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Profiles of local growth and industrial change: Facts and an explanation

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Profiles of local growth and industrial change: Facts and an explanation

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ABSTRACT

In this paper we take a detailed look at the sectoral anatomy of regional growth in German regions over the period 1978-2008. In the aggregate, the German economy is characterized by a secular decline of the manufacturing sector and a rise of the modern service economy. This trend of structural change (Petty's law) by no means occurs uniformly across space, however. Some regions exhibit this trend even at an accelerated pace, while other regions develop their local economic structures against the trend and expand their manufacturing bases. We first develop a novel empirical approach that allows us to categorize all German regions into one out of three groups with "pro-trend", "anti-trend" or "featureless" regional growth. Afterwards we show that the differential exposure to international trade is an important cause of the divergent patterns of local industrial change.

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

JEL-Class.: R11, 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 during the same period. These (un-)favorable developments are often seen in close relationship to the local industrial structures of those areas: San Francisco has flourished as it became increasingly specialized in the booming IT sector that is generally on an upward trend in the economy. New York's success goes hand in hand with advanced services such as the financial industry that also rise in the aggregate. Detroit, on the other hand, declined because it was traditionally specialized in heavy manufacturing and has not managed to get rid of those regressive industries fast enough.

Apart from such often cited cases, surprisingly little is known about the systematic relationship between industrial change and economic growth at the local level. How does the sectoral anatomy of growth, or respectively, of decline differ across regions? Can a region only exhibit an exceptional long-run performance when it manages to build up employment in booming industries (and to get rid of declining industries) faster than others? Or can a region also thrive when it develops against the trend and expands in sectors that are declining elsewhere in the country? If this is so, under what circumstances is such a profile of local growth likely to work? These questions are highly relevant for policymakers who spend considerable resources on regional development strategies that typically require some idea about the local industry composition that is supposed to be supported.

Using comprehensive and highly disaggregated German employment data, we trace industrial change at the national and at the local level over a time span of thirty years (1978-2008). In the aggregate, we find 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 called *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 exhibited structural change profiles that differ quite substantially from this national average.

This paper consists of three steps. In the first step, we develop a novel empirical approach that allows us to categorize all German regions into one out of three groups with “pro-trend”, “anti-trend” or “featureless” regional growth, respectively. Most regions belong to the latter group. Growth in these regions was “featureless” in the sense that local change patterns closely mimicked aggregate developments, that is, industries expanded or shrank more or less according to national industry growth rates. The other two groups include regions where local growth and change differed more markedly from the national average. “Pro-trend” regions exhibited a similar *direction* of industrial change like the nation as a whole, but at an accelerated *speed*. That is, booming industries tended to grow faster than in the national average while declining industries tended to disappear faster. Conversely, in “anti-trend” regions industries grew that declined elsewhere, while national boom industries declined.

In the second step, we compare these different groups of regions from a descriptive point of view and report some interesting stylized facts about the initial characteristics and the subsequent growth performances of “pro-trend” and “anti-trend” regions. We show, for example, that the “pro-trend” pattern tends to come with the best overall performance. Yet, this profile where regions forge ahead in developing a modern service economy was neither a guarantee nor a prerequisite for regional success. Many “anti-trend” regions also had growth rates well above the national average. In other words, we observe strong differences in the sectoral anatomy of growth across regions that performed equally well overall.

Furthermore, we show that the initial sectoral structure in growing “pro-trend” regions was typically characterized by low manufacturing shares. In the following three decades, this small manufacturing sector was then replaced by modern services at an above-average speed. The growing “anti-trend” regions, by contrast, typically started off with a strong

manufacturing specialization that was henceforth even reinforced. Among the declining "pro-trend" regions, it was the other way around: They also started from high manufacturing shares but then massively lost manufacturing jobs, to an extent that could not be compensated by new employment opportunities in the service industries. We also discuss the role of local human capital in these different regional trajectories, and find that it is mostly associated to the "pro-trend" pattern that relies on the quick development of modern service industries.

Finally, in the third step, we turn to the important question what causes these divergent trends of growth and industrial change at the local level. The basic theory of structural change, *Petty's law*, typically explains the secular decline of manufacturing employment and the rise of the modern service economy by some combination of non-homothetic demand and productivity growth in the manufacturing sector. This leads to a reduction in labor demand there, while the increasing (income-elastic) demand for modern services leads to employment gains in those industries. This theory is essentially silent, however, on the spatial dimension of this transformation process. Therefore it cannot explain our descriptive evidence that regions differ vastly in the speed and even in the direction of their local industrial change profiles.

At a more disaggregated level, there are various static theories which explain the composition of local economic structures and the overall spatial distribution of economic activity by the fundamental trade-off between agglomeration and dispersion forces, both within and across industries.[1] These contributions from the economic geography literature predict that changes in local industrial structures over time will result from changes in exogenous forces that affect this trade-off. This can refer to changes in intra-national spatial frictions (such as transport or commuting costs), but also to changes in the competitiveness of foreign countries with which the domestic economy is linked via international trade.

[1] See Fujita and Thisse (2002) or Duranton and Puga (2004) for overviews of this very large literature. See Helsley and Strange (2012) for a recent theoretical contribution that explicitly introduces intra- and inter-industry agglomeration economies in a system-of-cities model in the spirit of Henderson (1974). Behrens et al. (2012) study the role of spatial frictions in shaping the fundamental trade-off between agglomeration and dispersion forces and quantify their impacts on the US economic geography.

In fact, we argue that the observed patterns of “pro-trend” and “anti-trend” growth can be explained (at least partly) by the differential import and export exposure of German regions. During our observation period, the German economy experienced a massive increase in aggregate trade, particularly with Eastern European and Asian countries since the early-1990s when “globalization” gained momentum. Given the substantial variation in initial sectoral employment patterns, German regions were thus differently exposed to the newly arising import competition from, and the new export opportunities in “the East”. To give an example, export-oriented ``automobile regions'' may have expanded their manufacturing sectors as a result of the new market opportunities. Regions specialized in import-competing industries, say “textile regions” or “coal and steel regions”, on the other hand, may see a displacement of their manufacturing jobs by the foreign import penetration.

Summing up, we argue that industrial change across German regions can be understood by a combination of two overlapping trends: *Petty’s law* is at work, as we clearly observe the aggregate trend away from manufacturing and towards services. Yet, single German regions can be leading or lagging behind this trend, or even develop into a different direction, depending on their initial local specialization patterns. In particular, the size and the composition of the local manufacturing sector seem to matter for the subsequent regional evolution, as it determines the regional exposure to international trade which in turn is an important driver of local growth and change.

The rest of this paper is paper is organized as follows. In section 2 we discuss some related literature. Section 3 introduces the data and our approach of categorizing German regions into different groups. The descriptive analysis on the differences between “pro-trend” and “anti-trend” regions is presented in Section 4. In Section 5 we analyze the impact of trade exposure on local growth and industrial change. Finally, Section 6 concludes and discusses the implications of our results for regional development strategies and policy.

2. Related literature

One of the most active current debates in the urban economics literature concerns the identification and the disentangling of the different Marshallian agglomeration forces.[2] Within that literature, several papers have investigated the "sectoral scope of agglomeration economies" (Rosenthal and Strage, 2004). In particular, seminal papers by Glaeser et al. (1992) and Henderson et al. (1995) have launched an intensive discussion about how the local economic structure affects productivity and growth at the local level.[3] Those studies focus on external effects caused by agglomeration (localization and urbanization effects), and ask whether an environment of specialization or diversity is most conducive for the growth of local industries. Our focus in this paper is different. We do not aim to analyze why firms from particular industries agglomerate in space, or under which circumstances particular local industries grow the fastest. Our basic unit of analysis is not a local industry, but the region as a whole. We try to understand how the change in local industry compositions is related to the regional long-run growth performance.

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; Lopez and Südekum 2009). This evidence suggests that a regional development strategy based on the idea of "clustering" might be promising.[4] Yet, it remains unclear what this really implies for a region as a whole: Of which type of industries should a regional cluster consist? Obviously, by the nature of the concept, not all regions can become specialized in the same industries. Hence, it is crucial to address the question if overall regional growth is only stimulated by a specialization

[2] See, among others, Rosenthal and Strange (2001), Glaeser and Mare (2001), Henderson (2003), Yankow (2006), Duranton et al. (2009) or Ellison et al. (2010).
[3] See Combes and Overman (2004) for an overview. Blien et al. (2006) and Dauth (2012) have analyzed those issues for the case of Germany.
[4] See Duranton (2011) for a critical assessment of the concepts of "clusters" and "cluster policies", which are often associated with the work of Porter (1990).

("clustering") of booming industries that also grow elsewhere (like, for example, the IT or biotech sector). Or can it also be a promising option for a single region to specialize in activities that decline elsewhere in the country, i.e., to become the host of sectors that gradually disappear from other locations?

The current empirical agglomeration literature does not address those questions; neither does the extensive literature that analyzes how the specialization of regions and the geographical concentration of industries in Europe and the US have changed over time (see Combes and Overman, 2004 and Holmes and Stevens, 2004 for surveys). That literature typically only traces the *strength* of regional specialization (often measured with the Krugman specialization index or some related concept), but it does not keep track of the *direction* of the change in local industry compositions. Regions can increase the degree of idiosyncrasy of their local economic structure compared to the national average in very different ways, however. We develop such a distinction in this paper by constructing different groups of regions that exhibit "pro-trend" and "anti-trend" growth, respectively.

Another related paper is Glaeser's (2005) case study on the city of Boston. It provides a particularly good example how a city that is able to "reinvent" itself can compensate for employment losses due to the decline of previously important industries, by shifting towards new and previously underdeveloped sectors. This implicitly suggests a positive relationship between the strength of local industrial change and regional growth, as is also further discussed in Glaeser et al. (2011). However, it is an open question if this case study points at a general relationship. Is Boston's growth experience the only possible option for a successful regional development, or are there others strategies? Second, a notable theoretical contribution is Duranton's (2007) work on urban evolutions. In his model, random innovations lead to the relocation of industries between cities. Every city thus persistently exhibits changes in local industry compositions, 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 since all industries are symmetric, it also does not matter which industries enter (or leave) the city.

Empirical evidence on the relationship between local industrial change and growth is also scant. Findeisen and Südekum (2008) use the excess churning index developed in Duranton (2007) and find no evidence that industry churning and growth are notably correlated in Germany. That is, somewhat in contrast to the Boston case discussed above, they find that many German cities have grown strongly even though the magnitude of industry reallocations was rather modest. Our analysis goes beyond their approach, because it quantifies not only the *speed* but also the *direction* of regional structural change processes, and sets this into perspective to the long-run growth performance of the German regions.

Finally, a very novel focus of this paper is the analysis of international trade as a driver of local industrial change. In a recent important paper, Autor et al. (2012) have analyzed the impact of regional import exposure (with respect to China) on employment growth and other local labor market indicators across US local labor markets. In Dauth et al. (2012) we have applied and extended that approach to German regions. There we have shown, that import exposure has a negative impact on regional employment growth, both in manufacturing and beyond. Yet, there is also a positive effect of local export exposure on regional growth that is, on average, even stronger than the opposite import-exposure effect. Trade integration with respect to Eastern Asian and European countries has, in the aggregate, therefore caused positive job growth in the German economy. In particular, it has created manufacturing jobs and thereby worked against the general Petty`s law according to which the manufacturing sector should gradually decline. In this paper, we push this analysis one step further and distinguish regions according to their local patterns of industrial change. We show that the distinct features of those patters can be explained by differential local trade exposure. The successful “anti-trend” regions, for example, which build up manufacturing employment against the general trend, are indeed regions with a strongly positive export exposure.

3. Categorizing patterns of regional growth and change

3.1. Data

In our empirical analysis, we draw on extensive employment data from the German establishment history panel 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.[5] Finally, for this paper we only use the first and the last year of the observation period (1978 and 2008) in order to analyze the process of industrial change over a 30-year period. We observe the total employment level measured in full time equivalents[6], as well as some standard characteristics such as the qualification, age, gender, and establishment size structure of the workforces at the local industry level.

3.2. Preliminaries: Regional and national growth

Our starting point is the long-run employment growth rate of some sector s in region r between two time periods 0 und 1:

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

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

[5] There has been a major classification change in 1999. A direct conversion of the old into the new classification is impossible. Time-consistent industry codes were created using a procedure introduced by Eberle et al. (2011).
[6] See Spengler (2008) for further details on this dataset.

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

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

Thus,

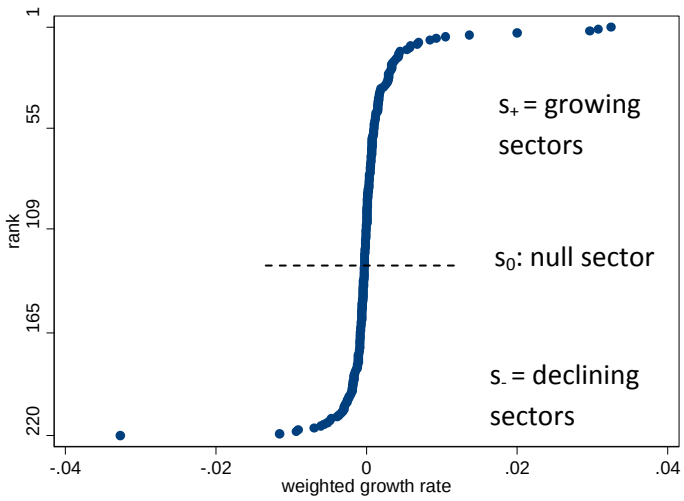
$$g_r - g_{nat} = \sum_s \left(\frac{emp_{rs0}}{emp_{r0}} \cdot \frac{emp_{rs1} - emp_{rs0}}{emp_{rs0}} - \frac{emp_{s0}}{emp_0} \cdot \frac{emp_{s1} - emp_{s0}}{emp_{s0}} \right) = \sum_s \left(w_{rs} - w_s \right) = \sum_s \Delta w_{rs}$$

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. Growing industries at the national level have $w_s > 0$, while declining industries have $w_s < 0$. 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 the top of this national 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 $w_s = 0$.[7]

By and large, 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, such as 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. Our data in fact shows that some regions exhibit distinctively different patterns than the country as a whole.

3.3. Examples of local industrial change profiles for individual regions

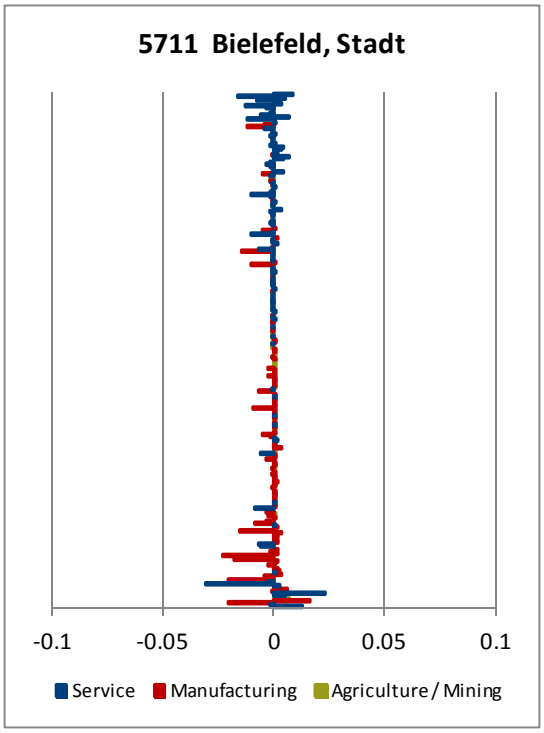
To illustrate these profiles of local industrial change we plot, separately for each region r, the deviations in the weighted industry growth rates Δw_{rs} while ordering industries according to the national hierarchy growth hierarchy. We thereby obtain individual profiles which display how regional growth differs from aggregate national growth in its sectoral anatomy. Figure 2 (panel 2a-2g) shows examples of local change profiles for particular German regions.

Figure 2a depicts an example (Bielefeld) where regional growth is featureless in the sense that the weighted industry growth rates in that region tend to match the national average. That is, also in Bielefeld some sectors grow faster than others, which leads to sectoral employment shifts over time. But those shifts closely follow the national pattern of industrial change.

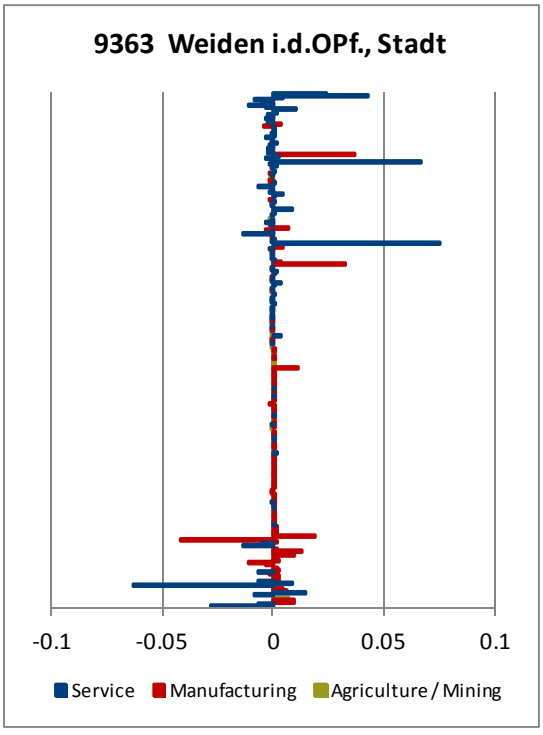
[7] Notice that there are many small industries close to the "null sector", which can have exorbitant unweighted growth rates. An example is commercial hunting (WZ 15, rank 109) whose total national employment is negligible with only 22 (32) full time equivalents in 1978 (2008). That is, this industry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

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

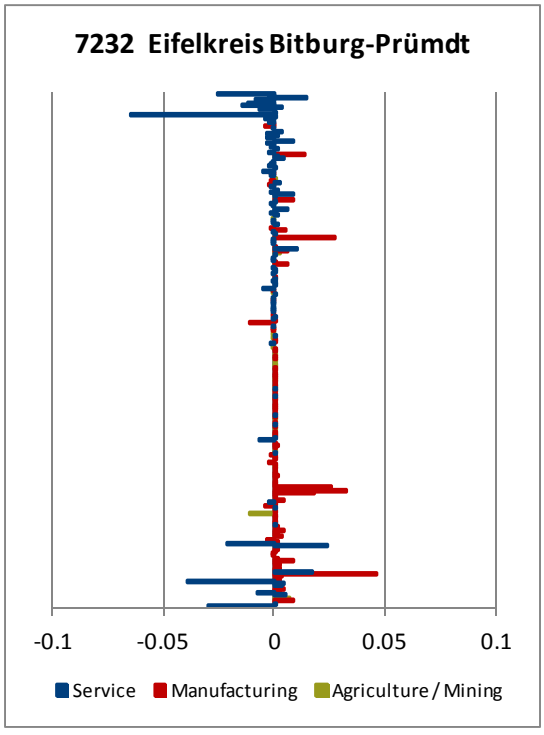
a) Featureless regional growth



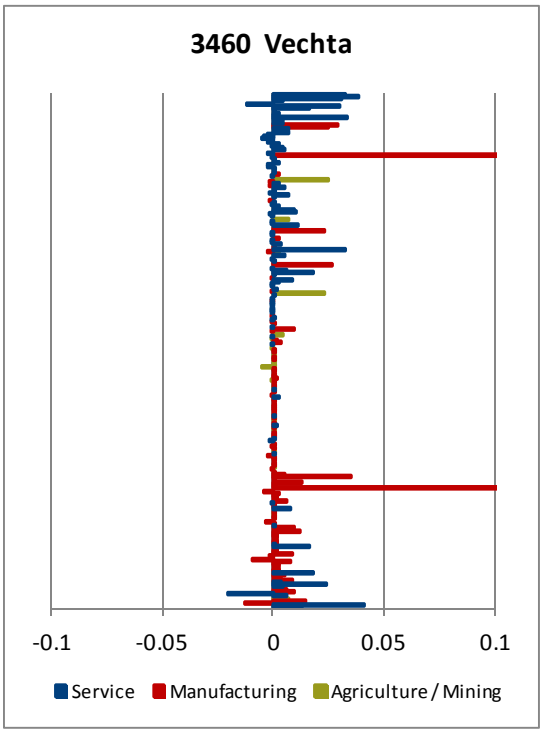
b) Pro-trend growth



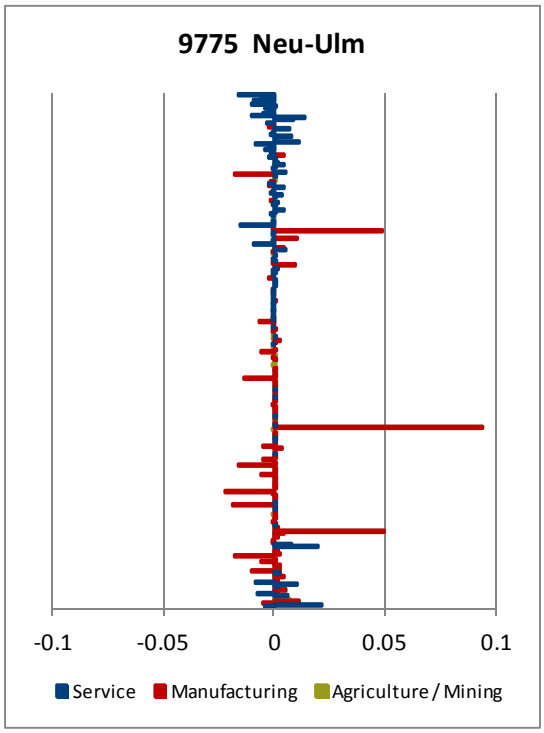
c) Anti-trend growth



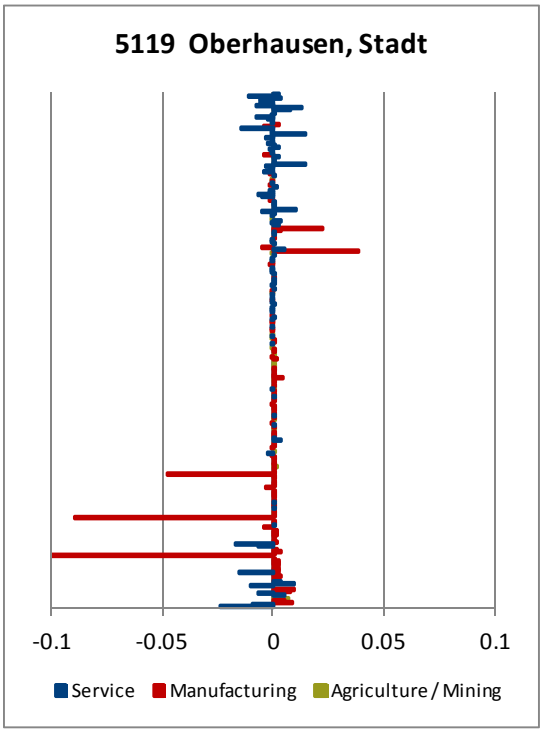
d) Pro-trend growth



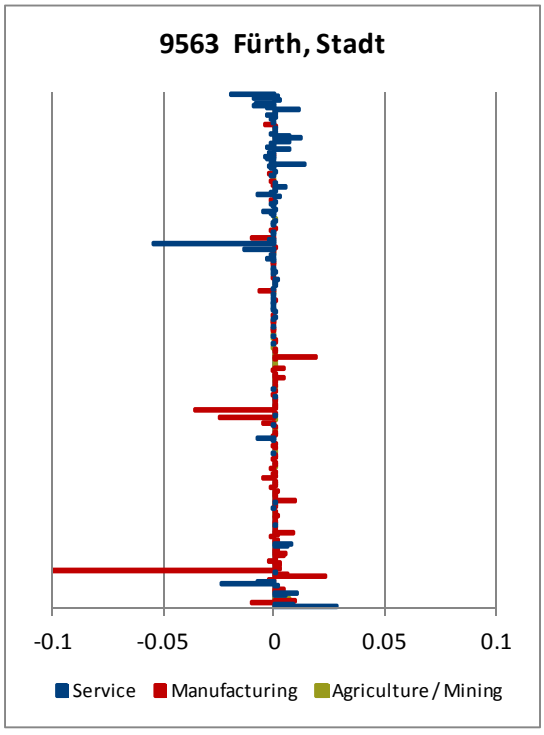
e) Anti-trend growth



f) Pro-trend growth



g) Pro-trend growth



Graphically, in such regions with "featureless growth" we have values of Δw_{rs} that are close to zero for most industries, so that the profile is fairly vertical and exhibits only small amplitudes to the left or to the right throughout the entire range.

Figures 2b and 2c show examples where regional growth differs more markedly from the national average. In figure 2b we depict an example of a region (Weiden) that exhibits a "pro-trend" pattern: the national boom industries (the rising s+ sectors) tend to grow stronger in this region 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 type therefore follow the *direction* of the national industrial change, but at an accelerated pace.[8]

Quite a different pattern can be observed in figure 2c which refers to the region of Bitburg-Prüm. This region evolves against the national trend, because regional growth mainly occurs in nationally declining s- sectors. For example, manufacturing of beverages (WZ 159) or retail sale (WZ 521) have grown strongly in Bitburg-Prüm, while these industries are declining from a nationwide perspective. We therefore observe notable amplitudes to the right in the bottom range of the figure. At the same time this region has experienced decline (or at least considerably lower growth) in national boom industries such as architectural and engineering activities (WZ 742) or forwarding agencies (WZ 634), hence some strong amplitudes to the left in the top range of the figure. We label such a pattern of industrial change as observed in Bitburg-Prüm as "anti-trend" regional growth.

While figures 2b and 2c illustrate examples of regions that exhibit both above-average growth and decline across sectors, there are also cases where amplitudes are almost unidirectional. This is shown in figures 2d and 2e. There we illustrate the examples of Vechta and Neu-Ulm,

[8] The city of Frankfurt is a similar example of a "pro-trend" region. Here, the s+ sector monetary intermediation (WZ 651) has a weighted growth rate of 44%, while in the average of all cities this has been only 6%. At the same time, declining s- industries such as wholesale of household goods (WZ 514) disappeared much faster in Frankfurt as compared to other cities.

respectively, where we mostly observe amplitudes to the right throughout the entire range of the figure. 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 is "pro-trend" insofar as there are more and stronger right-amplitudes in the upper than in the lower range. That is, regional growth in Vechta is still mostly driven by national boom industries, e.g. by the manufacture of plastic products (WZ 252) that has grown enormously there in the last 30 years. Yet, national declining industries also tended to grow above the average there, e.g. furniture manufacturing (WZ 361) by 23%, which is stronger than the national average but by a much lower margin than plastic products.

In Neu-Ulm, in contrast, we observe growth that is mainly driven by sectors on the bottom of the national hierarchy. 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. In that sense, Neu-Ulm exhibits "anti-trend" growth.

It is important to note how the local change profiles are related to overall regional growth. By construction, a consolidation of all positive and negative amplitudes leads to the regional excess growth rate, $g_r - g_{nat} = \sum_s \Delta w_{rs}$. A region with perfectly featureless growth (with no amplitudes at all) therefore grows exactly with the national rate g_{nat}, while a region that only has amplitudes to the right (to the left) must exhibit a positive (negative) excess growth rate. When the regional profile shows amplitudes into both directions, the sign of $g_r - g_{nat}$ depends on whether the above-average employment gains (the amplitudes to the right) outweigh the above-average losses (the amplitudes to the left).

This is neatly illustrated in figure 2f, which depicts the profile of the city of Oberhausen. That city is located in the industrial core area of Germany, the Ruhr area, and has experienced a substantial decline of mining and steel industries in the recent past as indicated by the 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 the traditional manufacturing industries. Overall, Oberhausen is therefore a declining city with $g_r - g_{nat} < 0$ that nonetheless reveals a "pro-trend" pattern of industrial change.[9]

Finally, the city of Fürth as shown in figure 2g is another example of a pro-trend region with overall decline. Yet, here we have almost no right-amplitudes but comprehensive above-average decline (left-amplitudes) across all sectors. Still, Fürth is a "pro-trend" region, because this decline has been less severe in the national boom industries so that local change in Fürth is still into the same direction as in the national average.

3.4. Classification of regions

Summing up, the sectoral anatomy of growth differs widely across regions, and we believe that the regional profiles as shown in figure 2 are a useful tool to illustrate those detailed regional idiosyncrasies. Even more importantly, these profiles allow to reveal common features in local growth anatomies, and the key idea 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 have roughly similar patterns of local industrial change.

Consider figure 3 that indicates the areas A, B, A' and B' within a regional change profile. All amplitudes in area A imply excess growth in a $s+$ sector in region r, whereas amplitudes in area B imply excess growth in a nationally declining $s-$ industry. Analogously, amplitudes in A' and B' indicate above-average decline in $s+$ or, respectively, in $s-$ industries. Summing the absolute values of these amplitudes,

[9] The local change pattern is actually similar as in Weiden, shown in figure 2b, with the exception that in the latter case the employment gains in $s+$ sectors compensated the employment losses in $s-$ industries so that Weiden is overall a growing region.

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

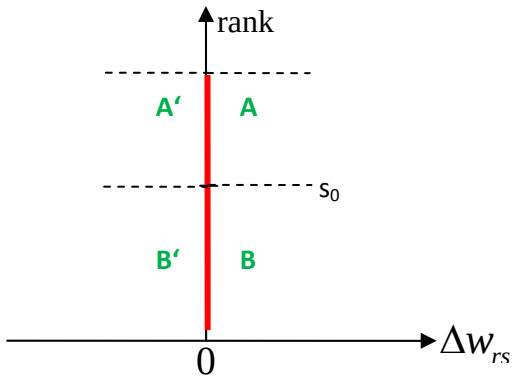
$$\left|B_r\right| = \sum\nolimits_{s-} \left|\Delta w_{rs}\right| \quad if\ \Delta w_{rs} > 0 \qquad \left|B'_r\right| = \sum\nolimits_{s-} \left|\Delta w_{rs}\right| \quad if\ \Delta w_{rs} < 0$$

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

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

The term D_r can be understood as the *excess change* (EC) of region r. It is a measure for the *strength* of the change in the local industry composition over time, compared to the average national pattern of industrial change.[10] A region with perfectly featureless growth has $D_r = 0$, while all other regions have $D_r > 0$. The higher is D_r, the stronger are the differences of the regional growth profile from the national pattern. Yet, with D_r alone we cannot further disentangle the *direction* of the regional change, i.e., we cannot distinguish if that region exhibits more a "pro-trend" or an "anti-trend" profile.

Figure 3: The local profile of industrial change



To get to such a distinction, a first step could be to simply calculate the shares of the amplitudes $\left|A_r\right|, \left|B_r\right|, \left|A_r'\right|$ and $\left|B_r'\right|$ in the total regional excess change. One would then

[10] Notice that D_r is conceptually related but still differs from the raw and the excess churning indices introduced in Duranton (2007).

expect that "pro-trend" regions have a relatively larger share $|A_r|/D_r$ than $|B_r|/D_r$ since growth in those regions is mostly driven by booming $s+$ industries. The opposite can be expected in "anti-trend" regions. Alternatively, "pro-trend" regions are likely to have a higher share $|B_r'|/D_r$ than $|A_r'|/D_r$, as decline in those regions mainly occurs in $s-$ industries.

However, classifying regions only according to these shares would not be fully adequate for a cross-regional comparison. This is for two reasons. First, our aim is to single out regions where local industrial change differs *markedly* from the national average. However, regions may have high values of, say, $|A_r|/D_r$ even if "pro-trend" amplitudes $|A_r|$ are small in absolute terms, if the overall growth in that region is also essentially featureless (i.e., if the EC index D_r is low). Second, we believe that it is not warranted to lump together urban and rural regions for the purpose of a cross-regional comparison of regional change profiles, but that it is economically more meaningful to treat urban and rural regions separately.

We hence follow a slightly modified procedure to classify the three types of regions. First, we distinguish cities and rural areas.[11] We then divide the group cities into those that grew faster than the national average of all cities, and those that grew slower. For the rural areas we use an analogous procedure, using the average national growth rate of all rural areas as the benchmark. For the group $\nu = \{\text{cities, rural areas}\}$ and the respective sub-groups with above- and below-average growth $k = \{+,-\}$ we calculate the average level of the EC separately,

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

where N_+^ν (N_-^ν) is the numbers of regions of type ν that grew faster (slower) than the respective average.[12]

[9] 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.

[12] In order to simplify the terminology, we use the word "declining", if a region grows below the average of its respective regional type. This does not mean that the region necessarily has a negative long-run growth rate.

Then, we calculate the following shares for every region, keeping track of its "type" $\{\nu,k\}$ for ν ={cities, rural areas} and $k=\{+,-\}$.

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

That is, we do not set the region-specific amplitudes $|A_r|$, $|B_r|$, $|A_r'|$ and $|B_r'|$ into perspective to the excess change of the region itself, but to the average EC-level in comparable regions of the same $\{\nu,k\}$ - type. This approach is useful, because high values of one of those shares then indicate that the local change profile in that region actually shows some marked features. Finally, we calculate the simple arithmetic means of these shares ($\bar{\alpha}_k^{\nu}$, $\bar{\beta}_k^{\nu}$, $\bar{\alpha}_k^{\nu\prime}$, $\bar{\beta}_k^{\nu\prime}$) and then classify regions as "pro-trend" or "anti-trend" according to the following rule, with all remaining regions that are neither classified as "pro-" nor "anti-trend" being defined as "featureless".

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

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

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

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

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

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

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

What is the rationale behind this assignment rule? Consider regions with $k=$"+" that grow stronger than the national average of all cities or, respectively, all rural areas. The first condition for "pro-trend" growth requires that, within this region, growth is mainly driven by

nationally booming $s+$ industries.[13] In addition, the second condition requires that the growth of $s+$ industries in that region is also stronger than in the average across all other growing cities or, respectively, growing rural areas. Because of this second condition we avoid classifying regions as "pro-trend" where the right-amplitudes are small in absolute terms, even if the majority of them occur in the upper range. The definition of "anti-trend" regions follows a similar logic: a growing region ($k = "+"$) is classified as "anti-trend": i) if growth within the region is stronger in national bust industries ($s-$) than in boom industries ($s+$), and ii) if this growth of $s-$ industries is also stronger than in other comparable regions.

Turning to the declining regions ($k = "-"$) we pay particular attention to the sectoral anatomy of the decline when classifying them into groups. More specifically, for the "pro-trend" group we firstly require that, within the region, $s-$ industries decline stronger than $s+$ industries. In addition, this decline of $s-$ industries must be stronger than in the average of comparable declining regions, to make sure that we actually capture cases with marked features.[14] "Anti-trend" behavior in a declining region is, in turn, associated with a pattern where national boom industries decline faster in the region than national bust industries, and where this decline of boom industries is also faster than in the average of similar declining regions.

Table 1 shows the number of regions that are classified into the three different groups. As can be seen, most regions (136 out of 326) show no marked deviations in their regional growth anatomies from the average national pattern, and are thus classified as "featureless". 105 regions exhibit a "pro-trend" pattern, and 85 regions belong to the group with "anti-trend" growth.[15] The map in Figure 4 illustrates the geographical pattern of "pro-trend" and "anti-

[13] Notice that $\alpha_r^{\{\nu,k\}} > \beta_r^{\{\nu,k\}}$ by construction implies $|A_r|/D_r > |B_r|/D_r$ in that region.

[14] For the declining "pro-trend" regions we do not use the pattern of right-amplitudes in the local change profile (at least not in the benchmark classification system), essentially because there are regions without strongly growing sectors. Consider figures 2f and 2g above. Both Oberhausen and Fürth are "pro-trend" regions with overall decline, but only in the former case we can also observe above-average growth in s+ industries. In Fürth we mostly observe above-average decline, but still with a pro-trend pattern.

[15] It is important to point out that our main results do not crucially hinge on the particular definition of "pro-trend" and "anti-trend" regions. We have conducted several robustness checks where the groups are defined

trend" growth. Some concentration of marked regional 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 all around Western Germany.

Table 1: Means of regional characteristics

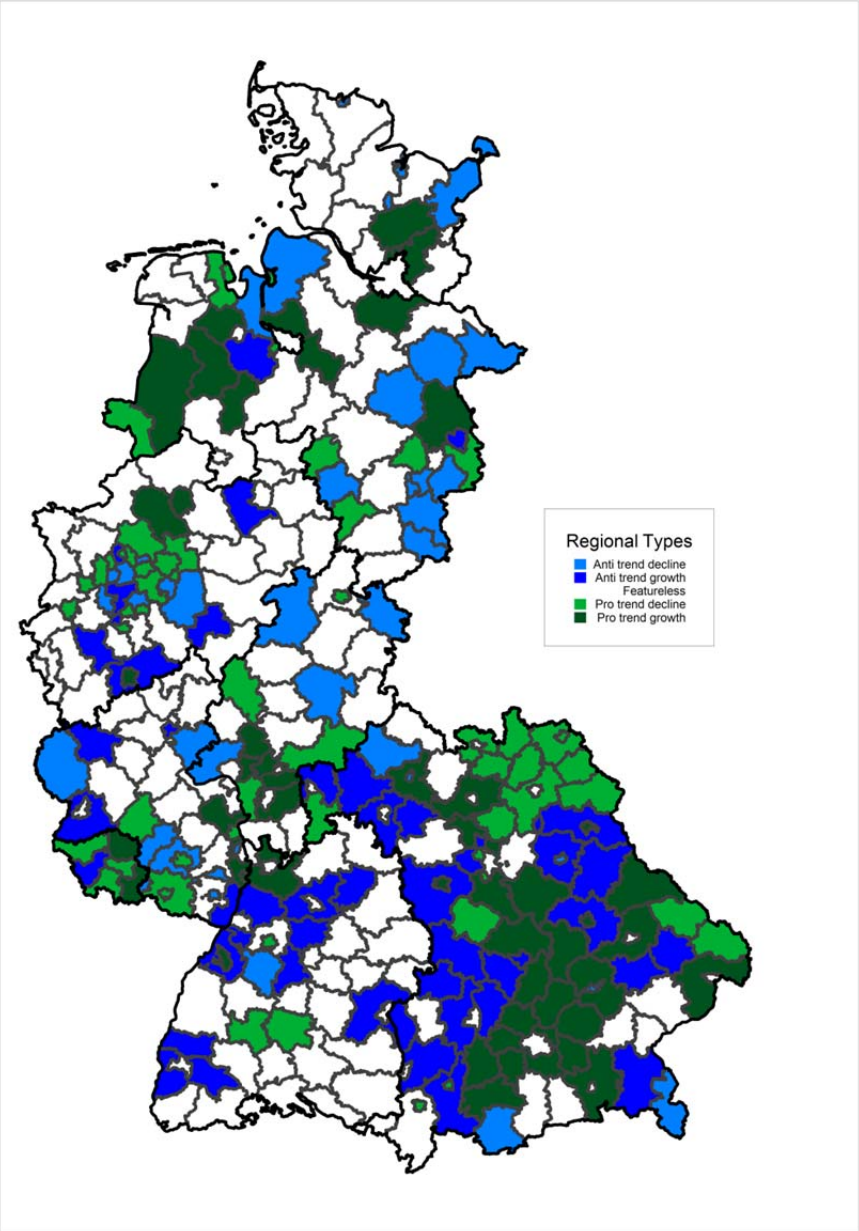
	pro-trend growth		anti-trend growth		featureless growth		aggregate
	grow (+)	decline (-)	grow (+)	decline (-)	grow (+)	decline (-)	
Number of regions	50	55	45	40	75	61	326
(cities / rural areas)	(15 / 35)	(20 / 35)	(15 / 30)	(10 / 30)	(26 / 49)	(15 / 46)	(101 / 225)
Excess growth rate ($g_r - g_{nat}$)	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	--
Excess churning rate	5.17	5.05	4.63	4.85	4.48	4.35	--
Share manufacturing	35.65	47.42	48.60	34.32	39.23	40.06	40.91
Krugman specialization index	0.662	0.747	0.731	0.672	0.627	0.625	0.672
Share skill-intensive occup.	4.02	3.54	3.47	3.88	3.98	4.30	3.89

Table 1 also reports the average excess employment growth rate $g_r - g_{nat}^{v}$ in the different groups. As can be seen, among the growing regions, "pro-trend" growth is on average associated with the best long-run performance, while "anti-trend" regions had a somewhat smaller average growth rate. Among the declining regions this ranking is reversed, i.e., regions with "pro-trend" decline suffered from the lowest average excess growth. This is consistent with Figure 5 which shows kernel density estimates of the excess growth rates in the different groups. It is important to note that, although the "pro-trend" pattern tends to

differently. There we typically impose somewhat stricter conditions before a region gets classified as "pro-trend" or "anti-trend", respectively. Our main insights remain robust to these re-classifications.

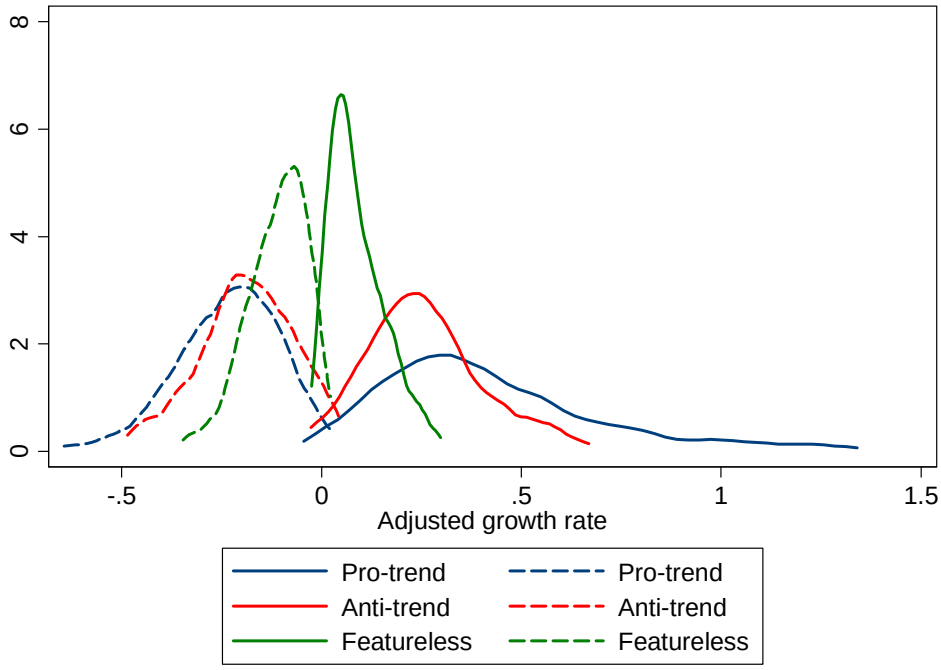
come with the highest growth among the successful regions, there is considerable overlap in the distributions. Put differently, a "pro-trend" profile seems to be neither a guarantee nor a prerequisite for a good regional growth performance.[16]

Figure 4: Growing and declining "pro-trend" and "anti-trend" regions



[16] In Table 1 we also report the average excess change and the average churning rate of the regions in the different groups. As can be seen, "pro-trend" regions exhibited on average more local industry turnover than "anti-trend" regions. That is, a "pro-trend" pattern is positively correlated not only with overall regional growth but also with the overall strength of local industrial change. By construction, regions with featureless growth exhibit the smallest degrees of excess change or churning.

Figure 5: Excess growth in the different groups of regions



4. What distinguishes "pro-trend" and "anti-trend" regions?

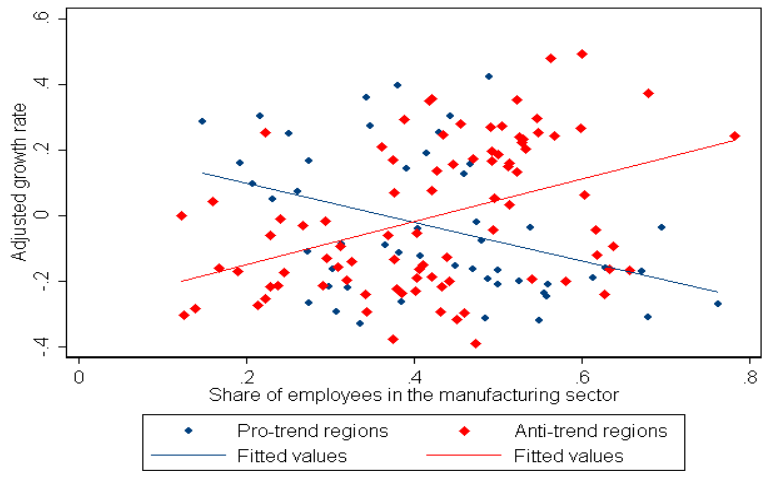
In the previous section we have defined groups of regions with a similar history of industrial change during the last three decades. Our aim in the remainder of this paper is to shed some light on the important question which economic forces are behind those divergent regional trends. In this section we first report some average initial characteristics of "pro-trend" and "anti-trend" regions, as well as correlations between those characteristics and subsequent regional growth. More specifically, in sections 3.1 – 3.3 we discuss the initial share of manufacturing employment, the initial degree of regional specialization, and the initial endowment with human capital. It turns out that these characteristics, and also the correlation of these characteristics with long-run regional growth, differs quite substantially across groups, suggesting that there are meaningful differences in the initial conditions of "pro-trend" and "anti-trend" regions that are linked to their subsequent growth and change patterns. Based on these stylized facts, which we summarize in 3.4., we then argue in the next section that the observed local patterns can be explained (at least partly) by the differential exposure

of German regions to international trade, that is, import competition and export opportunities arising on world markets.

4.1. Initial manufacturing employment

As shown in Table 1, the initial share of manufacturing employment in the base year 1978 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 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 regions (48.6 versus 34.3 per cent). This suggests that the initial manufacturing share is negatively correlated with regional growth among the "pro-trend" regions, but positively correlated among the "anti-trend" regions. Figure 6 corroborates this impression.

Figure 6: Employment growth and initial employment in manufacturing sectors



There we plot the regional excess growth rates against the initial regional manufacturing shares. For the "pro-trend" regions the fitted regression line has an estimated slope of -1.083*** which is highly statistically significant. Among the "anti-trend" regions, the

estimated correlation is positive with a highly significant slope coefficient equal to 0.885*** (also see Table 2 below where we summarize these results). Stated differently, a large initial manufacturing share appears to be a burden among the "pro-trend" but a blessing among the "anti-trend" regions.

Recall that the overall structural change at the national level is, by and large, characterized by a secular decline of traditional manufacturing and a rise in modern service industries. In fact, the manufacturing share has declined in most German regions between 1978 and 2008, particularly in cities where it fell by 33.8% on average. Yet, the strength of this trend is not the same everywhere. In the growing "anti-trend" cities the manufacturing share fell by only 1.5%, and in rural "anti-trend" areas there was even an expansion of manufacturing industries by 12.8%. For "anti-trend" regions, it was thus apparently an advantage to have a huge industrial basis to build upon, and the initial specialization in manufacturing was even reinforced in the subsequent three decades. Conversely, for "pro-trend" regions a large manufacturing sector has been a disadvantage, because the transition from manufacturing towards services – that went on particularly quickly in those regions – then involved the need for more sectoral reallocations.

One can also look at the facts from Table 1 from a different perspective. The successful "pro-trend" regions and the declining "anti-trend" regions both started off with a similar average manufacturing share in the base period 1978, roughly 35 per cent. Similarly, the successful "anti-trend" regions and the declining "pro-trend" regions initially also had a similar average manufacturing share of roughly 48 per cent. In other words, among the regions with a small initial manufacturing share the successful ones were, on average, characterized by a "pro-trend" growth pattern where the already small manufacturing sector was replaced at a rapid pace. In contrast, for the regions with large initial manufacturing shares, the successful ones showed an "anti-trend" growth pattern where the manufacturing sector was even expanded or at least was replaced relatively slowly.

Table 2: Bivariate regression coefficients of several regional characteristics

	Pro-trend regions (N=105)		Anti-trend regions (N=85)		All regions (N=326)	
	Koeff.	s.e.	Koeff.	s.e.	Koeff.	s.e.
Initial share of manufacturing industries	**-1.083** ***	0.26	**0.885** ***	0.17	-0.089	0.11
Krugman specialization index	**-1.437** ***	0.34	**0.676** ***	0.24	-0.127	0.14
Initial share of skill-intensive occupations	**4.401** **	2.27	-1.239	1.55	0.477	0.90

4.2. Initial regional specialization

A similar difference between the regional types can be found with respect to the initial degree of regional specialization as measured by the standard Krugman index.[17] It can be seen in Table 1 that the initial level of specialization is much higher in the declining "pro-trend" and the growing "anti-trend" regions than in the growing "pro-trend" and the declining "anti-trend" ones. Regressing the excess growth rates on the initial Krugman-index (see Table 2) we find an insignificant correlation across all German regions. For "pro-trend" regions the correlation is strongly negative, however, while for "anti-trend" regions it is positive.

The correlation between regional specialization and growth has often been discussed in the context of the sectoral scope of agglomeration economies (see Rosenthal and Strange, 2004). That literature has traditionally distinguished intra- and inter-sectoral knowledge spillovers (also sometimes called Marshall-Arrow-Romer [MAR] versus Jacobs-externalities). In a study for Germany, Blien et al. (2006) find that local employment growth is strongly fostered by industrial diversity, thus suggesting a somewhat dominant role of Jacobs externalities. Our

[17] The Krugman index is defined as $KSI_r = \sum_s \left| \ell_{r,s} - \ell_s \right|$, where $\ell_{r,s}$ and ℓ_s are the regional and national employment shares of sector s, respectively. By construction, this index ranges between zero (no regional specialization) to two which indicates the most extreme degree of specialization. We use the total national employment shares, but our results would not change if we instead used ℓ_s for urban or rural areas, respectively.

findings for the "pro-trend" regions are broadly in line with those results, but in addition we find a substantial cross-regional heterogeneity in the association between industrial diversity/specialization and regional growth. Among the "anti-trend" regions we find that long-run regional growth is positively related to the initial specialization of the local economic structure, a finding more in line with intra-intra industry MAR externalities.

More importantly, it should be noted that regions with a higher initial manufacturing share tend to exhibit higher degrees of specialization in the data; the raw correlation is 0.54. The finding that specialization is negatively correlated with growth among "pro-trend" regions but positively correlated among "anti-trend" regions thus reflects (at least partly) the differences in the initial employment shares in manufacturing industries discussed before (see Figure 6).[18]

4.3. Human capital and local growth

Finally, there is a huge literature studying the association of human capital and economic growth at the local level. Several studies find a robust positive correlation between the initial employment share of college educated workers and subsequent local employment/population growth of cities (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).

In our study, we measure the qualification structure of the local workforces by the share of employees in skill intensive occupations. [19] In the base year 1978, the average human capital

[18] This conclusion can be supported by regressing employment growth only on sectoral specialization indices for manufacturing and services, respectively (not shown in Table 2). Doing so yields insignificant slope parameters for specialization in both manufacturing and service industries in "anti-trend" regions and a negative coefficient of specialization only in manufacturing for "pro-trend" regions. The latter finding is likely to be due to the fact that a larger manufacturing sector in a region tends to come with higher regional specialization.

[19] Due to the distinctiveness of the German dual education system, after having completed an apprenticeship, skilled personnel can have a similar amount of human capital as college graduates from other countries. We feel that the share of employees in skill intensive occupations such as management, engineering or liberal and service professions (following the taxonomy of Blossfeld 1987) provides a more suitable measure for human capital. However, the results do not change qualitatively, if the share of college graduates is used instead.

share did not differ strongly across the groups; it ranged between 3.5 and 4 per cent in all types of regions. There are pronounced differences, however, when it comes to the correlation of the initial human capital share with the subsequent regional excess growth. Across all regions, we find a positive but insignificant correlation (see Table 2). The association between human capital and local growth is much stronger and highly statistically significant among the "pro-trend" regions. For the "anti-trend" regions, however, we even obtain a negative correlation though with huge standard errors.

Put differently, the presence of high skilled workers is apparently related to local growth only among regions which followed a particular trend of local industrial change, namely the "pro-trend" pattern. Relatively more skilled "pro-trend" regions seem to be more successful in mastering the transformation from manufacturing to modern services. With the "anti-trend" pattern, 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, the "anti-trend" regions did not effectively benefit from high initial human capital shares, since manufacturing is on average less skill-intensive than the modern service industries that flourished elsewhere, so that demand for high skilled workers was rather low in the course of the long-term developments in these regions.

4.4. Summary: Features of "pro-trend" and "anti-trend" growth

The descriptive evidence discussed in this section has, in our view, revealed some interesting correlations suggesting that certain initial conditions are associated with the "pro-trend" and the "anti-trend" profile of local industrial change. In particular, we have established the following insights:

- Regions with a relatively small initial manufacturing share and relatively low initial specialization tended to perform better with the "pro-trend" growth pattern. That is, these regions had the better overall performance if they replaced manufacturing employment and built up modern service employment faster than the national average. Local human capital was strongly related to regional growth for these regions.
- Strongly specialized regions with a relatively large initial manufacturing share, on the other hand, tended to perform better with the "anti-trend" pattern, that is, if they reinforced their manufacturing specialization. Local human capital was not strongly related to local growth in this regional trajectory.
- Vice versa, looking at the sectoral anatomy of regional decline, our evidence suggests that regions with small manufacturing shares performed badly if they were not "pro-trend" enough, that is, if they lagged behind in the transformation towards the modern service economy. Strongly specialized manufacturing regions, on the other hand, ended up rather unsuccessfully with the "pro-trend" pattern.

5. The impact of international trade on local industrial change and growth

So far we have documented patterns of industrial change, and reported some suggestive correlations how regions with different change profiles differ in some initial characteristics. However, we had little to say about the underlying causes of those trends. Our aim in this section is to fill this gap.

To be sure, both regional growth and the local pattern of industrial change are endogenous and simultaneously determined by some underlying economic forces. In other words, the "pro-trend" and the "anti-trend" patterns of local change do not *cause* differential local growth performances. Moreover, the taxonomy that regions with a large (small) initial manufacturing share revealed the better growth performance with the "anti-trend" ("pro-trend") profile, is still quite rough, because we have lumped together all manufacturing

industries. At a more detailed level, the manufacturing sector comprises very different industries, ranging from heavy coal and steel sectors and other traditional branches such as textile to very modern activities like engineering, specialized electronics or chemical products, or the automobile sector which has a high significance in the German economy.

In this section we take a more detailed look at specialization patterns *within* the manufacturing sector, and show that the differential trade exposure of German regions is an important economic force that can help to explain the different patterns of local growth and change at least partly.

5.1. Rising German trade and the impact on local industry compositions

During our observation period Germany was subject to a massive rise in external trade exposure ("globalization") that kicked in since the early 1990s. The increase in German export and import values was by far the strongest with respect to two trading partners: China and Eastern Europe,[20] as shown in Table 3 which summarizes the increase in 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 (see e.g. Feenstra and Hanson 1999). 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.

Multi-sector models of international trade, both of the Ricardo and Heckscher-Ohlin type as well as "new" trade theories, predict that such exogenous liberalizations will cause major perturbations in domestic industry structures. This may happen, for example, because shifts in relative prices induce countries to specialize in industries where they have a comparative

[20] 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.

advantage, or because changes in real market potentials cause changes in sales and profitability for domestic firms.

Table 3: 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

A vivid example for such effects is the decline of the coal and raw steel sectors in Germany, which disappeared rapidly from the economy since other low-wage countries, especially in Eastern Europe and China, developed their comparative advantage in those sectors. Germany turned from an exporter to a net importer of those goods (safe of some specialized niche and high-end products), thereby also displacing domestic employment of coal and steel workers. Other sectors in the German economy, however, gained massively from the liberalizations in the "the East", as new market opportunities arose for the classical German export goods such as cars, electronic apparatus, high-end chemical products, etc.

In a recent paper (see Dauth et al. 2012) we have analyzed the impacts of these major trade liberalizations for Germany from a regional perspective, drawing on an approach pioneered by Autor et al. (2012) for the United States. Given the substantial variation in initial sectoral

employment patterns, German regions are differently exposed to import competition and export opportunities arising from Eastern European and Asian countries. This particularly applies to regional specialization patterns *within* the manufacturing sector where most trade occurs. When the rise of "the East" kicked in during the early 1990s – for reasons that are exogenous from the perspective German regions – this may cause different local adjustment patterns. That is, trade-induced changes in local industry compositions that occur in parallel to the general trend of structural change (Petty's law) and either reinforce it or slow it down.

5.2. Data and measurement

To measure the trade exposure of a German region, we closely follow the approach by Autor et al. (2012) and Dauth et al. (2012). We first consider the import exposure of a German region i from "the East" which can be written as follows:

$$\text{Import Exposure}_{it} = \sum_{j} \frac{E_{ijt}}{E_{jt}} \cdot \frac{\Delta \text{Imp}_{jt}^{EAST}}{E_{it}}$$

where $\Delta \text{Imp}_{jt}^{EAST}$ 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 (in constant 1000 Euros of 2005). 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 1978. This measure thus captures the *potential* increase in import exposure of a German region, given its initial sectoral employment structure, as it apportions the *national* change in imports to the single German regions according to the regions' shares in national industry employment. Analogously, we measure region i's export exposure as follows,

$$\text{Export Exposure}_{it} = \sum_{j} \frac{E_{ijt}}{E_{jt}} \cdot \frac{\Delta \text{Exp}_{jt}^{EAST}}{E_{it}}$$

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

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

The data for this study are the same as in Dauth et al. (2012). Industry-level import and export volumes are taken 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 Euros of 2005 using exchange rates supplied by the German Federal Bank. We merge these trade data 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. Trade values of ambiguous cases are partitioned 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 service trade.

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

At first, we investigate the impact of trade (import and export exposure) with "the East" on excess employment growth and the strength of industrial change across all German regions. The regression results are reported in Table 4. In columns (1) and (2) the dependent variable is the regional excess employment growth rate $g_r - g_{nat}$. In columns (3) and (4) we use the strength of industrial reallocations as measured by our excess change (EC) index D_r, and in

(5) and (6) we use the excess churning rate introduced by Duranton (2007) as an alternative measure for the strength of local industrial reallocations as the outcome variable. As main dependent variables we include the respective import and export exposure measure of region r, or we consolidate the two and use the regional net trade exposure with "the East".[21]

Table 4: Impact of trade with "the East" on German regions

	Excess empl. growth		Excess change (EC)		Excess churning	
	(1)	(2)	(3)	(4)	(5)	(6)
Δimport exposure (gross)	-0.007 (0.05)	--	0.012 (0.05)	--	**0.003*** **(0.00)**	--
Δexport exposure (gross)	**0.011*** **(0.05)**	--	**-0.006**** **(0.03)**	--	**-0.003*** **(0.00)**	--
Δnet exposure EAST	--	**0.009**** (0.004)	--	**-0.004**** (0.002)	--	**-0.003**** (0.002)
Initial share of manufacturing industries	-0.179 (0.16)	-0.122 (0.10)	**0.226***** **(0.86)**	**0.134***** **(0.06)**	**-0.008***** **(0.005)**	**-0.008***** **(0.005)**
R^2	0.017	0.017	0.015	0.012	0.043	0.043

The results in column (1) show that a higher increase in regional import exposure is associated with lower local employment growth, while a higher increase in export exposure affects local employment growth positively. Given that average export exposure has risen stronger than import exposure, and given that the latter coefficient is somewhat larger than the former, the results also imply that – on average – the overall impact of trade exposure on employment growth has been positive. This conclusion is supported by column (2), which show that regions with higher net export exposure exhibit higher excess employment growth.

[21] Since the impact of trade exposure refers to the regional specialization patterns within the manufacturing sector, we control for the initial regional manufacturing employment share in all specifications.

All these findings are consistent with Dauth et al. (2012), who conduct several extended analyses and present a battery of robustness checks that we leave aside in this paper for brevity.[22] In particular, they address several estimation concerns, in particular reverse causality, and establish that the exogenous rise of "the East" had indeed a positive *causal* effect on total manufacturing employment growth in Germany. The rise of "the East" thus actually created new jobs in Germany but those employment gains are unevenly spread across space. Regions with export-oriented sectoral structures tended to gain, while import-competing regions tended to lose employment (both in the manufacturing and beyond). The main message of Table 4 is the same, and drawing on the analyses by Dauth et al. (2012) we are confident that these results actually indicate causal effects of trade. That is, the rise of trade exposure did not result because of preceding local manufacturing growth, but the "rise of the East" actually caused employment gains (losses) in export (import) exposed regions.

Our main focus in this paper is the impact of trade exposure on local industrial change. Columns (3) – (6) indicate that there is indeed a clear relationship: The stronger the regional import exposure increases, the stronger are the subsequent industrial reallocations as measured by the excess change (EC) or the excess churning indicator. Regions with more export-oriented industrial structures, on the other hand, exhibited significantly less industry turnover in the subsequent three decades. These results thus clearly support our hypothesis that trade exposure is an important driver of local industrial change in the German economy.

5.4. Trade exposure in "pro-trend" and "anti-trend" regions

Those results from Table 4, which refer to the impact of trade exposure on the overall *strength* of industry turnover, are also crucial to distinguish "pro-trend" and "anti-trend" profiles, i.e.,

[22] For example, Dauth et al. (2012) implement the instrumental variable strategy pioneered by Autor et al. (2012) where trade flows of other high-income countries are used as instruments for domestic regional trade exposure, thereby purging possibly confounding effects from domestic supply and demand shocks. They also investigate the impact of trade exposure on manufacturing employment growth only, showing that regions with higher net trade exposure retained the manufacturing sector in their local economy.

different *directions* of local industrial change. In Table 5 we report the average increase in import and export exposure across all "pro-trend" and "anti-trend" regions (in 1000 Euros).

The first important thing to notice 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. In regions with small manufacturing shares in 1978 (growing "pro-trend" and declining "anti-trend" regions) we observe relatively low import exposures. This correlation is quite plausible: Regions with a large manufacturing base are, on average, more strongly affected by the rise of "the East", since the Eastern countries mostly displaced German market shares in traditional manufacturing industries.

Table 5: Trade exposure "with the East" in "pro-trend" and "anti-trend" regions

	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)
Δimport exposure							
(gross)	5.92	8.63	8.72	6.84	7.58	7.44	7.54
Δixport exposure (gross)	6.99	8.21	10.86	8.50	8.65	8.45	8.57
Δnet exposure	1.06	-0.42	2.13	1.66	1.07	1.01	1.03

We observe striking differences, however, with respect to regional export exposure. This export exposure has risen fairly modestly in the declining "pro-trend" regions, even below the average of regions with featureless growth, so that the average net exposure is negative. For the growing "anti-trend" regions, however, we observe very strong increase in (gross and net) export exposure. That is, even though the declining "pro-trend" and the growing "anti-trend" regions started off with similar total shares of manufacturing industries, they revealed very

different export exposures because they were specialized in *different* manufacturing industries were Germany still had a comparative advantage on world markets.

How to interpret these differences in the average trade exposures across groups? It is clear that the growing "anti-trend" regions were strongly exposed to import competition from "the East", thanks to their large manufacturing bases. But their local manufacturing employment structures also had significant export-oriented branches that gained from the rising export exposure. 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, so that the import-driven employment losses could not be compensated within the manufacturing sector. As manufacturing jobs got lost in those regions, there has been a notable increase in the local service sectors (at least relative to other regions), but since the manufacturing sector has been so large in those regions, this rise of the service economy was not sufficient to compensate all manufacturing job losses.

A particularly clear example for such a regional profile are the declining "pro-trend" regions from the Ruhr area (e.g. Oberhausen or Duisburg), whose economic structures in the 1970s were strongly dominated by mining, steel and other heavy manufacturing industries. Those sectors were put under heavy strain in high-wage countries like Germany, because emerging economies including China and Eastern European transition countries rapidly gained world market shares. Regions specialized in those industries thus suffered from this increasing trade exposure, as sales on world markets were displaced by foreign competition which in turn lowered labor demand in those sectors in Germany. The affected manufacturing regions thus had little choice but to "re-invent" their local economies and to focus on different industries. Since no other manufacturing industries with sufficient export exposure were located in those regions, they turned to the development of modern service industries, like IT or logistics. Our evidence does, of course, not imply that this was the wrong strategic choice for local

development. What this example suggests, however, is that increasing trade exposure indeed led these regions to become “pro-trend” regions. The Ruhr area did – on average – not yet manage to deliver an above-average regional growth performance during our observation period. It could well be that an even longer time period is required before this “pro-trend” sectoral reallocation materializes for those strongly affected manufacturing regions.

For the regions with initially small manufacturing shares, we observe that the growing “pro-trend” regions were least affected by trade exposure from “the East”. Both the import and the export exposure were below the German average. Those regions thus apparently exhibited the general trend of structural change (Petty’s law) in a clean form, without notable industry reshufflings resulting from trade exposure, and transformed their local economy towards modern services fairly quickly. Recall from above that the growth profile in the growing “pro-trend” regions is closely linked to local human capital, and that these regions did on average deliver the best long-run growth performance (see Figure 4). Our findings suggest that this above-average performance was not directly the result of trade, because the successful “pro-trend” regions did not directly benefit from a high export exposure. Such positive direct effects of trade are mainly visible in the successful “anti-trend” regions which gained manufacturing jobs because of their export-oriented local structures. The successful “pro-trend” regions, on the other hand, have gained more indirectly because they were somewhat sheltered from the impacts of trade, and developed modern and skill-intensive employment structures in service industries mainly focusing on domestic demand.

Finally, the declining “anti-trend” regions had a manufacturing base of similar size as the growing “pro-trend” regions, but they were still somewhat more strongly exposed to trade. By and large, that impact was positive as export exposure dominated import exposure (in contrast to their declining counterparts from the “pro-trend” group). As the manufacturing sector thus contributed to job growth in those regions, the transformation towards the service economy thus went on somewhat more slowly there. However, the beneficial impact of trade on

manufacturing employment was still not large enough to lead to an above-average overall growth performance, since the positive net trade exposure is still much smaller than in the growing "anti-trend" regions. In short, those declining "anti-trend" regions performed better than their "pro-trend" counterparts because they did not suffer from major adverse trade shocks. Still, their manufacturing bases have been too small to be real job motors, so that they ended up with below-average performance as the rise of the service economy was too small in those regions.

Summing up, the overall 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.

6. 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. In the aggregate, the German economy is characterized by a secular decline of the manufacturing sector and a rise of the modern service economy. 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.

Every region is, of course, unique and features specific evolutions and idiosyncrasies that are often tightly connected to the fate of single firms. The local change profiles that we have developed in this paper are a helpful tool in our view, as they not only visualize these idiosyncratic developments but 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 clearly shows that there has been no single "road to success" for regional growth. Initial conditions matter a great deal when it comes to finding the strategy that seems most promising for a particular region. In that regard, our study suggests that the size and the composition of the local manufacturing sector 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 the manufacturing sector, despite the fact that the development of the local service economy has been somewhat lagging behind in those areas. For these "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 compensate the massive job losses in manufacturing. Coping with this legacy of structural transformation is painful and lengthy, and requires a notable effort

either in building up the service economy or in modernizing the manufacturing base so that it becomes competitive in export markets.

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