jobs, an effect again dominated by the untradable sector. Tradable sector wages are not significantly affected. As expected from theory, increases in public employment apply an upwards pressure on local prices, increasing asking rents.

These results are overwhelmingly in line with the theoretical assumptions and other papers based on periods of public sector expansion. However, they differ from studies investigating public employment reductions, including the one previous paper available for Germany by Senftleben-König (2014). My calculations provide additional evidence on the existence of an asymmetric reaction of private employment on public sector expansion and contraction (Auricchio et al. 2020). The causes of this effect are yet unknown.

The study by Senftleben-König (2014) calculating the public-private multiplier for Germany in a phase of public sector shrinkage combined with my calculations allows me to present a theory-led, evidence-based thesis on the cause of the asymmetric multiplier effect, especially for Germany. A better understanding of this effect is a crucial requirement to determine the validity of my results and to be able to assess the political consequences of public employment policies.

The foundation of the theoretical framework holds regardless of the directionality of public employment changes. Using public sector expansion or reduction data, more public employment leads to more total employment. Even though Senftleben-König (2014) finds a crowding-out effect on the private sector of -0.5, this means that one additional public job increases total employment by 0.5. In my model, total employment grows by 1.7 jobs. In both cases, these expansions correlate with higher wages in the private sector. Nevertheless, in the analysis by Senftleben-König (2014), higher wages are connected with the crowding out of private-sector jobs while they are not in my calculations.

Following the theoretic framework, this difference can most likely be explained by regional demand. It is the decisive factor leading to an increase in non-tradable employment despite higher wages and housing costs. Given the results by Senftleben-König (2014), regional demand must not have increased sufficiently with public employment increases between 2003 and 2007; therefore, companies were faced with higher costs (higher wages and rents) that they could not successfully pass on to their customers, forcing them to reduce their workforce or relocate. From 2009 to 2019, this must have been different. Here, public employment spurred the regional purchasing power up to a point where businesses could not only stagnate but grow. This is likely caused by the structural difference in the data. While my model is based in an environment of overall growth in public employment, Senftleben-Königs (2014) is not. Therefore, we must rethink the mechanism for this scenario.

The positive influence on wages detected by Senftleben-König (2014) means that, as most districts experienced public sector employment cuts, the regional wage level primarily decreased. The decline in regional purchasing power due to fewer jobs and lower wages seems to be compensated by the lower labor costs in non-tradable sector enterprises. This explains the insignificant impact of public employment on the sector. The situation is different in the tradable sector. Since, in theory, this sector is not, or at least less, influenced by regional demand, the decline in the regional wage level is the decisive factor that allows companies in the sector to create more jobs. The positive effect on tradable- and the indifferent influence on untradable employment combined explain the significant increase in private employment following public employment reductions (Senftleben-König 2014).

The situation is different in the context of growing public employment. Here, the increased regional purchasing power due to higher wages and more public jobs overcompensates the higher wage costs for companies in the non-tradable sector. Thus, employment is also increasing in this sector. At the same time, the tradable sector is not significantly affected by higher wage levels (Appendix C Table 10) and benefits only to a small extent from higher regional demand. Therefore, no significant effect can be observed overall.

Two causes explain the differences in regional demand between the periods: Migration and Privatization. In Italy, public sector jobs were mainly reduced by not filling posts once they became vacant through retirement (Auricchio et al. 2020). For Germany, public employment reductions in the 2000s can partly be attributed to similar hiring ban policies. They were accompanied by privatization (mainly in the health sector) (Bosch 2012). This means that private-sector-increases and public-sector-decreases in this phase were partly due to changes in the classification of the jobs themselves as a once public job in 2003 was labeled private in 2007. More generally, employment ban policies create a significant difference between the influence of public sector increases and reductions on migration and local demand. While public sector increases might lead to in-migration (as in Spain, Jofre-Monseny et al. 2020), public job reduction does not necessarily promote outmigration. If public employment reductions are mainly due to retirement and transitions to the private sector (Bosch 2012) the likelihood of a migration response is reduced. Since retired people are less mobile than those in the “job-finding phase” (Milbert & Sturm 2016), it is not unlikely that regions grow with public sector expansion but do not shrink following retirement-based reductions. This again means that the number of consumers reacts more strongly to public sector expansion than contraction. There is limited but clear evidence to support this thesis. Senftleben-König (2014) estimates the connection between public sector growth and net-migration and finds a small, insignificant connection. On the other hand, Jofre-Monseny et al. (2020) detect a strong, significantly positive influence of public employment on working-age – as well as total population.

If public jobs are reduced through voluntary exits and retirement and retirees and former public employees do not leave their regions (as is indicated by Senftleben-König (2014)), they remain an essential factor of regional demand. If the newly created public sector jobs in most regions from 2009 to 2019 were at least partly filled by movers, these would increase regional demand. Therefore, migration responses and the terms of the public job reduction can explain the different reactions of regional demand to the directionality of public employment changes. As shown above, the asymmetric reaction of regional demand can itself conclusively explain the asymmetric response of private employment to public employment growth. In accordance with the latest findings on the government spending multiplier (Lu & Zhu 2021), public sector expansion influences regional labor markets significantly more positively than its contraction harms them.

7 Conclusion

Public entities are by far the largest employers in Germany. Federal and state governments use the scope and location of these workers as a tool to spur regional and national employment or support lagging regions, for example following the economic outfalls of the Corona crises (Wolter et al. 2020). Given the magnitude, changes in public employment inevitably affect private sector employment and the regional economy. Especially for times of public employment expansion, there is a lack of knowledge whether this hurts or spurs private employment. The Corona stimulus package for example is expected to create 60 000 additional public jobs (Feld et al. 2020; Wolter et al. 2020). Previous research identified a crowding-out effect of about -0.5 for Germany (Senftleben-König 2014). If this were to hold true, the measure would displace 30 000 private jobs and therefore be an inefficient stimulus to the economy. My calculations do, however, suggest otherwise.

Focusing on the period 2009 to 2019, where the public sector expanded overall, I find a strong, positive multiplier effect of public on private employment. Controlling for the population, region and qualification structure, the multiplier is highly significant at 0.7. To put this into perspective, with everything else unchanged, the 60 000 additional public jobs planned would create 42 000 private jobs over the regions.

The non-tradable sector drives the detected positive effect. This was expected as this sector benefits most from increased local demand and can pass on higher prices and wages to the local consumers. At the same time, the tradable sector remains unaffected. Public employment increases therefore shift the sectoral composition in favor of untradables.

The general equilibrium effect states that prices and employment adapt until an equilibrium is reached. With increased employment, therefore increased demand for workers, I find wage levels to rise. This effect, however, is again only noticeable in the untradable sector where workers can move more freely into public employment given the higher similarity of the required skills. The tradable sector remains unaffected.

I detect a significant effect of public employment increases on regional price levels, expressed as asking rents, with one percentage point more public employment leading to 2.8 pp higher asking rents. As higher prices and wages put pressure on local businesses, the positive employment effect found overall can be traced back to an increase in local demand that overcompensates the general equilibrium effect.

My results differ decisively from those of Senftleben-König (2014) but they resemble those from the United Kingdom and Spain (Faggio & Overmann 2014, Jofre-Monseny et al. 2020). This strengthens the theory that the multiplier effect is asymmetrical and reacts differently to public employment in- and decreases. Developing a theory to explain these differences, I argue that the demand effect is highly dependent on the context of the investigation. Demand increases more with public sector expansion than it decreases with its contraction. This can be explained by the specific circumstances of public sector contraction in the available studies for Italy (Auricchio et al. 2020) and Germany (Senftleben-König 2014). As the jobs were mostly reduced through employment bans or privatization, the stock of consumers did not decrease decisively with public employment reductions. At the same time, newly created public positions are at least partly filled by movers, which increases local demand in addition to the higher income in the regions.

While my estimations support nationwide economic policies like the Corona stimulus package, the targeted use of public employment to promote lagging regions is less promising. The results of the instrumental variable regression show that the Ordinary Least Squares estimates are biased downwards. This means, that public employment forfeits most of its economic potential if it is over proportionately increased in lagging regions as a measure of structural aid. The inner workings of this effect require further research. My analysis does not include whether public employment increased in absolute terms in lagging regions or if it just decreased slower than private employment. As on the national level, it seems likely that this is a decisive difference.

The importance of public employment is evident in broad numbers as well as in the influence its changes have on other parts of the economy. Closing a gap in literature, I conducted the first follow up analysis on the effect of public employment changes on private employment in one country under periods of public sector expansion and contraction. I was able to show that public employment growth substantially increases private employment, wages, and rents. By providing a conclusive explanation that the opposite effect found by Senftleben-König (2014) for the period 2003-2007 is due to asymmetry rather than country-specifics, I was able to resolve questions about the effectiveness of public employment as an economic stimulus tool. While public employment might not necessarily benefit every single district or sector, its increase to stimulate the economy as a whole is promising and can be supported by the evidence gained from 2009 to 2019 in Germany.

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Appendix A

Wages

For wages, I rely on data provided by the Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder". The statistic reports gross wages and salaries paid in German districts. Wages are registered for the same sectoral groups as in the Erwerbstätigenrechnung, but self-employed are excluded from this statistic. All wages are reported in total sums across the districts. To separate the statistic into public- and private-, tradable and non-tradable sector wages, I use the sectoral groups described above. Total wages are brought to a shared basis between the counties. The mechanism is exemplified for the manufacturing sector in equation (6).

$$Real\ Hourly\ Gross\ Wage\ (Tradable)_{d,t} = \frac{Gross\ Wages\ Manufacturing_{d,t} + Gross\ Wages\ Agriculture_{d,t}}{Labour\ Volume\ Manufacturing\ (h)_{d,t} + Labour\ Volume\ Agriculture\ (h)_{d,t}} Price\ level_{l,t} \quad (1)$$

I add up the total wages paid in district (d) and year (t) in the private-, public-, tradable-, and non-tradable sectors, respectively. I divide this figure by the sum of the labor volume in hours for the respective group of industries (Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder" 2021). This creates hourly gross wages and assures comparability across regions with different population counts. Additionally, I deflate the gross wages with the price level in state l, as regional price levels are only available for 2008 (Kawka 2010: 401). This produces the final, real hourly gross wages of employees.

Thuringia did not report gross wages on a district level till 2014, leading to 23 districts being dropped from the analysis. While not ideal, this decision was made as the recently released data (Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder" 2021) are the best option to run the analysis. The only alternative would be to aggregate microdata from the sample of integrated labour market biographies (SIAB), as has been the approach by Senftleben-König (2014). This, however, comes with several disadvantages. Firstly, the SIAB only provides data on a 2 % sample of the integrated employment biographies. At the same time, the newly available information by the National Accounts Comity covers all payments within the given time. Secondly, wages in the SIAB are top coded and only report up to the social security threshold, which can only partly be corrected by implementing artificial numbers and therefore adds uncertainty. Finally, the SIAB is a highly complex dataset that requires multiple cleanings and changes which mostly rely on assumptions and decisions by the individual researcher to be usable (Dale-Olsen & Schøne 2020), which reduces comparability.

Appendix B

Regions

I want to investigate the influence of public employment changes on local labor markets in Germany as a whole. Therefore, the focus on major cities that prevails in some studies would not fit this analysis as it lacks generalizability (Osman & Kemeny 2022: 13). Instead, I use a data set available for all German districts (Landkreise). As several border reforms merged and transformed districts in Mecklenburg-Vorpommern in 2011, the 2019-borders are used for the analysis, and data is summed up for the merged districts. The Demmin district was split up and included in the districts Vorpommern-Greifswald and Mecklenburgische Seenplatte, which were merged from three districts each (Landtag Mecklenburg-Vorpommern 2010). The only option to produce valid data for those districts would be, to sum up the data of Vorpommern-Greifswald and Mecklenburgische Seenplatte, which would create a synthetic district about four times the size of the Saarland. The comparability to other regions would be mostly lost for this artificial district as there would be the possibility of different developments leveling each other out within it. Therefore, these districts are excluded from the analysis, leaving 399 districts within the borders of 2019 for all employment and rent-related analyses. As Thuringia did not report wages at a district level until 2014, 23 districts are additionally excluded from the wage analyses. This leaves a total of 376 districts for which wage data are available.

Appendix C

Table 5: *Correlation statistics between the control variables, own calculations, Pearson Correlations; Unemployment Share based on 2009, Qualifications on 2012, West/East and Urban/Rural are dummy variables, Source: (Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) 2021b)*

	Total Population (ln)	Unemployment	West	Urban	Academic Degree	Vocational Degree
Total Population (ln)	1	0.057	-0.032	0.468	0.375	-0.456
Unemployment	0.057	1	0.694	-0.070	0.207	0.144
West	-0.032	0.694	1	-	0.172	0.417
Urban	0.468	-0.070	-	1	0.454	-0.599
Share Academic	0.375	0.207	0.172	0.454	1	-0.589
Share Vocational	-0.456	0.144	0.417	-0.599	-0.589	1

Table 6: *(Continued on pp. IX, X) Descriptive Statistics of the baseline data by region; Private Wages refer to Private Sector Real Hourly Wages; the unemployment rate is included as an additional control; own calculations, Sources: (Statistisches Bundesamt (Destatis) 2020; Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) 2020, 2021a, 2021b; Statistische Ämter des Bundes und der Länder 2021a, 2021b)*

		Mean					Δ Mean 2009 - 2019					Standard Derivation				
		Total	East	West	Urban	Rural	Total	East	West	Urban	Rural	Total	East	West	Urban	Rural
Total Employment	2009	101.912	97.133	103.019	146.093	58.391						130.853	191.273	112.738	173.297	25.619
Total Employment	2019	112.882	104.619	114.795	163.645	62.877	10,8%	7,7%	11,4%	12,0%	7,7%	155.653	236.544	130.441	207.312	28.556
Public Employment	2009	8.961	9.692	8.792	12.784	5.195						12.125	18.445	10.151	16.176	2.466
Public Employment	2019	9.460	9.633	9.420	13.636	5.347	5,6%	-0,6%	7,1%	6,7%	2,9%	13.322	20.310	11.143	17.814	2.513
Private Employment	2009	92.951	87.442	94.227	133.310	53.195						119.284	173.014	103.277	157.877	23.729
Private Employment	2019	103.422	94.985	105.375	150.009	57.530	11,3%	8,6%	11,8%	12,5%	8,1%	142.843	216.397	119.973	190.179	26.715
Share Public Employment	2009	8,9%	10,1%	8,7%	8,8%	9,1%						2,9%	2,9%	2,9%	3,1%	2,7%
Share Public Employment	2019	8,6%	9,4%	8,4%	8,5%	8,8%	-3,5%	-6,3%	-2,8%	-3,7%	-3,3%	2,9%	2,9%	2,8%	2,9%	2,8%
Tradable Employment	2009	31.715	33.868	31.217	45.554	18.084						45.253	76.609	34.314	60.712	8.261
Tradable Employment	2019	35.733	36.109	35.646	52.282	19.430	12,7%	6,6%	14,2%	14,8%	7,4%	53.635	91.271	40.449	72.002	8.936
Untradable Employment	2009	68.769	61.633	70.421	98.513	39.469						85.702	112.765	78.246	112.882	18.066
Untradable Employment	2019	75.649	66.885	77.677	109.265	42.534	10,0%	8,5%	10,3%	10,9%	7,8%	101.903	143.248	89.846	135.278	20.450
Public Sector Employment	2009	19.798	14.669	20.986	25.933	13.756						15.917	14.620	15.990	19.390	7.739
Public Sector Employment	2019	20.873	15.561	22.102	26.999	14.837	5,4%	6,1%	5,3%	4,1%	7,9%	17.207	15.176	17.436	21.075	8.829
Private Sector Employment	2009	48.971	46.964	49.435	72.580	25.713						73.686	99.832	66.377	98.531	12.119
Private Sector Employment	2019	54.776	51.324	55.575	82.266	27.697	11,9%	9,3%	12,4%	13,3%	7,7%	89.624	130.242	77.511	120.560	13.521
Asking Rent	2009	5,55 €	4,96 €	5,69 €	6,07 €	5,05 €						1,13 €	0,56 €	1,18 €	1,23 €	0,73 €
Asking Rent	2019	7,60 €	6,06 €	7,95 €	8,41 €	6,79 €	36,8%	22,3%	39,7%	38,6%	34,6%	2,03 €	1,33 €	2,00 €	2,18 €	1,48 €
Private Wages	2009	22,13 €	16,58 €	23,00 €	24,06 €	20,09 €						3,92 €	1,60 €	3,43 €	3,67 €	3,05 €
Private Wages	2019	25,30 €	20,29 €	26,09 €	27,27 €	23,22 €	14,3%	22,4%	13,4%	13,4%	15,6%	4,24 €	1,89 €	3,96 €	4,24 €	3,10 €
Tradable Wages	2009	26,17 €	18,58 €	27,39 €	29,26 €	22,96 €						5,89 €	3,05 €	5,29 €	5,49 €	4,38 €
Tradable Wages	2019	28,95 €	21,85 €	30,09 €	32,17 €	25,59 €	10,6%	17,6%	9,8%	9,9%	11,5%	6,58 €	3,82 €	6,20 €	6,45 €	4,80 €
Nontradable Wages	2009	19,79 €	15,74 €	20,43 €	21,25 €	18,25 €						3,20 €	1,53 €	2,91 €	3,23 €	2,33 €
Nontradable Wages	2019	23,17 €	19,51 €	23,76 €	24,71 €	21,56 €	17,1%	24,0%	16,3%	16,3%	18,1%	3,42 €	1,72 €	3,26 €	3,55 €	2,40 €
Control Variables																
Total Population	2009	203.708	211.432	201.920	277.649	130.871						231.893	389.817	177.285	306.365	61.765
Vocational Degree 2012	2012	63,7%	68,9%	62,5%	60,1%	67,3%						6,0%	6,0%	5,3%	5,4%	4,2%
Academic Degree 2012	2012	9,7%	11,3%	9,3%	11,7%	7,7%						4,4%	4,4%	4,3%	5,0%	2,4%
Unemployment Rate	2009	7,7%	12,6%	6,6%	7,5%	7,9%						3,4%	2,3%	2,5%	2,9%	3,8%

		1. Quartile					Median					3. Quartile				
		Total	**East**	**West**	**Urban**	**Rural**	**Total**	**East**	**West**	**Urban**	**Rural**	**Total**	**East**	**West**	**Urban**	**Rural**
Total Employment	2009	47.200	43.400	47.775	66.000	39.250	68.700	62.500	70.200	108.850	53.200	113.000	99.500	117.825	159.000	70.200
Total Employment	2019	49.400	42.100	54.725	72.975	41.600	74.500	64.700	78.000	123.050	58.200	127.100	100.000	129.050	174.850	76.650
Public Employment	2009	3.855	4.240	3.736	5.565	3.237	6.010	6.218	5.885	8.534	4.626	9.751	8.908	10.146	14.438	6.839
Public Employment	2019	4.095	4.080	4.163	5.675	3.403	6.180	5.960	6.323	9.175	4.875	10.280	8.795	10.696	15.249	6.798
Private Employment	2009	42.775	38.104	43.874	60.999	35.674	62.482	56.209	64.587	100.283	48.577	104.569	88.919	107.903	146.232	64.185
Private Employment	2019	45.235	36.250	48.235	65.239	37.920	69.245	57.135	71.370	111.958	53.515	116.725	89.720	120.104	159.023	70.715
Share Public Employment	2009	7,0%	8,2%	6,8%	6,8%	7,3%	8,2%	9,3%	8,0%	7,9%	8,6%	10,4%	11,0%	10,2%	10,1%	10,6%
Share Public Employment	2019	6,7%	7,3%	6,5%	6,5%	6,8%	8,0%	8,8%	7,8%	7,6%	8,2%	9,8%	11,0%	9,7%	9,7%	10,3%
Tradable Employment	2009	13.900	13.600	13.925	19.275	12.050	21.400	19.200	21.750	30.950	16.100	34.800	31.100	35.600	51.150	22.500
Tradable Employment	2019	15.500	13.800	15.800	22.475	12.850	23.300	18.500	23.600	35.650	17.300	38.800	31.600	40.300	56.725	24.450
Untradable Employment	2009	30.900	28.600	31.725	44.050	26.400	47.000	40.100	48.750	75.150	35.400	79.200	61.400	81.950	106.450	47.800
Untradable Employment	2019	32.600	28.200	34.650	48.700	28.250	52.400	41.900	53.500	81.550	39.300	85.700	63.400	89.775	112.000	53.250
Public Sector Employment	2009	9.700	8.100	10.325	10.850	8.550	15.000	10.500	15.700	21.000	11.800	25.000	17.800	26.625	35.750	17.650
Public Sector Employment	2019	9.900	8.300	10.525	10.800	9.050	15.500	10.700	16.500	21.700	12.800	26.300	18.300	28.575	36.475	18.300
Private Sector Employment	2009	20.700	18.600	21.275	28.775	16.700	30.900	30.500	30.900	51.350	23.800	52.200	46.000	56.275	74.225	31.550
Private Sector Employment	2019	21.700	17.900	23.225	32.575	17.450	33.400	30.700	33.700	56.350	25.600	58.800	47.000	60.975	79.325	34.200
Asking Rent	2009	4,78 €	4,62 €	4,89 €	5,14 €	4,58 €	5,23 €	4,80 €	5,37 €	5,72 €	4,90 €	5,96 €	5,23 €	6,25 €	6,72 €	5,37 €
Asking Rent	2019	6,05 €	5,23 €	6,58 €	6,75 €	5,57 €	7,13 €	5,56 €	7,57 €	8,09 €	6,63 €	8,64 €	6,29 €	9,00 €	9,66 €	7,66 €
Private Wages	2009	19,71 €	15,59 €	20,64 €	21,63 €	17,78 €	21,95 €	16,47 €	22,55 €	23,55 €	20,21 €	24,13 €	17,44 €	24,82 €	26,05 €	22,09 €
Private Wages	2019	22,50 €	18,82 €	23,40 €	24,24 €	20,79 €	24,84 €	19,82 €	25,32 €	26,59 €	22,91 €	27,50 €	21,09 €	27,87 €	29,41 €	25,07 €
Tradable Wages	2009	22,21 €	16,68 €	23,68 €	26,10 €	19,55 €	26,13 €	17,50 €	26,94 €	28,56 €	22,95 €	29,54 €	20,07 €	30,05 €	32,03 €	26,10 €
Tradable Wages	2019	24,35 €	19,07 €	25,67 €	28,15 €	22,11 €	28,45 €	20,65 €	29,26 €	30,95 €	25,03 €	32,21 €	23,88 €	32,96 €	35,72 €	28,48 €
Nontradable Wages	2009	17,86 €	14,63 €	18,50 €	19,13 €	16,60 €	19,46 €	15,25 €	19,83 €	20,29 €	18,29 €	21,18 €	16,33 €	21,66 €	22,88 €	19,96 €
Nontradable Wages	2019	20,95 €	18,46 €	21,50 €	22,23 €	19,86 €	22,62 €	18,98 €	23,04 €	23,64 €	21,30 €	24,78 €	20,13 €	25,13 €	26,66 €	22,90 €
Control Variables																
Total Population	2009	105.554	99.987	106.842	132.671	88.567	148.470	152.523	148.410	217.143	122.812	238.281	217.373	250.375	313.043	164.451
Vocational Degree 2012	2012	59,8%	64,6%	59,0%	56,9%	64,3%	64,0%	70,4%	62,9%	60,2%	67,2%	67,9%	73,1%	66,4%	63,7%	70,2%
Academic Degree 2012	2012	6,7%	8,4%	6,5%	8,0%	6,0%	8,5%	9,8%	8,1%	10,4%	7,1%	11,4%	12,2%	11,3%	14,5%	9,4%
Unemployment Rate	2009	4,9%	11,2%	4,7%	5,0%	4,8%	6,8%	12,6%	6,1%	6,8%	7,0%	9,7%	14,0%	8,1%	9,2%	10,8%

X

		Minimum					Max					N				
		Total	**East**	**West**	**Urban**	**Rural**	**Total**	**East**	**West**	**Urban**	**Rural**	**Total**	**East**	**West**	**Urban**	**Rural**
Total Employment	2009	19.700	23.200	19.700	23.100	19.700	1.673.400	1.673.400	1.131.000	1.673.400	163.400	399	75	324	198	201
Total Employment	2019	20.000	20.900	20.000	24.700	20.000	2.066.700	2.066.700	1.292.300	2.066.700	194.500	399	75	324	198	201
Public Employment	2009	1.386	1.530	1.386	2.036	1.386	159.671	159.671	95.337	159.671	13.204	399	75	324	198	201
Public Employment	2019	1.415	1.460	1.415	2.125	1.415	176.035	176.035	110.005	176.035	13.035	399	75	324	198	201
Private Employment	2009	17.996	20.672	17.996	19.724	17.996	1.513.729	1.513.729	1.052.598	1.513.729	152.946	399	75	324	198	201
Private Employment	2019	17.405	18.970	17.405	21.030	17.405	1.890.665	1.890.665	1.203.715	1.890.665	183.800	399	75	324	198	201
Share Public Employment	2009	3,8%	5,6%	3,8%	4,6%	3,8%	25,9%	22,4%	25,9%	25,9%	17,5%	399	75	324	198	201
Share Public Employment	2019	3,6%	5,4%	3,6%	4,6%	3,6%	25,3%	21,8%	25,3%	25,3%	17,0%	399	75	324	198	201
Tradable Employment	2009	6.000	7.100	6.000	7.600	6.000	669.700	669.700	322.100	669.700	45.200	399	75	324	198	201
Tradable Employment	2019	6.600	6.600	7.100	7.700	6.600	796.400	796.400	383.500	796.400	53.700	399	75	324	198	201
Untradable Employment	2009	12.500	14.300	12.500	15.200	12.500	984.300	984.300	796.500	984.300	117.600	399	75	324	198	201
Untradable Employment	2019	12.000	12.700	12.000	16.200	12.000	1.250.200	1.250.200	893.800	1.250.200	137.700	399	75	324	198	201
Public Sector Employment	2009	2.100	2.100	3.100	2.100	2.200	116.600	116.600	103.600	116.600	43.400	399	75	324	198	201
Public Sector Employment	2019	1.300	1.300	2.600	2.100	1.300	117.500	117.500	113.200	117.500	50.900	399	75	324	198	201
Private Sector Employment	2009	8.200	9.900	8.200	8.600	8.200	867.700	867.700	692.900	867.700	74.200	399	75	324	198	201
Private Sector Employment	2019	8.300	8.800	8.300	11.700	8.300	1.132.700	1.132.700	786.500	1.132.700	86.800	399	75	324	198	201
Asking Rent	2009	3,82 €	4,19 €	3,82 €	4,39 €	3,82 €	11,26 €	7,19 €	11,26 €	11,26 €	8,41	399	75	324	198	201
Asking Rent	2019	4,56 €	4,56 €	4,72 €	4,83 €	4,56 €	18,31 €	11,82 €	18,31 €	18,31 €	11,97	399	75	324	198	201
Private Wages	2009	14,51 €	14,51 €	15,77 €	14,58 €	14,51 €	36,88 €	22,74 €	36,88 €	36,88 €	28,50 €	375	51	324	192	183
Private Wages	2019	17,79 €	17,79 €	18,73 €	18,50 €	17,79 €	44,84 €	27,15 €	44,84 €	44,84 €	33,74 €	375	51	324	192	183
Tradable Wages	2009	14,41 €	14,41 €	16,83 €	14,82 €	14,41 €	49,02 €	30,35 €	49,02 €	49,02 €	34,19 €	376	52	324	192	184
Tradable Wages	2019	16,96 €	16,96 €	18,60 €	18,74 €	16,96 €	57,96 €	32,95 €	57,96 €	57,96 €	40,57 €	376	52	324	192	184
Nontradable Wages	2009	13,90 €	13,90 €	15,24 €	14,37 €	13,90 €	32,36 €	21,55 €	32,36 €	32,36 €	26,77 €	376	52	324	192	184
Nontradable Wages	2019	17,36 €	17,36 €	18,54 €	18,26 €	17,36 €	36,75 €	26,46 €	36,75 €	36,75 €	32,74 €	376	52	324	192	184
Control Variables																
Total Population	2009	34.109	39.526	34.109	42.994	34.109	3.442.675	3.442.675	1.774.224	3.442.675	357.056	399	75	324	198	201
Vocational Degree 2012	2012	44,4%	49,3%	44,4%	44,4%	56,9%	78,8%	78,8%	73,5%	76,7%	78,8%	399	75	324	198	201
Academic Degree 2012	2012	3,3%	6,6%	3,3%	4,2%	3,3%	29,7%	28,9%	29,7%	29,7%	15,9%	399	75	324	198	201
Unemployment Rate	2009	2,2%	8,2%	2,2%	3,0%	2,2%	17,8%	17,8%	15,3%	15,3%	17,8%	399	75	324	198	201

Table 7: *2 SLS Regression, First stage regression results, own calculations*

2SLS Regression: Bathik Instrument – Private Employment Growth					
	Dependent variable:				
	Private Employment 2SLS				
	(1)	(2)	(3)	(4)	(5)
Instrument	-9.081***	-7.340***	-5.816***	-9.855***	-7.342***
	-1915	-1911	-1748	-1819	-1808
Total population (ln)		0.022***			0.014***
		(0.005)			(0.005)
West			0.068***		0.077***
			(0.008)		(0.009)
Urban			0.012**		-0.020***
			(0.006)		(0.007)
Share academic				-0.064	0.342***
				(0.084)	(0.095)
Share vocational				-0.460***	-0.100
				(0.059)	(0.078)
Constant	0.128***	-0.139**	0.051***	0.431***	-0.076
	(0.010)	(0.060)	(0.012)	(0.043)	(0.099)
Observations	399	399	399	399	399
R2	0.054	0.099	0.244	0.217	0.334
Adjusted R2	0.051	0.095	0.238	0.211	0.324
Residual Std. Error	0.063	0.061	0.056	0.057	0.053
F Statistic	22.496***	21.780***	42.519***	36.450***	32.762***

Notes:

Standard errors are reported in parentheses. Observations at the district level. Total population (ln) for the base year 2009; qualification structure for 2012. Private employment is expressed as contributions to total employment growth from 2009 to 2019. The instrumental variable is defined as the public employment share of total employment in the district (2009) multiplied by the overall growth of public employment in Germany (2009-2019), excluding the respective district. Public employment and private employment based on the Personalstandsstatistik (Statistische Ämter des Bundes und der Länder 2021c). For an overview of the variables, see Table 2. Estimates were produced using the lm command in R to calculate an Ordinary Least Squares regression, outputs were created using stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01

Table 8: *OLS results of the main specification (1) and two alternative specifications with an unemployment control (2),(3); own calculations*

OLS Regression: Public Employment Growth – Private Employment Growth			
	Dependent variable:		
	Private Employment		
	(1)	(2)	(3)
Public Employment	0.699***	0.406*	0.396*
	(0.249)	(0.221)	(0.222)
Total population (ln)	0.021***	0.020***	0.020***
	(0.005)	(0.004)	(0.004)
Unemployment Share		-0.011***	-0.011***
		(0.001)	(0.001)
West	0.076***		0.004
	(0.010)		(0.011)
Urban	-0.017**	-0.012*	-0.013**
	(0.007)	(0.006)	(0.006)
Share academic	0.003***	0.002**	0.002**
	(0.001)	(0.001)	(0.001)
Share vocational	-0.0004	-0.002***	-0.002**
	(0.001)	(0.001)	(0.001)
Constant	-0.223**	0.034	0.014
	(0.094)	(0.071)	(0.086)
Observations	399	399	399
R2	0.320	0.468	0.469
Adjusted R2	0.309	0.460	0.459
Residual Std. Error	0.054	0.047	0.047
F Statistic	30.691***	57.557***	49.252***

Notes: Standard errors are reported in parentheses. Observations at the district level. Total population (ln), and unemployment for the base year 2009, qualification structure for 2012. Private and public employment are expressed as contributions to total employment growth from 2009 to 2019. Public employment and private employment based on the Personalstandsstatistik (Statistische Ämter des Bundes und der Länder 2021c). For an overview of the variables, see Table 2. Estimates were produced using the lm command in R to calculate an Ordinary Least Squares regression, outputs were created using stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01

Table 9: *OLS and 2SLS Regressions for the periods 2012-2019 and 2014-2019, own calculations*

Additional OLS and 2SLS Models for 2010-2019 and 2014-2019				
	Dependent variable:			
	Private Employment Growth			
	OLS		2SLS	
	2010 - 2019	2014 - 2019	2010 - 2019	2014 - 2019
	(1)	(2)	(3)	(4)
Public Employment Growth	1.255***	0.074***	5.173***	0.440*
	(0.250)	(0.024)	(1.407)	(0.241)
Constant	0.075***	0.047***	0.061***	0.033***
	(0.003)	(0.002)	(0.006)	(0.010)
Observations	399	399	399	399
R2	0.060	0.024		
Adjusted R2	0.057	0.021		
Residual Std. Error	0.061	0.038	0.077	0.048
F-Statistic	25.151***	9.591***		

Notes:

Standard errors are reported in parentheses. Observations at the district level. R2s are only reported for the OLS Models as they are invalid for 2SLS models. Private and public employment are expressed as contributions to total employment growth from 2009 to 2019. The instrumental variable is defined as the public employment share of total employment in the district (2009) multiplied by the overall growth of public employment in Germany (2009-2019), excluding the respective district. Public employment and private employment based on the Personalstandsstatistik (Statistische Ämter des Bundes und der Länder 2021c). For an overview of the variables, see Table 2. Estimates were produced using the IVReg command of the Applied Econometrics with R Package (Kleiber & Zeileis 2008), outputs were created using stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01

Table 10: *Effect of regional public sector employment growth on tradable and untradable sector wages, OLS Regression, own calculations*

OLS Regression: Public Sector Employment – Sectoral Wage Growth				
	Dependent variable:			
	Untradable Sector Wages		Tradable Sector Wages	
	OLS			
	(1)	(2)	(1)	(2)
Public Sector	-0.370***	0.199*	-0.421***	0.161
	(0.108)	(0.115)	(0.138)	(0.149)
Total population (ln)		0.009*		-0.007
		(0.005)		(0.006)
West		-0.070***		-0.050***
		(0.010)		(0.013)
Urban		-0.010		0.004
		(0.007)		(0.009)
Share academic		0.078		0.527***
		(0.087)		(0.112)
Share vocational		0.144**		0.481***
		(0.073)		(0.094)
Constant	0.188***	0.030	0.123***	-0.127
	(0.005)	(0.086)	(0.006)	(0.111)
Observations	376	376	376	376
R2	0.030	0.255	0.024	0.225
Adjusted R2	0.028	0.243	0.022	0.212
Residual Std. Error	0.054	0.048	0.069	0.062
F Statistic	11.680***	21.097***	9.357***	17.812***

Notes: Standard errors are reported in parentheses. Observations at the district level. Total population (ln) for the base year 2009; qualification structure for 2012. Public sector employment is expressed as contributions to total employment growth from 2009 to 2019. Private sector wages are reported as growth of real, hourly wages, based on (Arbeitskreis "Volkswirtschaftliche Gesamtrechnungen der Länder" 2021). Sectoral differentiation based on the WZ2008 sectors (Statistische Ämter des Bundes und der Länder 2021d). For an overview of the variables, see Table 2. Estimates were produced using the lm command in R to calculate an Ordinary Least Squares regression, outputs were created using stargazer (Hlavac 2018).

*p<0.1; **p<0.05; ***p<0.01