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Globalization and Local Profiles of Economic Growth and Industrial Change

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ABSTRACT

We analyze how globalization has affected the sectoral anatomy of regional growth in Germany over the period 1978-2008. The aggregate German economy is characterized by a secular decline of manufacturing and a rise of modern service industries. This trend– also known as Petty's law – is not uniform across space, however. Some regions exhibit it at an even accelerated pace, while other regions have reinforced their manufacturing specializations. We first categorize all German regions into one of three groups, with "pro-trend", "anti-trend" or "featureless" growth. Afterwards we propose an explanation why a particular region ended up in one of those groups: We argue that the regional profiles of growth and change are systematically related to the initial sizes, and the import and export exposures of the local manufacturing sectors.

Keywords: Structural change, local industry compositions, trade exposure, local employment growth

JEL-Class.: R11, O14, F16

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1. Introduction

In many countries, there are vast differences in the long-run performance of single regions. In the United States, for example, New York, Boston, or cities in the Sun Belt have experienced exceptional economic growth in the last decades, while industry towns in the Rust Belt have declined over the same period. These (un-)favorable developments are often seen in close relationship with the local industrial structures of those areas: San Francisco or New York flourished as they became increasingly specialized in booming sectors such as ICT or finance that are generally on the rise in the economy. Detroit, on the other hand, declined because it was traditionally specialized in heavy manufacturing industries (Glaeser et al. 2011).

Apart from such often-cited cases, however, we know surprisingly little about the systematic relationship between industrial change and economic growth at the local level. How does the sectoral structure of growth, or respectively, decline differ across regions? Can a region only exhibit an exceptional overall performance when it manages to build up employment in booming industries (and to get rid of declining industries) faster than others do? Can a region also thrive when it develops against the trend and expands in sectors that are declining elsewhere in the country? What are the underlying causes of such a profile of local growth and change, and under which circumstances would it work?

The main aim of this paper is to shed some light on these important and policy-relevant questions, using comprehensive and highly disaggregated German employment data covering a time span of thirty years (1978-2008). We first document an aggregate trend that employment in many advanced service industries such as health care or business consulting expanded, while heavy manufacturing industries tended to shrink. This represents the well-known trend of structural change, also known as *Petty's law*, which characterizes most advanced economies including Germany. Yet, our evidence shows that this process by no means occurs uniformly across space, but that single regions can exhibit local profiles of industrial change that differ substantially from the national average.

Our analysis consists of two steps. In the first step, we develop a novel empirical approach to categorize all German regions into one of three groups, with "pro-trend", "anti-trend" or "featureless" regional growth, respectively. In the latter group, the sectoral anatomy of growth does not differ markedly from the national average. In the former two groups, we find such marked features. In particular, "pro-trend" regions exhibit a similar *direction* of industrial change like the nation as a whole, but at an accelerated *speed*. That is, booming industries tend to grow faster, while declining industries tend to disappear faster than in the aggregate economy. Conversely, in "anti-trend" regions, industries tend to grow that decline elsewhere, while national boom industries develop relatively slowly. Comparing these groups descriptively, we find that the "pro-trend" pattern tends to come with the highest total growth, but "anti-trend" regions turn out not to be very far behind. In other words, we observe notable differences in the structure of growth across regions with similar total performance.

In the second step, we then aim to provide an economic explanation for these divergent local trends. The basic theory of *Petty's law* typically posits that the secular decline of manufacturing employment and the rise of the modern service economy is due to some combination of non-homothetic demand and productivity growth. This theory is essentially silent, however, on the spatial dimension of this transformation process. Economic geography models explain the geographical distribution and composition of economic activity by the fundamental trade-off between agglomeration and dispersion forces within and across industries.[1] This literature has traditionally stressed fundamentals such as transport or commuting costs as key drivers of local economic change. More recent research then emphasizes that the internal structure of an economy is also affected by external forces, namely the exposure to international trade (Autor, Dorn and Hanson 2013; Dauth, Findeisen and Suedekum 2014; Holmes and Stevens 2014; Brülhart, Carrère and Trionfetti 2012).

[1] Fujita and Thisse (2002) or Duranton and Puga (2004) provide overviews of this very large literature. See Helsley and Strange (2014) for a recent theory that introduces intra- and inter-industry agglomeration economies in a system-of-cities model in the spirit of Henderson (1974).

Since the early-1990s, Germany experienced a massive increase in trade, particularly with respect to Eastern European and Asian countries. We link this rising trade exposure to the single German regions, given their initial employment patterns. This exercise reveals that regions are affected very differently by the import penetration from, and the new export opportunities arising in "the East". Our analysis then suggests that the patterns of "pro-trend" and "anti-trend" growth that we observe in the data are driven, to a notable extent, by the initial size and the differential import and export exposures of the local manufacturing sectors. More specifically, we show that the most successful "pro-trend" regions tended to have small initial manufacturing shares with relatively low trade orientation towards the East. Being relatively isolated from trade shocks, *Petty's law* worked rather undisturbedly in those regions, and modern services quickly replaced the small manufacturing sectors; human capital apparently played a major role in this process. The most successful "anti-trend" regions, by contrast, typically started with a large manufacturing share. They henceforth even reinforced this specialization, because the local structure of manufacturing was highly export-oriented and these regions thus benefited substantially from the rise of new markets in the East. Among the declining "pro-trend" regions, it was the other way around: They also started with a large manufacturing sector, yet with a substantially higher degree of import exposure. As a result, those regions massively lost manufacturing employment, to an extent that could not be compensated by new jobs in service industries.

Summing up, our research suggests that "globalization", by triggering processes of (de-)specialization, is one key force that has shaped the observed local profiles of growth and industrial change across German regions.

The rest of this paper is organized as follows. In section 2, we discuss some related literature. Section 3 introduces the data and our approach of categorizing regions into three groups. In Section 4, we analyze the impact of trade exposure and provide an economic explanation for the observed divergent trends of local growth and change. Section 5 concludes.

2. Related literature

Within the large literature on Marshallian agglomeration forces, several papers have investigated the "sectoral scope of agglomeration economies" (Rosenthal and Strage 2004; Helsley and Strange 2014). In particular, seminal papers by Glaeser et al. (1992) and by Henderson et al. (1995) have launched a discussion how the local economic structure affects productivity and growth across cities and regions.[2] Our focus in this paper is different. We do not aim to analyze why firms from particular industries agglomerate in space, or whether an environment of specialization or diversity is most conducive for the growth of local industries. Our basic unit of analysis is the region as a whole, and we try to understand how the change in local industry compositions relates to the overall regional performance, thereby distinguishing between the prototypical "pro-trend" and "anti-trend" patterns.

This adds a new perspective to the existing literature on urban growth. Recently, that literature seems to settle with the conclusion that there are pervasive and highly localized spillovers both within narrowly defined industries (Henderson 2003; Cingano and Schivardi 2004) and across vertically related industries (Ellison et al. 2010). Yet, even if this evidence suggests that "clustering" offers some productivity gains, it remains unclear what this implies for local policymakers:[3] Of which type of industries should a regional "cluster" consist? Our stylized facts suggest that an increasing specialization in booming industries (the "pro-trend" pattern) is not a necessary condition for above-average total growth. We rather find that several "anti-trend" regions have performed almost equally well, despite an increasing specialization ("clustering") in activities that decline elsewhere in the country.

Our study also relates to Duranton's (2007) work on urban evolutions. In his model, innovations lead to relocation of industries between cities. Every city exhibits changes in local

[2] Also see Combes (2000) and Brülhart and Mathys (200) for extended analyses, and Combes and Overman (2004) for an overview. Blien, Suedekum and Wolf (2006) and Dauth (2013) address those issues for Germany.

[3] Duranton (2011) provides a critical assessment of the "cluster" concept, which is often associated with Porter (1990). While Duranton addresses the key question if policy instruments can and should be used to conduct "cluster policies", we are mainly interested in the composition of clusters with booming or declining industries.

industry compositions over time, and some cities grow while others decline due to these industry reshufflings. However, there is no aggregate structural change at the national level in the model by Duranton (2007), and therefore it is not possible to distinguish whether particular regions develop along with, or against the national trend. Drawing on this work, Findeisen and Suedekum (2008) study the relationship between industry churning and local growth in Germany. They find that many growing regions only exhibit rather modest levels of industry turnover. Our analysis in this paper goes beyond their approach, because we quantify not only the *speed* but also the *direction* of local industrial change, and set this into perspective to the long-run overall regional performance and to regional trade exposure.

Finally, a specific focus of this paper is the analysis of international trade as a driver of local industrial change. In a recent important paper, Autor, Dorn and Hanson (2013) analyze the impact of rising Chinese import exposure on employment growth and other outcomes across US local labor markets. In Dauth, Findeisen and Suedekum (2014) we have extended their approach to German regions. We find that import exposure has a negative impact on regional employment growth, both in manufacturing and beyond. Yet, in contrast to the US experience, there is also a positive effect of local export exposure. On average, this effect even dominates. Trade integration with respect to China and Eastern Europe has therefore caused positive aggregate job growth in Germany, though it has produced winners and losers at the regional level. In the current paper, we push this analysis further.

We distinguish regions according to their local profiles of industrial change, and argue that a combination of two factors drives the distinct features of those patters: the differential local trade exposures, and the general forces behind Petty’s law. In the successful “pro-trend” regions, mostly the latter force seems to be at work while trade shocks only played a relatively small role. In successful “anti-trend” regions, conversely, trade shocks were considerably more important, particularly on the export side, and this has worked against (and even reversed) Petty’s law.

3. Local profiles of growth and change

3.1. Data

In our empirical analysis, we draw on extensive employment data from the German Establishment History Panel (BHP) at the Institute for Employment Research (IAB). This data originates from social security notifications and covers all employees in Germany (except the self-employed and civil servants) between 1978 and 2008. We aggregate the data to the level of local industries, where the regional dimension corresponds to the 326 Western German NUTS-3-regions (*Landkreise* and *kreisfreie Städte*), which are roughly comparable to US counties. Within each region, we can distinguish employment in 220 industries encompassing the full range of economic activities. The industry classification system is the German WZ93, which is comparable to 3-digit-code ISIC. For each local industry, we observe the total employment level measured in full time equivalents, as well as some standard characteristics such as the qualification, age, gender, and establishment size structure of the workforces.[4]

3.2. Preliminaries: Regional, sectoral and national employment growth

Our starting point is the long-run employment growth rate of some sector s in region r between two time periods 0 (the year 1978) and 1 (the year 2008):

$$g_{rs} = \frac{emp_{rs1} - emp_{rs0}}{emp_{rs0}}$$

The growth rate of a region's aggregate employment g_r and the national rate of employment growth g_{nat} are then, respectively, given by

$$g_r = \frac{emp_{r1} - emp_{r0}}{emp_{r0}} = \sum_s \frac{emp_{rs0}}{emp_{r0}} \cdot \frac{emp_{rs1} - emp_{rs0}}{emp_{rs0}} = \frac{\sum_s \left(emp_{rs1} - emp_{rs0}\right)}{emp_{r0}}$$

$$g_{nat} = \frac{emp_1 - emp_0}{emp_0} = \sum_s \frac{emp_{s0}}{emp_0} \cdot \frac{emp_{s1} - emp_{s0}}{emp_{s0}} = \frac{\sum_s \left(emp_{s1} - emp_{s0}\right)}{emp_0} \quad .$$

[4] See Spengler (2008) for further details on this dataset. Notice that there has been a major classification change in 1999. Time-consistent industry codes are created using a procedure introduced by Eberle et al. (2011).

Thus,

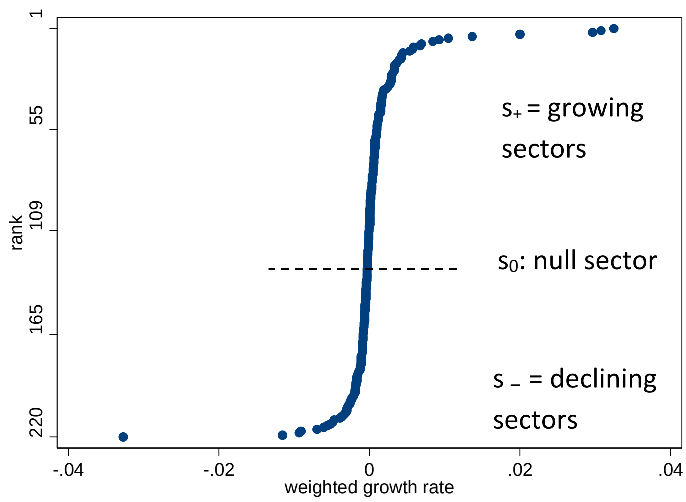
$$g_r - g_{nat} = \sum_s \left(\frac{emp_{rs0}}{emp_{r0}} \cdot \frac{emp_{rs1} - emp_{rs0}}{emp_{rs0}} - \frac{emp_{s0}}{emp_0} \cdot \frac{emp_{s1} - emp_{s0}}{emp_{s0}} \right) = \sum_s \left(w_{rs} - w_s \right) = \sum_s \Delta w_{rs} \quad (1)$$

is the excess growth of region r which equals the sum of the differences in weighted industry growth rates, $\Delta w_{rs} = w_{rs} - w_s$. We first order all $s = 1,...,220$ industries according to

$$w_s = \frac{emp_{s0}}{emp_0} \cdot \frac{emp_{s1} - emp_{s0}}{emp_{s0}} = \frac{emp_{s1} - emp_{s0}}{emp_0},$$

i.e., their weighted sectoral growth rates at the national level. National boom industries are characterized by $w_s > 0$, and declining industries at the national level by $w_s < 0$. In Figure 1 we plot w_s from top to bottom in the order of the national sectoral growth hierarchy.

Figure 1: (Weighted) sectoral employment growth rates at the national level (w_s)



On top of this hierarchy, there are growing industries (denoted by s+), such as health care (WZ 841) or management consultancy (WZ 741), while on the bottom, we find declining sectors (denoted s-) like mining of hard coal (WZ 101) or wearing apparel (WZ 182). The middle part of this figure comprises the „null-sectors" s_0 where $w_s \approx 0$.[5]

[5] Notice that there are many small industries close to the "null sector", which can have exorbitant un-weighted growth rates. An example is commercial hunting (WZ 15, rank 109) whose total national employment is negligible with only 22 (32) full time equivalents in 1978 (2008). That is, this industry has an un-weighted growth rate of about 45% but a weighted growth rate of zero due to its very small contribution to overall growth.

The growing s+ sectors are mostly service industries, particularly modern and advanced services, while the declining s- sectors are typically agricultural and heavy manufacturing industries. Yet, Germany also has some fast growing manufacturing industries, e.g. aircraft construction (WZ353) or surface finishing (WZ 285). Similarly, there are also some declining service sectors at the national level, for instance specialized retailing (WZ 524). Even more importantly, of particular interest for this paper is the fact that this average pattern of industrial change by no means occurs uniformly across regions. In fact, some regions exhibit distinctively different patterns of industrial change than Germany as a whole.

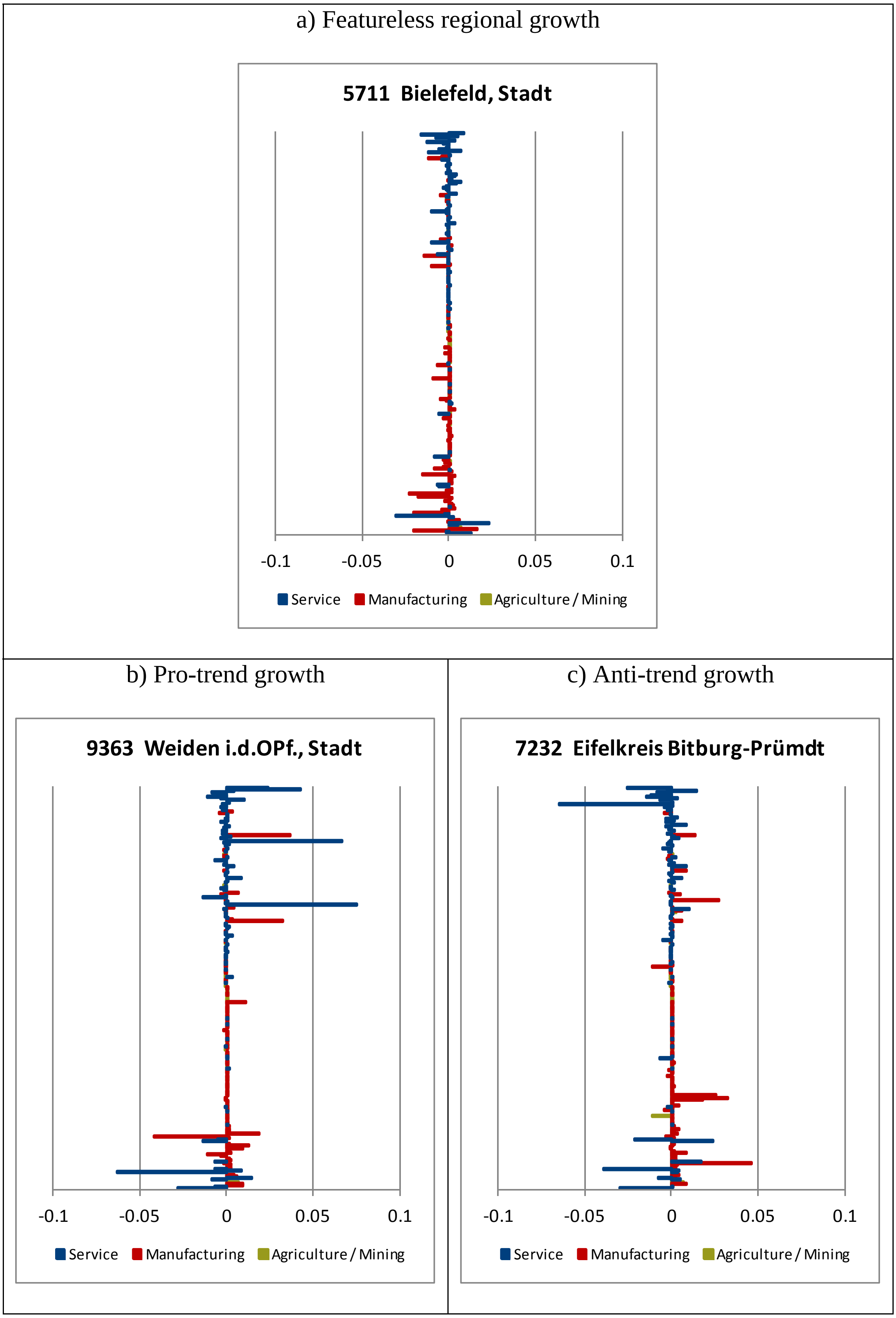
3.3. Local change profiles: Some examples

To illustrate this point, we plot – separately for each region r – the deviations in weighted industry growth rates Δw_{rs} and order industries according to the national sectoral hierarchy. We thereby obtain individual *local change profiles* for every region, which display how regional growth differs from aggregate national growth in its sectoral composition.

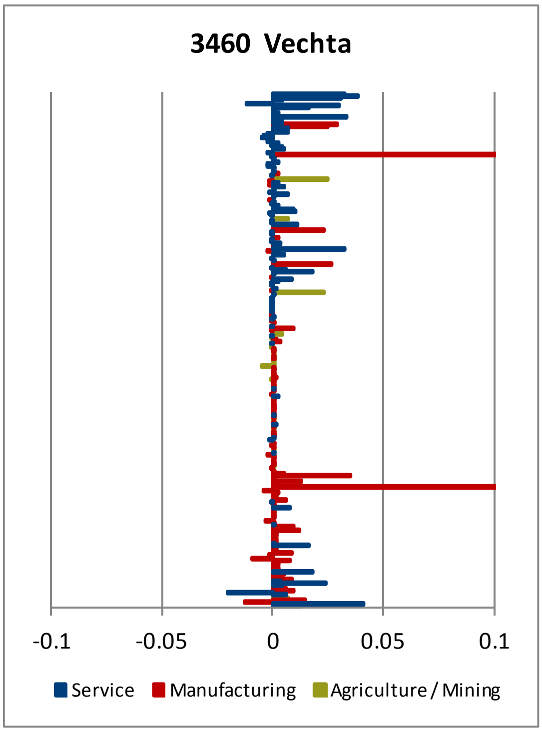
Figure 2 (panels a-g) shows examples of such local change profiles for particular German regions. Figure 2a depicts a case (Bielefeld) where regional growth is featureless in the sense that the weighted industry growth rates tend to match the national average fairly closely. That is, also in Bielefeld some sectors grow faster than others, which leads to sectoral employment shifts over time. However, those shifts mostly follow the national pattern of industrial change. Graphically, in such regions with “featureless growth”, Δw_{rs} is close to zero for most industries, so that the profile exhibits only small amplitudes in the entire range.

Figures 2b and 2c show examples where regional growth differs more markedly from the national average. In particular, figure 2b (Weiden) depicts a typical “pro-trend” pattern of local growth, while figure 2c (Bitburg-Prüm) shows an example of an “anti-trend” region.

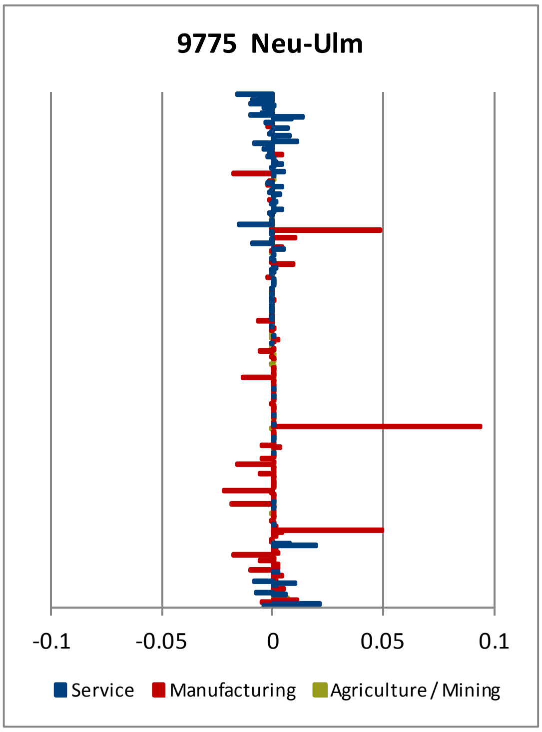
Figure 2: Local change profiles of German regions – some examples



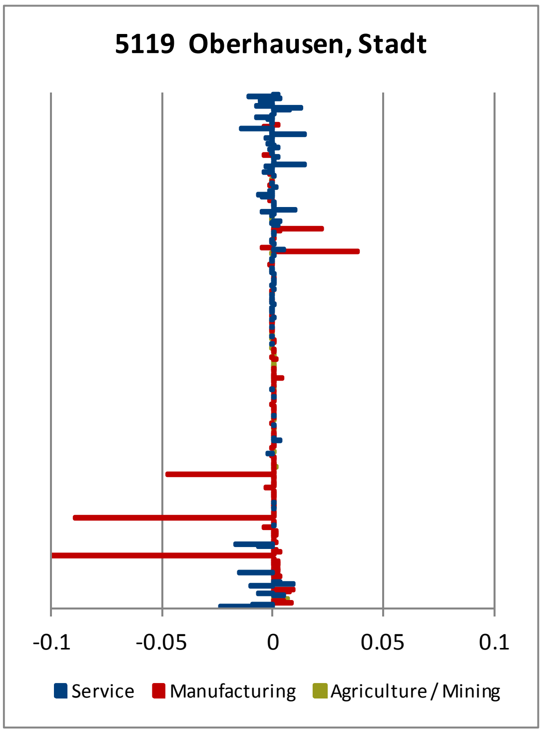
d) Pro-trend growth



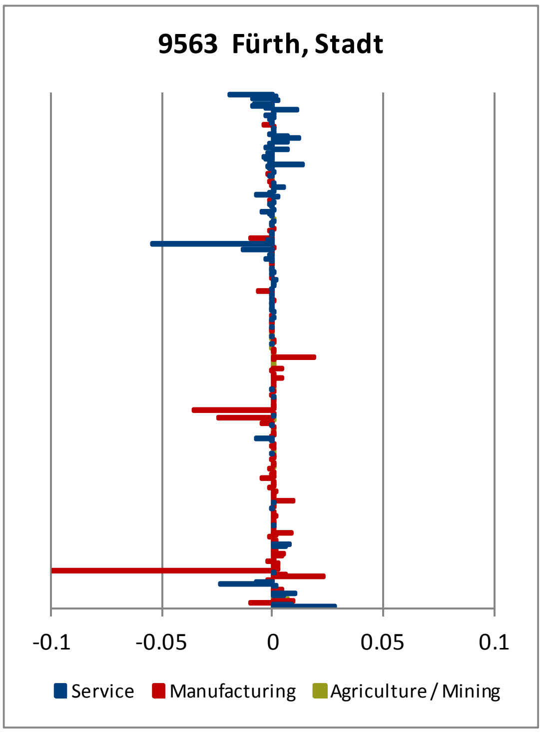
e) Anti-trend growth



f) Pro-trend growth



g) Pro-trend growth



In figure 2b, we observe that national boom industries (the rising s+ sectors) tend to grow relatively stronger in Weiden than in the national average, while the nationally declining s- sectors tend to disappear faster. Graphically, we thus observe amplitudes to the right mostly in the upper range and amplitudes to the left mostly in the lower range of the figure. Regions of this “pro-trend” type therefore follow the *direction* of the national process of structural change, but at an accelerated speed.

Quite a different pattern we observe in figure 2c. This region evolves against the national trend, because regional growth mainly occurs in nationally declining s- sectors such as, for example, manufacturing of beverages (WZ 159) or retail sale (WZ 521). We thus observe notable right-amplitudes in the bottom range of figure 2c. At the same time, the region has experienced decline (or at least considerably lower growth) in national boom industries, hence the strong left-amplitudes in the top range of figure 2c.

There are also cases where amplitudes are almost unidirectional. Figures 2d and 2e illustrate the examples of Vechta and Neu-Ulm. In both cases, we mostly observe right-amplitudes throughout the entire range. That is, (almost) all industries grew stronger and (almost) no sector disappeared faster in those regions than in the national average. Still, despite this comprehensive growth, the profile of Vechta (figure 2d) is “pro-trend”, since there are more and stronger right-amplitudes in the upper than in the lower range.[6] In Neu-Ulm (figure 2e), by contrast, growth is mainly driven by sectors on the bottom of the national hierarchy,[7] so that this region exhibits an “anti-trend” profile of local growth.

Figure 2f shows a particularly interesting example, which refers to the city of Oberhausen situated in the industrial core of Germany, the Ruhr area. This city has experienced a substantial decline of mining and steel industries in the past 30 years, as can be seen from the

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[6] For the case of Vechta, the manufacture of plastic products (WZ 252) has grown enormously there in the last 30 years. Yet, national declining industries also tended to grow above the average, e.g. furniture manufacturing (WZ 361) by 23%. This is stronger than the national average, but by a much lower margin than plastic products

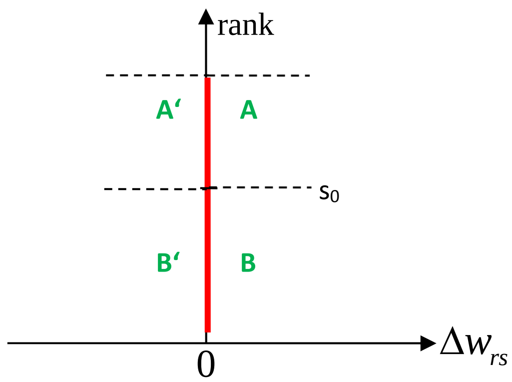
[7] For example, manufacture of machine tools (WZ 294) is a nationally declining industry that grew substantially in Neu-Ulm, while booming industries such as the manufacture of pharmaceuticals (WZ 244) had lower (though mostly still positive) excess growth rates in that region.

strong left-amplitudes in the lower range. Oberhausen did build up some modern service industries in the meantime, as evidenced by the right-amplitudes in the upper range, but this has not been sufficient to compensate for the losses in traditional manufacturing. Overall, Oberhausen is therefore a declining city with $g_r - g_{nat} < 0$ that nonetheless reveals a "pro-trend" pattern of industrial change.[8] Finally, figure 2g shows another example (Fürth) of a pro-trend region with overall decline. Here we observe almost comprehensive regional decline (left-amplitudes) which still has been somewhat less severe in boom industries.

3.4. *Classification of regions*

The main aim of our classification is to divide regions into three different groups (with "pro-trend", "anti-trend" and "featureless" growth) where the regions within the same group exhibit local change profiles with similar features, indicating that those regions have experienced certain analogies in their recent history of local growth and industrial change.

Figure 3: The local profile of industrial change



Quite naturally, such a classification is always somewhat arbitrary, but the following approach strikes us being a natural first step: Consider figure 3 which depicts a stylized local change profile of some region r. All amplitudes in area A imply excess growth in $s+$

[8] Note that a consolidation of all amplitudes in the profile yields the regional excess growth rate as given in (1), $g_r - g_{nat} = \sum_s \Delta w_{rs}$. A region that exhibits stronger right-(left-)amplitudes overall, therefore must have a positive (negative) excess growth rate.

sectors in region r, whereas amplitudes in area B imply excess growth in nationally declining $s-$sectors. Analogously, amplitudes in A' and B' indicate above-average decline in $s+$ or, respectively, in $s-$ industries. Summing the absolute values of these amplitudes,

$$|A_r| = \sum_{s+} |\Delta w_{rs}| \quad if\ \Delta w_{rs} > 0 \qquad |A'_r| = \sum_{s+} |\Delta w_{rs}| \quad if\ \Delta w_{rs} < 0$$

$$|B_r| = \sum_{s-} |\Delta w_{rs}| \quad if\ \Delta w_{rs} > 0 \qquad |B'_r| = \sum_{s-} |\Delta w_{rs}| \quad if\ \Delta w_{rs} < 0,$$

and adding up the resulting values, $|A_r| + |B_r| + |A_r'| + |B_r'| \equiv D_r$, we obtain

$$D_r \equiv \sum_s |\Delta w_{rs}| = \sum_s \left| \frac{emp_{rs1} - emp_{rs0}}{emp_{r0}} - \frac{emp_{s1} - emp_{s0}}{emp_0} \right| = \frac{1}{emp_{r0}} \cdot \sum_s \left| \Delta emp_{rs} - \tfrac{e_{r0}}{e_0} \cdot \Delta emp_s \right| \tag{2}$$

We call the term D_r from (2) the *excess change* of region r. It is a measure for the *strength* of the change in local industry compositions over time, compared to the average national pattern of structural change.[9] Yet, with D_r alone we cannot further disentangle the *direction* of the regional change, i.e., we cannot distinguish "pro-trend" and "anti-trend" profiles.

To get to such a distinction, one could simply calculate the shares of the amplitudes $|A_r|, |B_r|, |A_r'|$ and $|B_r'|$ in the total excess change D_r. This would not be adequate in our view, however, because these shares can become large even if the amplitudes are small in absolute terms, i.e., if local industrial change is still essentially featureless. Moreover, we believe that one should not lump together urban and rural regions in a cross-regional comparison, but that it is more meaningful to treat urban and rural regions separately.

We hence follow a slightly modified procedure. First, we distinguish cities and rural areas.[10] Then we divide the group of cities (rural areas) into those that grew faster than the respective

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[9] D_r is conceptually related to, but distinct from, the excess churning index introduced by Duranton (2007).

[10] In line with the classification of the Federal Institute for Research on Building, Urban Affairs and Spatial Development, we define cities with a population of more than 100.000 or other regions with a population density of more than 300 citizens per km² as urban regions.

national average, and those that grew slower. For the group ν={cities, rural areas} with above- and below-average growth, $k = \{+,-\}$, we compute the average excess change,

$$\bar{D}_{+}^{\nu} = \left(1/N_{+}^{\nu}\right) \cdot \sum_{\nu+} D_r \qquad \bar{D}_{-}^{\nu} = \left(1/N_{-}^{\nu}\right) \cdot \sum_{\nu-} D_r$$

where N_k^{ν} is the number of areas of the respective type $\{\nu, k\}$-type, and we then calculate the following shares for every region:

$$\alpha_r^{\{\nu,k\}} = \left|A_r\right| / \bar{D}_k^{\nu} \qquad \beta_r^{\{\nu,k\}} = \left|B_r\right| / \bar{D}_k^{\nu} \qquad \alpha_r'^{\{\nu,k\}} = \left|A_r'\right| / \bar{D}_k^{\nu} \qquad \beta_r'^{\{\nu,k\}} = \left|B_r'\right| / \bar{D}_k^{\nu}$$

That is, we set the region-specific amplitudes $\left|A_r\right|$, $\left|B_r\right|$, $\left|A_r'\right|$ and $\left|B_r'\right|$ into perspective to the average excess change level in comparable regions. Finally, we calculate the arithmetic means of these shares ($\bar{\alpha}_k^{\nu}, \bar{\beta}_k^{\nu}, \bar{\alpha}_k^{\nu}{}', \bar{\beta}_k^{\nu}{}'$) and then classify regions as "pro-trend" or "anti-trend" according to the following rule, with all other regions being defined as "featureless":

<u>"Pro-trend"</u>

for $k = "+"$: $\quad \alpha_r^{\{\nu,k\}} > \beta_r^{\{\nu,k\}}$ and $\alpha_r^{\{\nu,k\}} > \bar{\alpha}_k^{\nu}$

for $k = "-"$: $\quad \beta_r'^{\{\nu,k\}} > \alpha_r'^{\{\nu,k\}}$ and $\beta_r'^{\{\nu,k\}} > \bar{\beta}_k^{\nu}{}'$

<u>"Anti-trend"</u>

for $k = "+"$: $\quad \beta_r^{\{\nu,k\}} > \alpha_r^{\{\nu,k\}}$ and $\beta_r^{\{\nu,k\}} > \bar{\beta}_k^{\nu}$

for $k = "-"$: $\quad \alpha_r'^{\{\nu,k\}} > \beta_r'^{\{\nu,k\}}$ and $\alpha_r'^{\{\nu,k\}} > \bar{\alpha}_k^{\nu}{}'$

<u>"Featureless"</u> *otherwise*

What is the rationale behind this assignment rule? Consider regions with $k = "+"$ that grow stronger than the respective national average. The first condition for "pro-trend" growth requires that, within the region, growth is mainly driven by nationally booming $s+$ industries. In addition, the second condition requires that regional growth of $s+$ industries is also stronger than in comparable areas. We thereby avoid classifying regions as “pro-trend” where right-amplitudes $\left|A_r\right|$ are small in absolute terms. The definition of “anti-trend” regions follows a similar logic: i) growth within the region must be stronger in national bust industries than in boom industries, and ii) this growth of $s-$ industries must be stronger than in comparable regions. For the declining regions ($k = "-"$), we adopt an analogous approach.

3.5. The groups of German pro- and anti-trend regions

With our approach, we make sure that we only allocate such regions into the groups with “pro-trend” or “anti-trend” growth, where the respective local change profiles actually exhibit marked features that differ substantially from the national average.[11] Table 1 reports the number of regions as well as some mean regional characteristics in the different groups.

Table 1: Means of regional characteristics

	pro-trend growth		anti-trend growth		featureless growth		aggregate
	grow (+)	decline (-)	grow (+)	decline (-)	grow (+)	decline (-)	
number of regions	50	55	45	40	75	61	326
(cities / rural areas)	(15 / 35)	(20 / 35)	(15 / 30)	(10 / 30)	(26 / 49)	(15 / 46)	(101 / 225)
excess growth rate ($g_r - g_{nat}$)	41.95	-23.24	25.81	-18.74	8.82	-11.05	--
excess change (D_r)	98.68	74.91	82.53	67.58	68.21	60.21	--
share manufacturing	35.65	47.42	48.60	34.32	39.23	40.06	40.91
share high skilled workers	2.98	2.45	2.45	2.96	2.95	3.28	2.86
Δ import exposure (gross)	5.93	9.75	8.72	6.84	7.58	7.44	7.74
Δ export exposure (gross)	6.99	8.49	10.86	8.51	8.65	8.45	8.62
Δ net exposure	1.06	-1.27	2.13	1.66	1.07	1.01	0.88

[11] It is important to point out that our main results do not crucially hinge on the particular ad hoc definitions of “pro-trend” and “anti-trend” regions. We have conducted several robustness checks where we define the groups differently. There we typically impose somewhat stricter conditions before a region is classified as “pro-trend” or “anti-trend”, respectively. The key messages of Table 1 and Figure 4 are unaffected by these alternations.

Most regions (136 out of 326) we classify as “featureless”. 105 regions exhibit a “pro-trend” pattern, and 85 regions belong to the “anti-trend” group. The map in the Appendix illustrates the geographical configuration of these regional types. Some concentration of non-featureless growth is visible in Bavaria in the South-East, as well as some smaller clusters of “pro-trend” decline in the Ruhr area in the western part. Overall, however, it seems that “pro-trend” and “anti-trend” growth regions are scattered across Western Germany.

Table 1 also reports the average excess employment growth rate $g_r - g_{nat}^v$ across regions in the different groups, and in Figure 4 we illustrate kernel density estimates of these excess growth rates. As can be seen, the “pro-trend” pattern tends to come with the highest total growth among the successful regions. Yet, there is considerable overlap in the distributions. Put differently, a “pro-trend” profile seems to be neither a guarantee nor a prerequisite for a good overall performance. Many “anti-trend” regions were almost equally successful. Among the declining regions, we similarly find that “pro-trend“ and “anti-trend” regions also did not differ much in their overall performance, although they differ substantially in the sectoral structure of their growth profile.

Figure 4: Excess growth in the different groups of regions

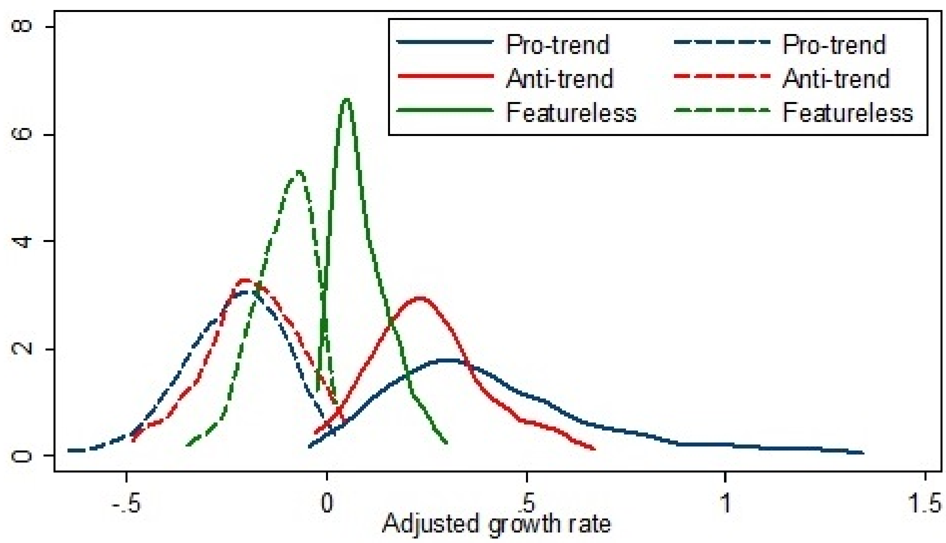

Table 1 also reports the average excess change across regions in the different groups. We see that "pro-trend" regions exhibit on average stronger amplitudes in their local change profiles than "anti-trend" regions. Moreover, excess change is higher for growing than for declining regions, pointing at a positive correlation between local growth and industry turnover. By construction, regions with featureless growth exhibit the smallest degrees of excess change.

4. The impact of international trade on regional growth and industrial change

So far, we have documented patterns of local industrial change and we have classified the German regions into three groups. However, we said little about the underlying causes of these divergent regional trends, i.e., *why* a particular region might exhibit a "pro-trend" or an "anti-trend" profile with above- or below-average total regional growth. In this section, we turn to the second step of our analysis and aim to provide an (at least partial) explanation.

Our hypothesis is that the differential regional trends described so far are shaped – to a notable extent – by "globalization", more specifically, Germany's rising international trade exposure with emerging economies in Eastern Europe and Asia. In this section, we first provide some background about this external trend of globalization, then derive a measure for local trade exposure (on the import and export side), and finally analyze how this local trade exposure has affected regional growth and change in the different groups.

4.1. Rising German trade with "the East"

During our observation period, there has been a massive increase in the aggregate German trade volume, in particular with respect to two trading partners: China and Eastern Europe. This is shown in Table 2, which summarizes the increase of the total German export and import volumes (in constant 2005-€) vis-à-vis various trading partners over the period 1978-2008. The reasons for the "rise of China" in the world economy, e.g., various market openings, massive productivity gains, trade cost reductions from its WTO accession, etc., are well documented in the literature (Feenstra and Hanson 1999; Autor et al. 2013). Similar causes led to the rise of Eastern Europe after the fall of the iron curtain and the transformation of the former socialist countries into market economies (Redding and Sturm 2008).[12] For both areas, we may thus argue that their rise in world economy occurred unexpectedly and quickly, and was exogenous from the point of view of German regions.

Table 2: Changes in German trade volumes, 1978-2008 (in billion €)

	China		Eastern Europe	
Period	Imports	Exports	Imports	Exports
1978	0.7	1.9	9.2	14.6
1988	3.1	3.0	11.0	13.3
1998	12.9	5.6	42.0	51.0
2008	53.1	30.1	103.8	134.0
Growth	**7568%**	**1496%**	**1030%**	**820%**

	Other Asian dev. countries		Rest of the World	
Period	Imports	Exports	Imports	Exports
1978	3.7	3.8	216.6	251.7
1988	5.0	5.1	289.3	380.7
1998	12.6	7.5	357.7	442.8
2008	20.0	16.2	490.1	662.4
Growth	439%	327%	126%	163%

Source: Own calculations based on UN Comodity Trade Statistics

Standard international trade theory predicts that such exogenous liberalizations cause perturbations in domestic industry structures, as countries specialize in their respective comparative advantage industries. From an aggregate perspective, rising German trade with "the East" (Eastern Europe and China) can thus be expected to induce expansions or, respectively, contractions of employment across industries. Until recently, however, researchers mostly ignored the regional implications of this process, i.e., how external trade liberalizations affect the internal structure of the domestic economy.

[12] Eastern Europe comprises the countries Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, and the former USSR or its succession states Russian Federation, Belarus, Estonia, Latvia, Lithuania, Moldova, Ukraine, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

4.2. Data and measurement of local trade exposure

In a recent paper, Dauth et al. (2014) have analyzed the impacts of these major trade shocks for Germany from a regional perspective, drawing on the pioneering work by Autor et al. (2013) for the United States. In this paper, we follow their approach to measure the trade exposure of a German region. We first consider the import exposure of a German region i from "the East", which can be written as follows:

$$\text{Import Exposure}_{it} = \sum_j \frac{E_{ijt}}{E_{jt}} \cdot \frac{\Delta \text{Imp}_{jt}^{EAST}}{E_{it}} . \qquad (3)$$

Here, $\Delta \text{Imp}_{jt}^{EAST}$ is the total change in the import value from "the East" (the sum of China and all Eastern European countries) to Germany that was observed in industry j between 1978 and 2008. E_{ijt}/E_{jt} represents region i's share of national industry employment in sector j, and E_{it} is the total manufacturing employment in region i in the base period. This measure thus captures the *potential* increase in import exposure of a German region, given its initial sectoral employment structure. It apportions the *national* change in imports to the single German regions according to their shares in national industry employment. Analogously, we measure region i's export exposure as follows,

$$\text{Export Exposure}_{it} = \sum_j \frac{E_{ijt}}{E_{jt}} \cdot \frac{\Delta \text{Exp}_{jt}^{EAST}}{E_{it}} , \qquad (4)$$

where $\Delta \text{Exp}_{jt}^{EAST}$ is the total national change in industry j's export flows to "the East". This measure thus captures the potential of regions, given their initial sectoral employment patterns, to benefit from rising demand from the "East" for German manufacturing products. Finally, to consider the net trade exposure of a German region, we compute

$$\text{Net Exposure}_{it} = \sum_j \frac{E_{ijt}}{E_{jt}} \cdot \frac{1}{E_{it}} \left(\Delta \text{Exp}_{jt}^{EAST} - \Delta \text{Imp}_{jt}^{EAST} \right) \qquad (5)$$

The industry-level data on import and export volumes come from the United Nations Commodity Trade Statistics Database (Comtrade). This data contains annual international trade statistics of over 170 reporter countries detailed by commodities and partner countries. Trade flows are converted into 2005-€ using exchange rates supplied by the German *Bundesbank*. We merge this information with our German sectoral employment data by harmonizing industry and product classifications. The correspondence between 1031 SITC rev. 2/3 product codes and the employment data (101 NACE 3-digit equivalent industry codes) is provided by the UN Statistics Division and allows unambiguously matching 92 percent of all commodities to industries. We partition trade values of ambiguous cases into industries according to national employment shares in 1978. Notice that these trade volumes are only for manufacturing industries, while there is no information on trade in services.

4.3. The overall impact of trade exposure on regional growth and change

We investigate the impact of trade exposure with “the East” on employment growth across German regions. More specifically, as our main dependent variable we use the regional excess growth rate $\left(g_r - g_{nat}\right)$ as defined in eq. (1). We regress this on the local measures of import and export exposure from (3) and (4), or alternatively the net exposure (5). We also control for the initial share of manufacturing employment in the region, since the variation in the local trade exposures mainly stems from the detailed sectoral specialization patterns within the local manufacturing sector. Finally, we add dummy variables that capture the broad location of the respective region, and more importantly, whether it belongs to the “pro-trend” or the “anti-trend” group. Table 4 shows the regression results.

In column 1, we consider the impacts of import and export exposure separately. For import exposure, we obtain a significantly negative coefficient. That is, regions with an initial industrial structure that makes them more vulnerable to rising import penetration from "the East" exhibited lower employment growth over the period 1978-2008.

Table 3: Impact of trade with "the East" on Western German Regions

dependent variable:	excess regional growth rate			excess regional change		
	(1)	(2)	(3)	(4)	(5)	(6)
north	-3.106	-2.409	-3.434	-0.137	-0.120	-0.103
	(4.09)	(4.06)	(3.97)	(0.13)	(0.13)	(0.12)
south	17.473***	17.587***	15.670***	-0.115	-0.112	-0.109
	(3.09)	(3.10)	(2.90)	(0.10)	(0.10)	(0.10)
pro-trend	9.401**	8.793**	42.127***	0.704***	0.689***	0.878***
	(3.70)	(3.68)	(10.98)	(0.09)	(0.09)	(0.33)
anti-trend	3.245	3.520	-35.736***	0.354***	0.360***	0.689*
	(2.95)	(2.91)	(7.43)	(0.11)	(0.11)	(0.41)
export exposure	1.575***			-0.012		
	(0.53)			(0.02)		
import exposure	-0.986***			0.026***		
	(0.28)			(0.01)		
net exposure		1.114***	0.660**		-0.023**	-0.022**
		(0.34)	(0.26)		(0.01)	(0.01)
initial share of manuf. employment	-0.507***	-0.365***	-0.360***	-0.014***	-0.011**	-0.007
	(0.18)	(0.12)	(0.11)	(0.00)	(0.00)	(0.01)
interaction pro-trend x manuf. share			-0.808***			-0.005
			(0.24)			(0.01)
interaction anti-trend x manuf. share			0.949***			-0.008
			(0.17)			(0.01)
R^2	0.152	0.148	0.258	0.183	0.180	0.183

Notes: N=326, robust standard errors in parentheses.

Regions with an export-oriented structure grew significantly stronger, however, and the marginal effect of export exposure seems to be stronger than the import effect. Moreover, as discussed before, we find that “pro-trend” regions grew somewhat faster on average.

In column 2, we address the consolidated impact of net export exposure. We find a significantly positive effect on excess growth, thus supporting the conclusion that more export-oriented regions (with higher net export exposure) tended to grow faster. Moreover, that specification reveals a negative coefficient of the initial manufacturing share. Across all German regions, a strong initial manufacturing specialization is thus negatively related to subsequent regional growth. However, there is a more nuanced picture for the different groups of regions. In column 3, we introduce interaction terms with dummy variables for our “pro-trend” and “anti-trend” groups. This exercise shows that a large manufacturing sector was particularly harmful for growth among “pro-trend” regions. Among the “anti-trend” regions, however, a larger manufacturing base is associated with a better growth performance.

In columns 4-6 of Table 4, we consider the effects of trade exposure on the strength of local industrial change. The specifications are analogous to columns 1-3, but the dependent variable is now the excess change D_r from eq. (2). First, notice that we find significantly higher excess change in both, “pro-trend” and “anti-trend” regions, as compared to regions with featureless growth. Moreover, a higher import exposure triggers stronger industry reallocations, i.e., more pronounced amplitudes in the local change profiles (in either direction). More export-oriented regions, by contrast, exhibited lower excess change.

In the next subsection, we will provide a detailed discussion of these results, in particular about the implied economic magnitudes and the ambiguous relationship between the initial manufacturing share and subsequent growth. For the moment, we like to stress that the estimation results shown in columns 1-3 of Table 4 are consistent with the findings by Dauth et al. (2014). They also show that the German economy substantially benefited from rising export opportunities in “the East”, unlike the US, which seems to be primarily affected by rising import exposure (Autor et al., 2013). More importantly, Dauth et al. (2014) provide a battery of extended analyses and robustness checks to investigate the *causal* effect of rising trade exposure on local growth. Those extensions, which include an instrumental variable approach based on third-country trade flows, an identification strategy based on gravity residuals, and various falsification and placebo tests, all address the main estimation concern that unobserved demand or supply shocks could simultaneously drive aggregate trade and regional performance measures. In the current paper, it is not our main aim to disentangle the causal effect of rising trade exposure from possible confounding effects. We are more broadly interested in how regional growth and change are affected by initial local specialization patterns that lead to a higher local exposure to trade shocks and possibly other, correlated types of shocks. We therefore suffice with ordinary least squares (OLS) estimations, which yield results that are qualitatively consistent with those established in Dauth et al. (2014).

4.4. Benchmarking the effects of trade exposure in "pro-trend" and "anti-trend" regions

We may summarize the two key insights from the previous empirical exercise as follows:

1.) The initial manufacturing share is negatively correlated with regional growth among the "pro-trend" regions, but positively correlated among the "anti-trend" regions.

2.) Strong local export exposure has spurred subsequent regional employment growth, while local import exposure had detrimental effects for regional growth.

The first main result is already visible in Table 1 above, which shows that the initial share of manufacturing employment differs quite strongly across the different groups of regions. In particular, the successfully growing "pro-trend" regions had a much smaller average share of manufacturing employment than the declining "pro-trend" regions (35.7 versus 47.4 per cent). Among the "anti-trend" regions, however, it is the other way around. Here we find that the growing regions had on average a much larger initial manufacturing share than the declining ones (48.6 versus 34.3 per cent). To understand the reason behind this difference, notice the average local trade exposures in the different groups as reported in Table 1.

The first important observation is that the highest import exposures are observed in declining "pro-trend" and in growing "anti-trend" regions, i.e., in those types of regions with the largest initial manufacturing shares. We observe striking differences, however, with respect to regional export exposures. It has risen quite modestly for the "pro-trend decliners", and the average increase in net export exposure is even negative for those regions. For the "anti-trend growers", however, we observe very strong average increases in (gross and net) export exposure. That is, even though the "pro-trend decliners" and the "anti-trend growers" started with similar *total* shares of manufacturing industries, they were specialized in *different* manufacturing industries and consequently revealed very different export exposures.

The "anti-trend growers" saw a strong increase in import competition from "the East", thanks to their large manufacturing bases. However, their local manufacturing employment structures also had significant export-oriented branches that gained from the rising foreign demand. Employment losses in the import-competing manufacturing industries could thus be compensated, and even be more than offset, by the export-driven employment gains in other manufacturing industries. In the declining "pro-trend" regions, on the other hand, there were no sufficient export-oriented sectors to cushion the import-driven employment losses within the manufacturing sector. As manufacturing jobs were displaced in those regions, there has been a notable increase in the local service sectors (at least relative to other regions). Yet, this rise of the service economy was not sufficient to compensate all manufacturing job losses.[13]

[13] Regions from the Ruhr area (e.g. Oberhausen or Duisburg) are clear examples for this regional profile. Mining, steel and other heavy manufacturing industries dominated the economic structures of those areas in the 1970s. High-wage countries like Germany de-specialized in those industries, because emerging economies including China and Eastern European transition countries rapidly built up a comparative advantage. Being specialized in those industries, the Ruhr area thus suffered from this increasing import exposure. The affected manufacturing regions "re-invented" their local economies (Glaeser 2005) and mostly turned to modern service industries, like ICT or logistics. However, those job gains did not compensate the huge manufacturing job losses.

Table 5 provides a quantitative benchmarking of those effects. It summarizes the implied impacts of rising trade exposure on total regional employment in the different groups.[14]

Table 4: Benchmarking the impact of trade with "the East"

type	total effect	% effect relative to working age pop.
total	203,231	1.22
pro-trend	23,293	0.52
anti-trend	75,982	2.16
featureless	103,956	1.20
pro-trend growth	26,684	1.48
pro-trend decline	-3,391	-0.13
anti-trend growth	55,427	3.23
anti-trend decline	20,555	1.13
featureless growth	57,692	1.30
featureless decline	46,264	1.09

On average, we estimate that the "rise of the East" has raised the aggregate German employment rate (full-time equivalent jobs relative to working age population) by about 1.2 percentage points. This corresponds to some 200,000 additional full-time jobs in the period 1978-2008 that would not exist without the rising trade integration with the East. Yet, this positive impact was by far largest for the "anti-trend growers" with their large and strongly export-oriented manufacturing bases. Here, the employment rate has increased by more than

[14] For this quantitative benchmarking, we use the marginal effect of net exposure (0.455) from a regression similar to column 2 of Table 4, but with the actual employment growth rate g_r (not the excess growth rate) as the dependent variable.

3.2 percentage points on average. By contrast, trade has led to a net job destruction in the group of “pro-trend decliners”, given their large and mostly import-competing manufacturing sectors. On average, this decline has been rather modest and amounted to only -0.13 percentage points. However, there is substantial variation within the group of “pro-trend decliners”, and for some regions, we estimate that trade has lowered the employment rate by more than 20 percentage points. Examples include Friesland, Coburg or Südwestpfalz, which had strong initial specializations in import-competing industries such as, respectively, lower-tier office machinery, games & toys, or textiles.

Turning to the other two groups, for the regions with initially small manufacturing shares, we observe in Table 1 that the “pro-trend growers” were least affected by trade exposure from the East, both on the import and on the export side. The predicted employment gains from trade as shown in Table 5 are, therefore, relatively modest for this group. The “pro-trend growers” apparently exhibited the general trend of structural change (Petty’s law) in a clean form, without major industry reshufflings resulting from rising trade exposure, and transformed their local economy towards modern services rather quickly. Finally, the “anti-trend decliners” had a manufacturing base of similar size, but with a somewhat larger (gross and net) export exposure. The impact of trade was thus mostly positive, and the manufacturing sector contributed to job growth in those regions. However, this positive impact was not large enough to lead to an above-average overall regional growth performance.

Summing up, the initial size of the local manufacturing sectors and the different specialization patterns *within* manufacturing appear to be important underlying causes *why* particular regions turn out to be growing/declining “pro-trend” or, respectively, “anti-trend” regions.

4.5. Human capital and local growth

In this final subsection, we briefly address the role of human capital for local growth in the different groups of regions. Several studies have found a robust positive correlation between the initial employment shares of college educated workers and subsequent local employment/population growth (Simon 2004, 1998; Simon and Nardinelli 2002; Suedekum 2008). The main reason why skilled cities grow faster seems to be the positive impact of human capital externalities on local productivity that translates into equilibrium employment gains (Shapiro 2006; Moretti 2004; Glaeser and Saiz 2004; Glaeser et al. 2011).

In our study, we measure the qualification structure of the local workforces by the share of employees with university degree. As can be seen in Table 1 above, in the base year 1978, the average human capital share did not differ strongly across the groups; it ranged between 2.4 and 3.3 per cent. We then repeat our previous empirical specification from Table 4, but now control for the initial regional human capital share, and interaction terms of the human capital share with our "pro-trend" and "anti-trend" dummies.

Table 5 shows the regressions results. Column 1 corresponds to Table 4 for reference. In column 2 we find that the positive effect of human capital on local growth is strongly concentrated on the group of "pro-trend" regions. Recall that trade shocks played only a relatively minor role in the successful "pro-trend" regions, and Petty's law operated quickly there. Table 5 suggests that high-skilled workers are particularly conducive for growth in such an industrial environment, where the modern service economy is built up.

Among the "anti-trend" regions, where regions tend to reinforce their initial manufacturing specialization, human capital does not seem to be a major driver of growth. At least we do not find evidence that relatively more skilled "anti-trend" grew faster over the last three decades. Apparently, since manufacturing is on average less skill-intensive than the modern service industries that flourished elsewhere, demand for high skilled workers was rather low in the course of the long-term developments in these "anti-trend" regions.

This finding, that human capital seems to spur growth mainly in such regions that exhibit a particular trajectory of local industrial change is, namely the "pro-trend" pattern, is – to the best of our knowledge – a novel finding in the literature on local growth.

Table 5: The impact of human capital on regional growth and change

dependent variable:	excess regional growth rate	
	(1)	(2)
north	-3.434	-2.297
	(3.97)	(4.09)
south	15.670***	17.165***
	(2.90)	(3.10)
pro-trend	42.127***	20.438
	(10.98)	(16.15)
anti-trend	-35.736***	-39.480***
	(7.43)	(9.18)
net exposure	0.660**	0.650***
	(0.26)	(0.24)
initial share of manuf. employment	-0.360***	-0.393***
	(0.11)	(0.11)
interaction pro-trend x manuf. share	-0.808***	-0.655**
	(0.24)	(0.26)
interaction anti-trend x manuf. share	0.949***	0.975***
	(0.17)	(0.17)
initial share of high skilled workers		-1.734***
		(0.56)
interaction pro-trend x share high skilled		5.408*
		(2.78)
interaction anti-trend x share high skilled		0.725
		(1.48)
R^2	0.258	0.280

Notes: N=326, robust standard errors in parentheses.

5. Concluding remarks

In this paper, we have taken a detailed look at the sectoral anatomy of regional growth in Germany over the period 1978-2008. The aggregate German economy is characterized by a secular decline of the manufacturing sector and a rise of modern services. However, this trend of structural change by no means occurs uniformly across space; some regions exhibit this trend even at an accelerated pace, while other regions develop their local economic structures against the trend and into the direction of larger manufacturing bases.

The local change profiles that we have developed in this paper may be a helpful new tool, as they not only visualize these idiosyncratic developments of every single region, but also allow for a systematic classification of regions. We have distinguished “featureless”, “pro-trend” and “anti-trend” regions, and then subdivided those groups into regions with above-average and below-average long-run employment growth. The regions within each of the groups feature a similar history of growth and industrial change over the last three decades. We first descriptively compared the groups and looked for some basic differences and similarities. Afterwards, we have identified regional trade exposure as an important underlying cause *why* regions exhibited so different patterns of local growth and change.

What are the main policy lessons from our paper? Most importantly, our study suggests that there has not been a single “role model” for successful regional growth. Some regions performed very well overall, even though regional growth was strongly based on declining industries. To the extent that regional policy can influence such developments in the first place, our result thus show that initial conditions matter a lot when it comes to finding the strategy that seems most promising for a specific region. In particular, the size and the composition of the local manufacturing sector seem to matter. Regions with a small manufacturing base that is little exposed to foreign competition should do best if they forge ahead in developing the modern service economy. Human capital appears to be crucial in this regional growth path. For regions with a large initial manufacturing base, however, this profile of local development may be much too costly as it involves massive and painful industry reshufflings and sectoral reallocations.

For these manufacturing regions, it is most important, according to our analyses, to take a detailed look at the overall trade exposure of the local manufacturing base. We find that regions with large and export-oriented manufacturing sectors have been quite successful in Germany in the last three decades when they have based their local development on the further expansion of this manufacturing sector, despite the fact that the development of the local service economy has been somewhat lagging behind in those areas. For those "anti-trend" regions that reinforce their manufacturing specialization, we also find no significant association of local human capital and regional growth in the data.

The situation is most delicate for regions with large and mainly import-competing manufacturing sectors. These regions suffered from the most severe job losses and the lowest average growth rates. The rise of the service sector has been visible in those regions, but it was not (yet) sufficient to cope with this legacy of structural transformation.

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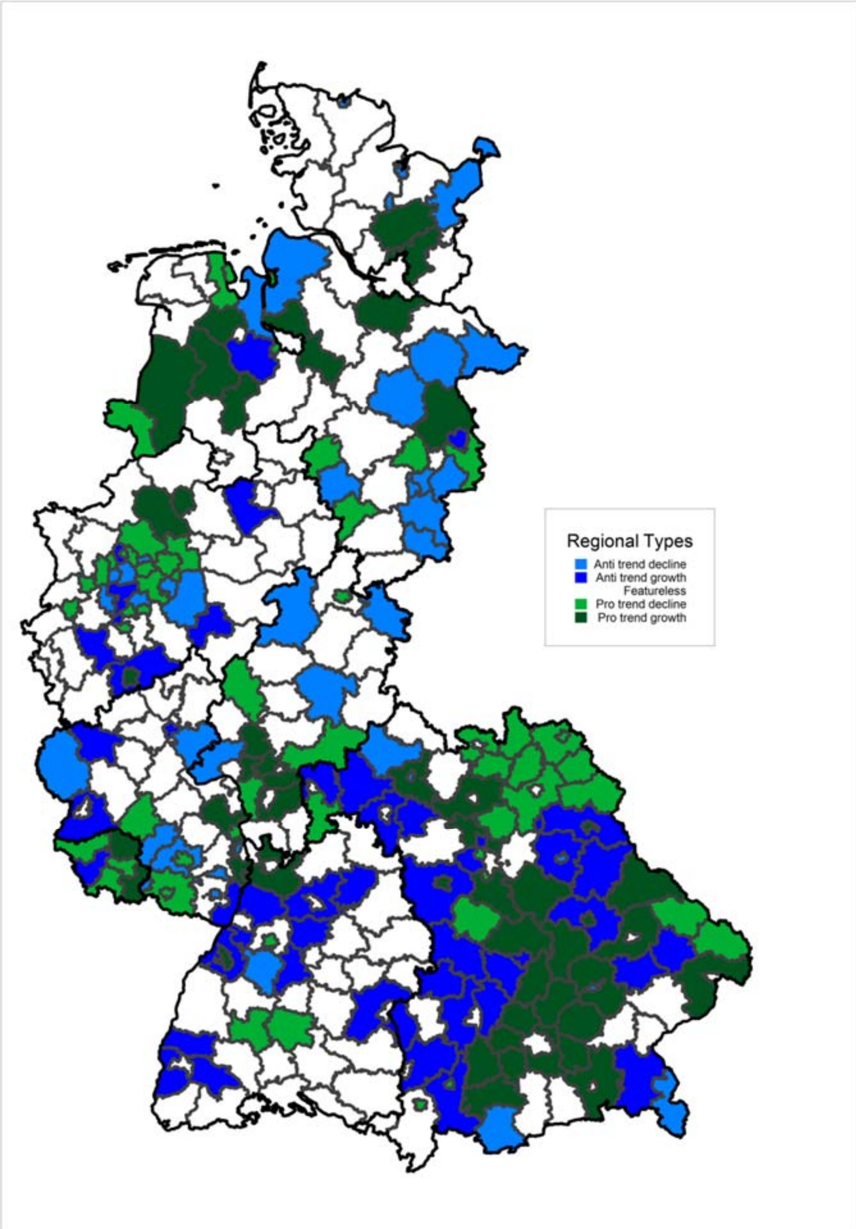
Figure A1: Growing and declining "pro-trend" and "anti-trend" regions



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