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Job polarization on local labor markets

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Job Polarization on Local Labor Markets

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Contents

Abstract

The labor markets of most industrialized countries are polarized. This means that employment has grown in jobs at the upper and lower tails of the wage distribution, while employment in the middle part of the distribution has stagnated or declined. However, there exists no measure that allows a quantitative comparison across different labor markets as yet. I propose a straightforward way to measure the actual magnitude of job polarization. To demonstrate its application, I use this measure to compare polarization across German local labor markets. Job polarization almost exclusively occurs in urban areas where the hypothesis of routine biased technological change is most likely to prevail.

Zusammenfassung

Die Arbeitsmärkte der meisten Industrienationen sind polarisiert. Das bedeutet, dass die Beschäftigung vor allem in Berufen am oberen oder unteren Ende der Lohnverteilung gewachsen ist, während die Beschäftigung in der Mitte der Verteilung stagniert oder geschrumpft ist. Bis jetzt existiert allerdings keine Möglichkeit, einen quantitativen Vergleich zwischen unterschiedlichen Arbeitsmärkten anzustellen. In diesem Papier stelle ich eine einfache Möglichkeit vor, wie das Ausmaß von Polarisierung am Arbeitsmarkt gemessen werden kann. In einer ersten Anwendung vergleiche ich die Polarisierung in deutschen Arbeitsmarktregionen. Das zentrale Ergebnis ist, dass Polarisierung fast ausschließlich in Städten auftritt, wo die verbreitete Erklärung des “Routine Biased Technological Chance” am ehesten zutrifft.

JEL classification: J31, J24, R23

Keywords: Polarization, Local Labor Markets, Job Tasks, Structural Change

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1 Introduction

Autor/Katz/Kearney (2006) and Goos/Manning/Salomons (2009) document a polarization of jobs in the United States and most European labor markets: Employment has grown in high and low paying occupations but has declined in the middle of the wage distribution. While the literature in labor economics provides a compelling theoretical explanation at the national level, recent works in urban economics suggest that this by no means happens uniformly across different regions within a country but depends on the economic structure of local labor markets. In this paper, I show that indeed polarization is much stronger in cities and that routine biased technological change is mainly an urban phenomenon.

The term job polarization was popularized by Goos/Manning (2007). They build upon the hypothesis of Autor/Levy/Murnane (2003) that technological change is routine biased, that is, technological change is complementary to interactive tasks at the upper tail of the wage distribution and erodes demand for routine tasks in the middle, but is neutral to non-routine unskilled labor such as personal service jobs. When occupations are ranked according to their initial average wage, jobs at both ends grow stronger than in the middle part of the distribution. The result is the U-shaped wage/employment profile familiar from many recent studies. Goos/Manning (2007) and Autor/Katz/Kearney (2006) find strong support for job polarization and its relation to routine biased technological change (RBTC), both in the United Kingdom and the United States. Autor/Dorn (2013) derive an integrated model on how technological change leads to a decline in routine manual work but an increase in non-routine service occupations. Taking their model to U.S. data on local labor markets, they find that regions with a high initial share of routine tasks are more prone to adopt information technology and exhibit relocation of routine workers to unskilled service jobs. Senftleben/Wielandt (2013) adopt this approach for Germany but corroborate the results only for female workers.

What has been neglected so far is that RBTC is not likely to spur polarization evenly across all local labor markets. Modern technology displaces routine tasks and is complementary to high paid jobs, but there is huge regional variation in the demand for high skilled work. Davis/Dingel (2013) show theoretically that knowledge intensive workers benefit most from agglomeration externalities and thus concentrate in large cities. Michaels/Rauch/Redding (2013) document a centennial trend of US cities specializing in interactive and analytical tasks, while routine tasks moved to rural regions. This suggests that job polarization most strongly occurs in urban areas. However, there is yet no standard on how to gauge the magnitude of job polarization in order to make a quantitative comparison across local labor markets.

The main aim of this paper is to demonstrate how polarization can be quantified in a straightforward way. I propose a polarization measure which can be calculated for any labor market given that there is comprehensive data on employment by occupations. The second contribution is the first analysis of polarization itself (rather than its consequences) at the local level. To this end, I measure polarization of 313 occupations in 204 functional local

labor markets (henceforth LLM) in Western Germany between 1980 and 2010.[1] There are huge disparities: while about half of all LLM show the familiar U-shaped wage/employment profile, others are not significantly or even inversely polarized. I exploit this variation to shed light on the structural features which distinguish polarized labor markets from others.

The main result of this paper is that polarization is almost exclusively restricted to urban areas where RBTC is strongest, while rural labor markets are affected to a much lesser extent. Another driver of polarization is the local industry structure: Urban regions with modern export oriented manufacturing industries have the most polarized labor markets.

2 A Straightforward Measure of Polarization

Figure 1 displays a graphical illustration of polarization of the German labor market from 1980 to 2010. 313 occupations in the manufacturing and service sector are ranked according to their average log wage and plotted against their employment growth rate.[2] Note that some occupations have huge growth rates due to their small size, such as Veterinarians at the top right of the graph. To prevent these to drive the results, I weight each observation with its share in total employment. Most occupations in the top third of the 1980 wage distribution grew in the past 30 years, but there is also a distinct, yet smaller upwards bending at the lower part of the distribution.

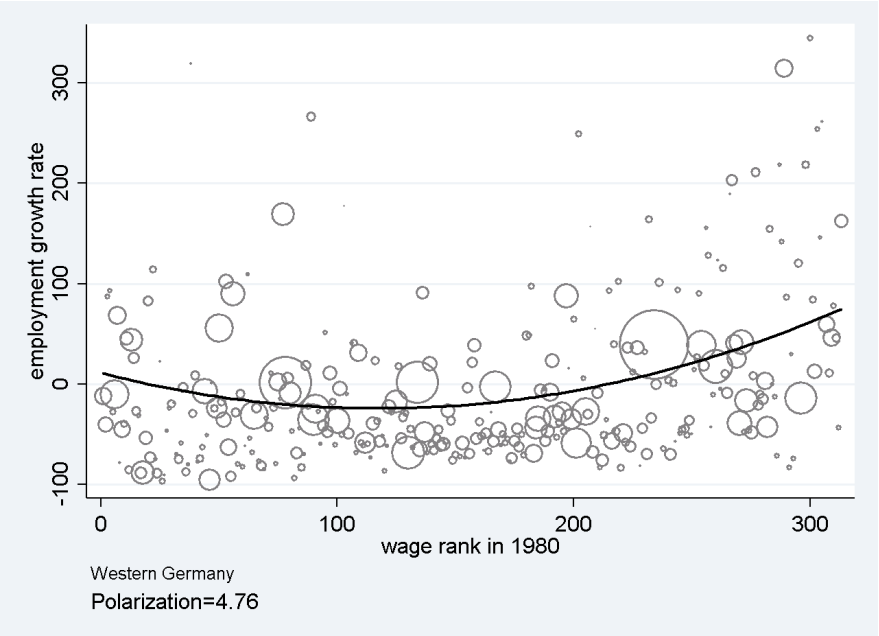


Figure 1: Employment growth rates by occupation, 1980-2010 (for Western Germany).

Note: Graph has been truncated at 350% for better illustration, which affects less than 0.5% of total employment.

[1] This data is aggregated from registry data of all German employees subject to social security on 30 June 1980 and 2010, provided by the German Federal Employment Agency. See the appendix for details on this data set and its preparation.

[2] Most recent papers on polarization present similar graphs (e.g. Goos/Manning, 2007; Autor/Dorn, 2013; Senftleben/Wielandt, 2013) but display smoothing regressions rather than the actual data points.

The figure also displays the fitted values of a quadratic regression (t-values in parentheses):

$$\widehat{\%\Delta Emp}_{1980-2010} = \underset{(0.95)}{11.118} - \underset{(-3.50)}{0.605} \times rank_{1980} + \underset{(4.76)}{0.003} \times rank^2_{1980} \quad (1)$$

As expected, the regression line in (1) is U-shaped and fits the actual data points fairly well ($R^2 = 0.12$). Goos/Manning (2007) already used the parameter of the squared term to demonstrate a U-shaped relationship without making a quantitative comparison. However, this coefficient is sensitive to the influence of single observations, for example when most of the wage/employment structure of a country is not polarized, except two occupations at both ends of the wage distribution. A close alternative, which accounts for how well the U fits to the data, is the t-ratio of the quadratic term (henceforth called polarization measure):

$$t_{rank^2} = \widehat{\beta}_{rank^2} / \left(\widehat{\sigma} / \left[SST_{rank^2} (1 - \rho(rank; rank^2)^2) \right]^{\frac{1}{2}} \right) = (\widehat{\beta}_{rank^2} / \widehat{\sigma}) c, \quad (2)$$

where $\widehat{\beta}_{rank^2}$ is the estimated coefficient of the quadratic term, SST_{rank^2} its total sum of squares, $\rho(rank; rank^2)$ its correlation coefficient with the level term, and $\widehat{\sigma}$ the standard error of the regression. Since the variables $rank$ and $rank^2$ do not vary between the countries or regions under analysis ($rank \in \{\mathbb{N} \mid 0 < rank \leq 313\}$), the denominator of the last fraction is a constant c. Hence, the t-ratio depends only on the curvature of the regression curve ($\widehat{\beta}_{rank^2}$) and its fit to the data ($\widehat{\sigma}$). The advantage of this measure is that it allows for a statistical test of polarization: if the wage structure, represented by 313 occupations, is sufficiently polarized then the t-ratio of the quadratic term should be larger than the critical value of a t-distribution with 310 degrees of freedom, for example 1.65 for the five percent level of significance (one sided test). In the case of aggregate Germany, the t-ratio is 4.76.

3 Polarization of Local Labor Markets

For a first application, I measure how strongly each of the 204 local labor markets in Western Germany became polarized between 1980 and 2010. The results are summarized in Table 1.[3] There is substantial variation in the polarization across regions: 144 LLM have a t-ratio larger than 1.68 and are hence significantly polarized, while 20 are polarized stronger than the aggregate country. Remarkably, 6 LLM are even negatively polarized, albeit only one has a t-ratio smaller than -1.68.

		frequency	
	t-ratio	absolute	relative
strongly polarized	$t > 4.76$	20	9.8
significantly polarized	$1.68 \leq t \leq 4.76$	124	60.78
not polarized	$0 \leq t \leq 1.68$	54	26.47
	$-1.68 \leq t < 0$	5	2.45
negatively polarized	$t < -1.68$	1	0.49

Table 1: Polarization measure in 204 LLM

[3] See the appendix for a histogram and map showing the distribution of the polarization measures.

Figure 2 displays the polarization profiles of the regions at both ends of the distribution of the polarization measures. The most polarized LLM is Munich (t = 7.14) and the least polarized LLM is Pirmasens in the rural part of Rhineland-Palatinate (t = -2.23). The difference between both is obvious: Munich is a large, prosperous city with corporate headquarters in the IT, electrical engineering, and vehicle manufacturing sectors, whereas Pirmasens is structurally weak. Pirmasens used to be the German capital of shoe manufacturing, a sector that dramatically declined due to import competition from low wage countries. Munich's growth in high paying jobs appears to have spurred demand for service jobs at the lower end of the wage distribution, which is in line with the model and findings of Autor/Dorn (2013). In contrast, Pirmasens lost employment mostly in low and medium paying jobs but did not have substantial growth in high paying jobs to compensate for this.

4 Exploring the Differences in Local Polarization

The most striking difference between the two examples is that Munich is a major city while Pirmasens is a rural region. In fact 67% (96) of all polarized LLM have a major city with at least 100,000 citizens, while only 17% (10) of all not polarized LLM have. It appears as if polarization mainly occurs in urban LLM, whereas rural regions are barely affected.

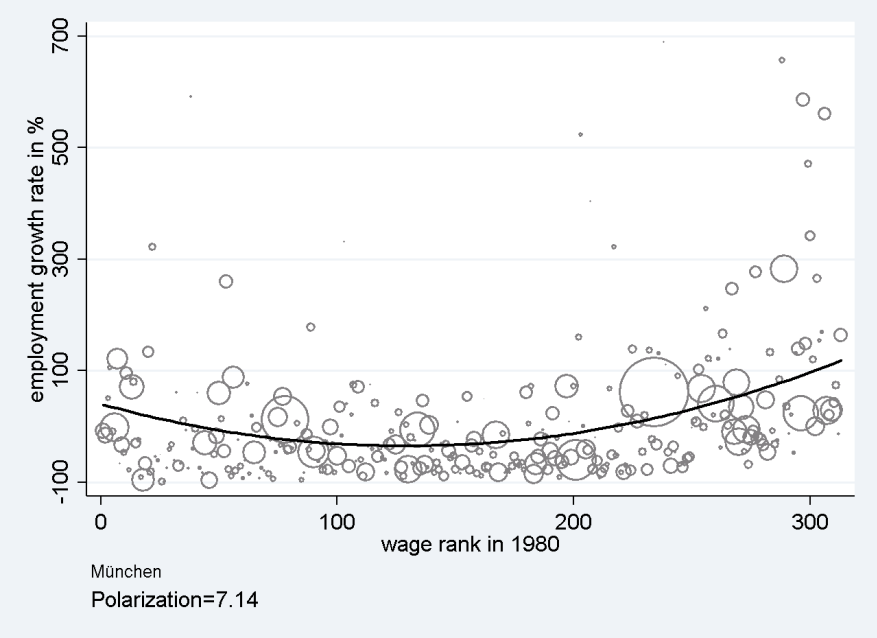
	Dependent variable: polarization measure 1980-2010			
	(1)	(2)	(3)	(4)
Dummy urban=1	1.721***	0.894***	0.762***	0.749***
	(0.23)	(0.22)	(0.20)	(0.21)
% Routine tasks	-0.091*			
	(0.05)			
% Routine cognitive tasks		0.518***	0.541***	0.445***
		(0.07)	(0.07)	(0.08)
% Routine manual tasks		-0.099***	-0.137***	-0.048
		(0.03)	(0.03)	(0.03)
% Manufacturing workers			0.019	-0.012
			(0.01)	(0.01)
Imports in 1000 € per worker				-0.056***
				(0.02)
Exports in 1000 € per worker				0.048***
				(0.02)
Constant	6.832**	-3.718*	-3.288*	-3.911**
	(2.75)	(2.06)	(1.92)	(1.97)
R^2	0.273	0.503	0.512	0.563

Observations: 204. All covariates are from the initial year 1980. All models include federal state dummies. Robust standard errors in parentheses. Levels of significance: *** 1 %, ** 5 %, * 10 %.

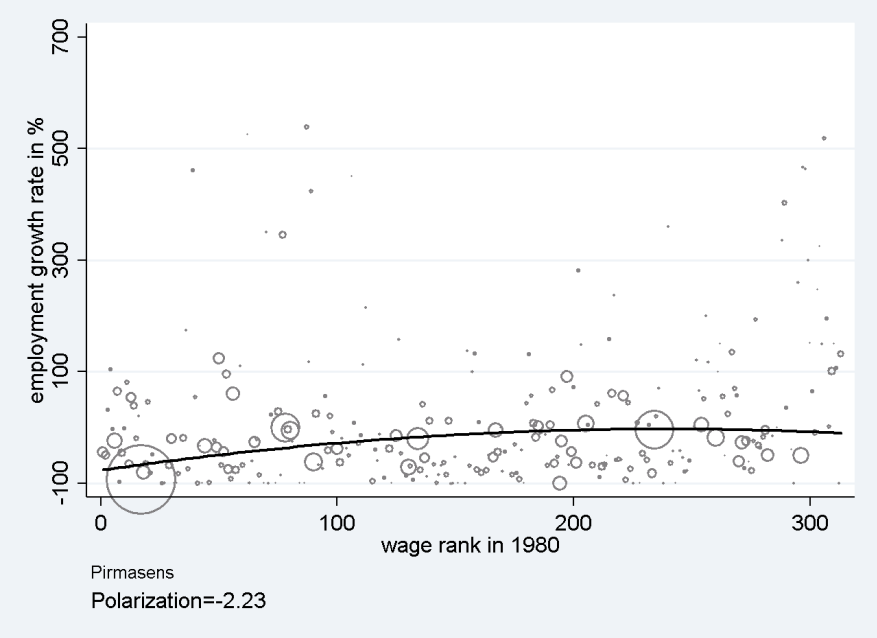
Table 2: Multiple regression coefficients

Table 2 shows how the polarization measure is related to several characteristics of the local economic structure in 1980, while controlling for urbanization and the federal state. The economic structure is represented by the share of routine tasks relative to all tasks performed in a region,[4] the share of manufacturing employment, and a region's openness

[4] See Spitz-Oener (2006) and Senftleben/Wielandt (2013) for details on how to construct task measures from



(a) Strongest Polarization



(b) Weakest Polarization

Figure 2: Changes in Employment Shares by Skill Percentile, 1980-2010.

to trade measured as potential world exports and imports per worker in 1,000 € along the lines of Dauth/Findeisen/Suedekum (2014).

Remarkably, the share of routine tasks is negatively related to polarization (column 1). However, this picture becomes clearer when routine tasks are split up in manual and cognitive tasks (column 2): Even when urbanization is held constant, polarization is stronger in regions where many routine cognitive tasks such as calculating, measuring, or bookkeeping are performed. These are the tasks which are easiest to be replaced by computers and are most prevalent in cities. Regions specialized in routine manual tasks, which typically occur in traditional manufacturing industries, have less polarized labor markets. This remains robust when the overall share of manufacturing employment is included into the model in column (3). Apparently, job polarization is to a lesser extend related to the sectoral specialization of a region rather than to production technology. This is corroborated by the coefficients of the measures for exposure to international trade in column (4): Job polarization is stronger in regions which produce goods for export. This typically involves modern, skill-intensive manufacturing. By contrast, regions specialized in import competing industries typically have a more traditional manufacturing sector where mostly routine manual tasks are performed.

5 Conclusion and Discussion

The common explanation of job polarization is that RBTC decreased demand for routine occupations which are typically found in the middle of the wage distribution. Employment in high paying jobs increases because of their complementarity to information technology. At the same time, there is increasing demand for services, which in turn spurs employment growth in typically low paying jobs.

This paper adds a new insight: while RBTC caused the decline of routine work, the complementary growth of high skilled jobs is not uniform among local labor markets. Since interactive tasks benefit most from agglomeration forces, high paid jobs tend to concentrate in cities (see Davis/Dingel, 2013; Michaels/Rauch/Redding, 2013). Job polarization is thus predominantly an urban phenomenon.

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A.1 Data Appendix

The analysis of job polarization at the regional level requires detailed and complete information of the labor force over a longer period of time. An ideal source for this information is the registry data of the German Federal Employment Agency (BA) which stems from the compulsory notifications to the social security insurance. Specifically, I use the Employment History (BeH) provided by the Institute for Employment Research (IAB). From the full sample of this spell-dataset, a cross section of all employees registered as employed on June 30th is drawn. This data covers all employees subject to social security, which are about 80 percent of the German labor force (Dustmann/Ludsteck/Schönberg, 2009). The subset of economically active people who are not included in this data set are civil servants, self-employed, and people who work for an income lower than a defined threshold (2010: 400 €).

The data is very reliable, since it used to calculate retirement pensions. The major caveat of this data is that wages are censored at the upper earnings limits of the compulsory social security system (e.g. 66,000 € in Western Germany, 2010). I use an imputation procedure suggested by Gartner (2005) to correct the topcoded values.

Since job polarization is a development over a longer period of time, I focus my analysis on Western Germany, where data is available continuously from 1978 to 2010. In order to relate different patterns of polarization to the industrial structure, I focus on employees in the manufacturing and service sectors and drop apprentices and all employees in the public sector and agriculture and mining. The resulting data set contains between 16,129,486 (1980) and 16,828,903 (2010) observations each year and provides information on daily wage (imputed), occupation, industry, qualification, place of work, as well as some social-demographic information. There is information on whether a person works full-time, minor part-time (less than 18 hours) or major part-time (between 18 and 39 hours) but not on the exact working hours. I estimate full-time equivalents by weighting minor part-time with $16/39$ and major part-time with $24/39$, respectively.

In the empirical section of this paper, I relate regional differences in a measure of job polarization to other regional characteristics. To this end, it is necessary to aggregate the data to functional local labor markets. The level of 326 counties (Landkreise und kreisfreie Städte – corresponding to NUTS-3 regions of the EU) is not adequate, since counties are administrative entities that have evolved historically but have no economic meaning. A more suitable aggregation are 204 labor market regions defined according to commuting patterns and accessibility, which is used for purposes of regional assistance (of the "Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur"), the joint effort of the German federal and state governments to align differences in the regional economic structures (Kropp/Schwengler, 2011). This classification bases on commuter flows between municipalities and can thus be regarded as a good approximation of functional labor markets. These regions are available from the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and will henceforth be called local labor

markets (LLM).[5] The BBSR also classifies German counties into urban and rural regions and into regions in between. I use this information to construct a dummy variable which takes the value of one if an LLM comprises at least one urban county.

For the control variables, several further data sets are used. First, in the literature on job polarization and skill biased technological change, it is argued that manual routine tasks are most likely to be displaced by machines and computers. I replicate the measure for the regional share of routine tasks presented by Senftleben/Wielandt (2013). To this end, I use the 1979 BIBB/IAB Qualification and Career Survey, a survey data set with roughly 30,000 observations. This data set contains, among other, information on the occupation and different activities performed by each individual. The activities are grouped in different task categories following Spitz-Oener (2006).[6] For each individual, the task measure proposed by Antonczyk/Fitzenberger/Leuschner (2009) is calculated as the number of activities of a category in relation to all activities performed by the same worker. This task measure can be interpreted as the percentage of her working time a person spends on performing a certain task (e.g. routine manual). Next, the average task share is calculated over all workers with the same occupation. Since the BIBB/IAB data use the same occupational classification as the BeH, the occupational task shares can be merged to the full sample of all employees. Finally, the routine task share of an LLM can be calculated as the average individual task share weighted by the employment in each occupation.

Further explanatory variables are the regional shares of manufacturing workers and high skilled workers in the total labor force.

Finally, there is a growing literature on how the increasing trade integration in the past decades, that is, the increase of both import competition and export opportunities from developing countries, spurred the regional structural change in Germany (cf. Dauth/Findeisen/Suedekum, 2014). To test if there is also an effect on the regional wage/employment structure, I construct measures for the regional trade exposure along the lines of Autor/Dorn/Hanson (2013): $TradeExp_{it} = \sum_j \frac{E_{ijt}}{E_{jt}} \frac{Tradeval_{jt}}{E_{it}}$, where $Tradeval_{jt}$ is the absolute value (in constant 1000 Euros of 2005) of commodities produced by industry j that have either been imported or exported between Germany and the rest of the World in 1980.[7] E_{ijt}/E_{jt} is region i's share of national industry employment in j, and E_{it} is total manufacturing employment in period t and region i. This variable can thus be interpreted as how strongly the average worker of an LLM is exposed to import competition or export opportunities.

[5] The results of this paper do not hinge on this choice. Robustness checks with 326 counties and 108 aggregate labor market regions yield basically the same results.

[6] I thank Alexandra Spitz-Oener for providing me with her classification schedule.

[7] The trade values stem from the *United Nations Commodity Trade Statistics Database*.

A.2 Table Appendix

	All	Rural	Urban
Polarization measure	2.63	1.86	3.34
	(1.59)	(1.34)	(1.46)
Dummy urban=1	0.52		
	(0.50)		
% Routine tasks	54.68	54.12	55.21
	(2.41)	(2.77)	(1.89)
% Routine cognitive tasks	17.91	17.18	18.57
	(1.46)	(1.04)	(1.47)
% Routine manual tasks	36.78	36.93	36.63
	(2.65)	(3.08)	(2.19)
% Manufacturing workers	42.17	39.98	44.19
	(11.46)	(10.92)	(11.63)
Imports in 1000 € per worker	29.78	30.67	28.95
	(7.02)	(7.04)	(6.92)
Exports in 1000 € per worker	38.78	36.22	41.14
	(9.26)	(8.64)	(9.23)
Number of local labor markets	204	98	106

Mean values, standard deviations in parentheses.

Table A.1: Descriptive statistics for local labor markets in 1980

A.3 Figure Appendix

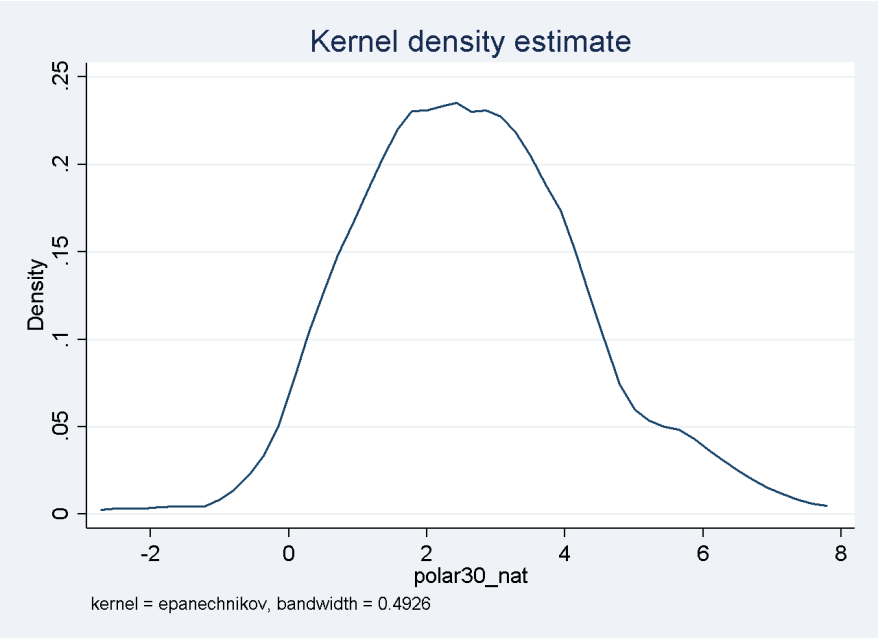

Figure A.1: Kernel Density Estimate of the 204 Regional Polarization Indices.

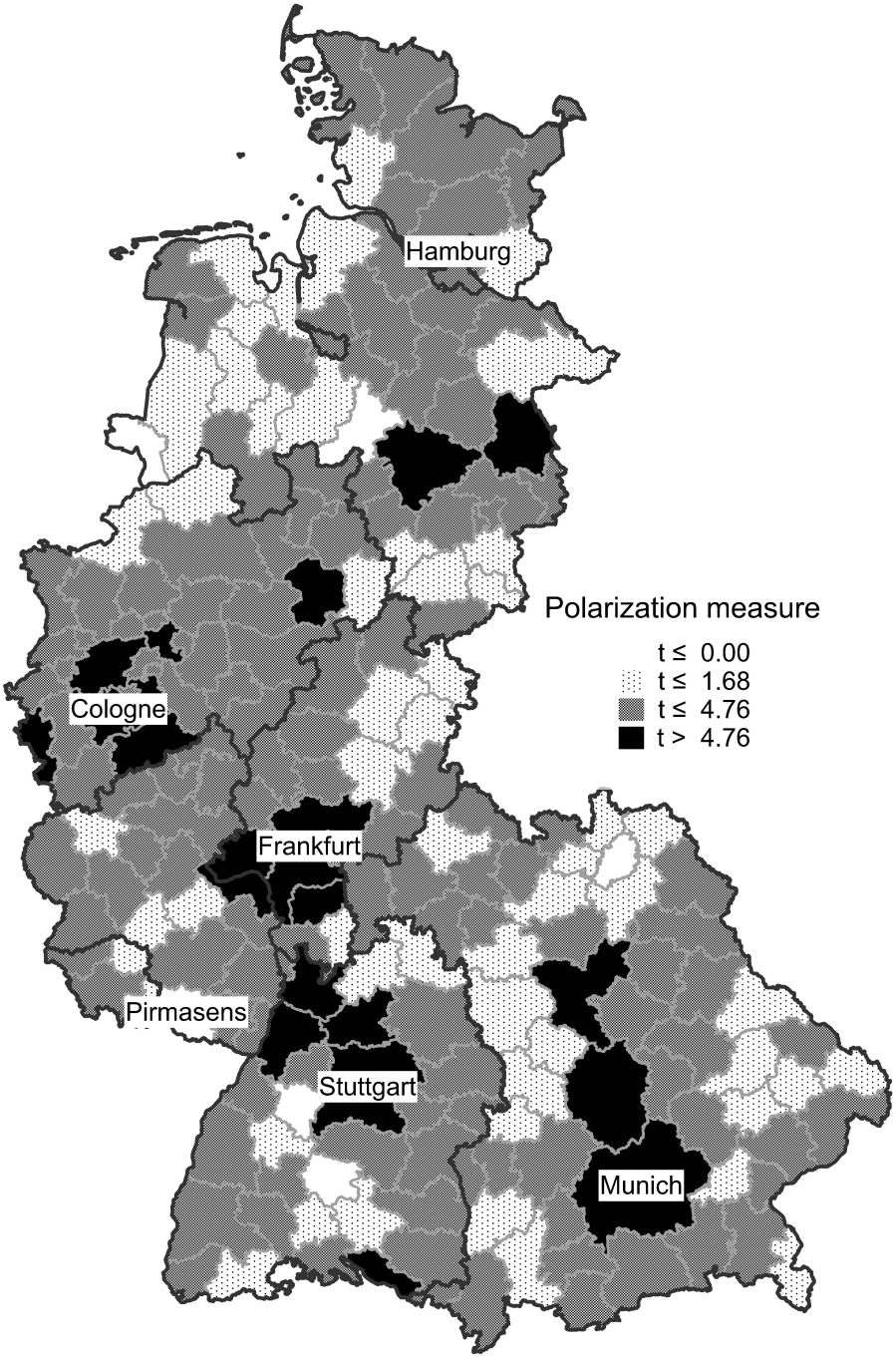

Figure A.2: Polarization of 204 Local Labor Markets.

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