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Structural Cohesion in Europe:
Stylized Facts

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Abstract: This paper establishes eight stylized facts on the evolution of the localization of economic activity across industries and regions in the EU-15 since 1980. Localization, which nests concentration and specialization, is measured by a Theil index. The stylized facts reveal a broad aggregate trend towards structural convergence in the EU-15. The by far most important drivers of this convergence have been the sectoral structural change from highly concentrated agriculture and manufacturing industries towards dispersed services, and a continuing dispersion of services. The manufacturing sector, by contrast, worked against this structural convergence as it has become spatially more concentrated. The stylized facts also reveal that virtually all countries and most of their regions participated in this structural convergence. The speed of aggregate structural cohesion slowed down considerably in the early 1990s, however.

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I. Introduction

Cohesion of regions is among the basic objectives of the European Union (EU), and economic integration at the EU or global level is often suspected of endangering or eroding this cohesion.[1] Theories like new economic geography (NEG) or the theory of endogenous growth suggest that economic integration may induce innovative, dynamic and wealth-generating industries to concentrate in the core regions, leaving the periphery with mature, slow-growth industries under high competitive pressure from world markets. Policymakers therefore usually prefer economic activities to scatter more or less evenly across space, and regions to be well diversified in terms of their industrial structures. And they often consider the concentration of modern, innovative manufacturing and service industries in a few core regions problematic as it may bring about well-diversified prospering regions along with highly-specialized backward and shock-vulnerable regions.

The evolution of the unevenness of the allocation of economic activities across industries and space has been analyzed repeatedly in the economic literature. Yet, this literature has not succeeded in providing economists and policymakers with a consistent and comprehensive set of stylized facts so far. It has rather generated a patchwork of partial and sometimes even contradictory results. In this paper, we consolidate this patchwork of results on concentration and specialization in Europe by deriving and discussing a set of eight interrelated stylized facts on the evolution of the allocation of economic activities across region-industries in Western Europe. Our study differs from earlier studies that contributed to the patchwork of results in that we use a comprehensive data set that covers several EU countries and all sectors over a fairly long time period of more than 20 years. The use of internationally comparable data allows us to systematically identify differences and similarities not only within but also between countries. The coverage of all sectors allows us to systematically identify differences and similarities not only within manufacturing but also between agriculture, manufacturing and services. And the coverage of a long time period allows us to identify not only the general trends in structural cohesion over time but also structural breaks in these trends. Our study also differs from earlier studies that contributed to the patchwork of results in that we use decomposable measures of localization (see Bickenbach and Bode 2008). These measures help us overcome the three main problems that prevented earlier studies from drawing a consistent and comprehensive picture of the evolution of the allocation of economic activities. First, localization measures overcome the dichotomy between concentration and specializa-

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[1] Article 174 of the *Treaty on the Functioning of he European Union* states that "[i]n order to promote its overall harmonious development, the Union shall develop and pursue its actions leading to the strengthening of its economic, social and territorial cohesion" (also see Article 3(3) of the *Treaty on the European Union*). In order to pursue these goals the EU will spend a total of 347 bill.€ via the Structural and Cohesion Funds in the 2007 – 2013 programming period (EU Commission 2007). About 81.5% of these funds are spent to promote the real convergence of the least-developed Member Stares and regions (convergence objective).

tion. Nesting—and being decomposable into—concentration and specialization measures, they help us clarify the relation between changes in concentration and changes in specialization in Europe. Second, they overcome the aggregation problem. Being weighted sums of the concentrations of individual industries or the specializations of individual regions, they allow us to assess the contributions of all industries and regions to the change of aggregate, European-wide localization, and to trace changes of aggregate localization back to the individual countries, regions, sectors or industries. And third, they overcome the dichotomy between measures with so-called "absolute" and "relative" references. We show that these two types of measures, which frequently yield apparently opposing results for the same data, complement—rather than substitute for—each other in terms of the information they carry.

The stylized facts we develop in this paper indicate that the EU-15 has experienced structural convergence after 1980. Relative localization has decreased, which implies that regions and countries have, on average, become more similar to each other in terms of their industrial specializations, and industries have, on average, become more similar to each other in terms of their spatial concentrations. The by far most important driver of this structural convergence has been the sectoral structural change from the highly localized agriculture and manufacturing sectors towards the more dispersed services sector. This driver has largely been neglected in the literature so far. The importance of this structural change becomes obvious, however, when the industry-specific concentration measures are aggregated across industries to get an idea of the localization of economic activity as a whole. A second driver of structural convergence is that structural change towards service industries has been faster in structurally "lagging" countries with still underdeveloped service sectors but slower in structurally "leading" countries with already well-developed service sectors. And a third driver has been structural convergence within the services sector. In terms of the composition of their service sectors, many countries and regions have converged towards the EU-15 aggregate. And at the same time almost all service industries have become spatially (even) less concentrated over time. The manufacturing sector has worked against this structural convergence, though. The sector as a whole as well as several of its industries have become spatially more concentrated, and several regions and countries have specialized increasingly in specific manufacturing industries. This increasing concentration and specialization in manufacturing has, among others, been due to a deepening of the division of labor between European countries in industries like textiles and clothing or transport equipment.

The speed of aggregate structural convergence slowed down considerably in the early 1990s, however. This structural break in the early 1990s originated mainly from the manufacturing sector, whose localization started to increase at an accelerated pace. Several manufacturing industries have become more concentrated since the early 1990s, and several regions have specialized increasingly in specific manufacturing industries since then. This increase in localization has been strong enough to almost neutralize the drivers of structural convergence

mentioned above during the 1990s and early 2000s. The structural break in the early 1990s may have been triggered by progress in economic integration in Europe, specifically the Single Market Program, which has helped intensify the spatial division of labor, or by the fall of the iron curtain, which has opened up new locational opportunities for producers of tradable goods.

The paper is organized as follows: Section II summarizes the results of selected studies that explore the evolutions of localization, concentration or specialization in Europe. Section III describes the methodology and the data used in this paper to derive the stylized facts on the evolution of the localization of economic activity in Europe. Section IV derives and discusses the eight stylized facts, proceeding from general to specific, i.e., from the localization of economic activity in the EU-15 on aggregate to the concentrations of individual sectors and industries on the one hand, and to the specializations of individual countries and regions on the other. Section V concludes.

II. Literature

This section briefly summarizes key results of the empirical literature on the evolution of localization, concentration or specialization in Europe. Rather than surveying this literature comprehensively, we focus on those results that either appear to be rather robust or are directly related to our stylized facts derived in Section IV.[2] We also do not survey in depth the analyses that measure the geographic concentration of individual industries at specific points in time by way of Ellison-Glaeser indices or K densities. While these measures have some clear methodological advantages over traditional concentration measures borrowed from income inequality analysis,[3] they are of limited use for studies like the present one that focus on drawing a picture of both the aggregated and the detailed evolutions of localization, concentration and specialization in Europe. They require very detailed data that are available for some countries but not for (Western) Europe as a whole, they cannot be aggregated across industries, and they cannot be used for analyzing the *specialization* of regions or countries.

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[2] See Combes and Overman (2004), Brakman et al. (2005), and Cutrini (2009, 2010) for complementing reviews of this literature. A more comprehensive survey of this literature would offer little additional insights for the question at hand because studies differ from each other in a variety of dimensions, which forms a serious obstacle to comparing and generalizing their results. Studies differ from each other by investigating different time periods, and different sectoral units (industries from all sectors or from manufacturing only), or spatial units (regions or countries), by employing different economic indicators (output, value added, trade, employment, or number of plants), and by evaluating the distributions of these indicators by means of different statistical indices (including Theil index, Gini coefficient, Ellison-Glaeser index, K density) and against different benchmarks (uniform references for so-called absolute measures, higher-level aggregates for so-called relative measures, or simulated counterfactual references).

[3] See Combes and Overman (2004), Duranton and Overman (2005), and Marcon and Puech (2010) for a detailed methodological discussion. The Ellison-Glaeser index facilitates controlling for indivisibilities in firm sizes, and the K density avoids biases that arise from spatial aggregation.

Most of the studies that explore the evolution of localization, concentration or specialization in Europe share, nonetheless, a common motivation, which is exploring the consequences of progress in European economic integration on the spatial or industrial allocation of economic activity. Using the new economic geography (NEG) as the theoretical background, industries may be expected to become more concentrated, and regions or countries to become more specialized, as trade costs and border impediments within Europe are reduced by the enlargements of the EU, the completion of the single market program of the EU, or the introduction of the common currency. In this context, the so-called "Krugman-hypothesis" has gained some prominence. Krugman (1991:76–83, 1993) hypothesizes that progress in economic integration in Europe should go along with increasing specialization of EU *countries* because it reduces trade costs across *national* borders. The degree of specialization of European countries should become more similar to that of U.S. census regions, which have been more specialized than European countries because they have been more integrated economically for a long time. The specialization of *regions* within European countries should not increase to the same extent, by contrast, because these regions have, like the states in the U.S., already been highly integrated with each other. Since the European countries will specialize in different industries, the concentration of industries across countries should also increase as economic integration proceeds in Europe. In terms of the localization measures used in the present paper, which are weighted averages of region-specific specialization measures as well as weighted averages of industry-specific concentration measures, the Krugman hypothesis holds that the localization of economic activity across countries and industries in Europe should increase while the localization of economic activity across regions and industries within the individual countries should not increase.

Surveying the literature up to the mid-2000s, Combes and Overman (2004) and Brakman et al. (2005) conclude that specialization and concentration tended to have increased at the country level but to have decreased at the regional level within countries since the 1970s.[4] These findings tend to support the Krugman hypothesis. They are, however, based on ad-hoc aggregations of specialization measures across regions, or concentration measures across industries. Combes and Overman (2004), for example, use a simple counting criterion, which does not take into account the relative structural importance of the countries or industries. Only recently, Krieger-Boden and Traistaru-Siedschlag (2008) and Cutrini (2009, 2010) have overcome this weakness by using localization measures proposed by Bickenbach and Bode (2008), which aggregate Theil indices of specialization and of concentration in a theoretically consistent way, namely by weighting them by the respective countries' or industries' (employment) shares. Cutrini (2010) finds that even though the localization of the manufac-

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[4] Combes and Overman (2004) emphasize significant disparities between regions and industries, though. They reckon that only about half of the EU regions have become less specialized, and only about two thirds of EU industries have become more dispersed.

turing sector between countries decreased rather than increased between 1985 and 2001, it decreased at a slower pace than the localization of the manufacturing sector within the individual countries. Even though this result is not supportive of the Krugman hypothesis proper, it offers some support for the hypothesis that structural inequalities between countries have increased relative to those within countries (see also Brülhart and Träger 2005). Unfortunately, Cutrini (2010) focuses only on the manufacturing sector, which, as will be shown below, should not be taken as representative for the economy as a whole because its localization patterns and dynamics differ markedly from those of the services sector.

If one is willing to argue that the European integration process was pushed to a higher level or re-gained momentum by the completion of the single market and the conclusion of the Treaty of the European Union (Maastricht Treaty) in the early 1990s, one may interpret the Krugman hypothesis as implying that the localization of economic activity across industries and countries in Europe should increase at an accelerated pace after the early or mid-1990s. In this case there should have been a structural break in the evolution of localization in Europe: the localization of economic activity in the EU as a whole, the concentrations of individual industries across EU countries, and the specializations of EU countries should have increased faster after the early 1990s. Cutrini (2010) and Brülhart and Träger (2005) do, in fact, report evidence for such a structural break. Cutrini finds that the decrease of localization of manufacturing between countries came to a halt in the early 1990s, and Brülhart and Träger (2005) find that the tendencies of industries from all sectors to concentrate (disperse) have tended to be somewhat stronger (weaker) after the early 1990s. In Section IV, we explore the evidence on the Krugman hypothesis more consistently and comprehensively. We show that the Krugman hypothesis holds well for the manufacturing but not for the services sector.

One puzzle discussed repeatedly in the literature on specialization or concentration is the discrepancy between so-called absolute and relative measures, which have often been found to evolve in opposite directions for the same data, even though they were used to describe and explore basically the same subject.[5] For relative measures, the benchmark of no specialization (or concentration) is the contemporaneous distribution of economic activity at the aggregate industrial (regional) level.[6] The main advantage of this relative benchmark is that it controls for the size differences between regions or industries. It varies over time, however, which eliminates from the measures the effects of structural change at the aggregate level, i.e., the

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[5] For example, Krieger-Boden and Traistaru-Siedschlag (2008) have found that localization in the EU decreased for a relative reference but increased with an absolute reference

[6] A region is considered as being not specialized, if its economic activities are distributed across industries like those in the country or the EU on aggregate, i.e., if the share of this region in total activity of the country or the EU is the same for all industries. And an industry is considered as being not concentrated, if it is distributed across regions like total employment, i.e., if the share of this industry in total regional activity is the same in all regions.

effects of economic activity shifting between regions, or shifting from mature to modern industries at the aggregate, country or EU level. For absolute measures, the benchmark of no specialization (or concentration) is the uniform distribution across industries (regions). Economic activity in the region (industry) under study is taken to be not specialized (concentrated) if it is distributed uniformly across all industries (regions). The main advantage of this benchmark is that it is time-invariant. It does, however, not account for the (historically determined) peculiarities of the industry and region classification systems. Focusing on absolute *concentration* measures, Combes and Overman (2004: 2861) argue that "[t]he implied null hypothesis is rather odd: Each location has an identical share in each industry independent of the locations overall size. It is hard to think of a random location model that would produce such a distribution." Regions or countries of grossly different sizes (like Luxembourg and Germany) simply cannot be expected to have the same, or at least similar, employment or output shares in any industries. A similar argument can be put forth for the use of the uniform reference in the analysis of specialization. The uniform reference does not account for the fact that industry classifications are, ultimately for historical reasons, much coarser within the service sector or for modern growing industries than within the manufacturing sector or for mature shrinking industries.[7] The neglect of these peculiarities of classification systems implies that absolute specialization measures will increase over time in (almost) any empirical application just as a consequence of a general structural change from "old" to "new" industries (Bickenbach et al. 2010).

In the present paper we mainly use relative measures of localization, concentration or specialization to derive the stylized facts. In addition to these relative measures, we also use a modified absolute measure to explore the effects of shifts in EU aggregate employment across regions and from mature to modern industries at the EU level. The no localization benchmark of this modified absolute measure is time-invariant but still controls for the peculiarities of the region and industry classification systems. Instead of the uniform distribution, we use the distributions of aggregate employment across regions and across industries of the initial year of our study, 1980, as our absolute reference for all years. In addition to this, we use a specific decomposition result derived in Bickenbach et al. (2010) to formally relate our absolute localization measure to our relative localization measure. We will show in Section III.1 that the difference between the two measures is indicative of the level of structural changes across regions and across industries of aggregate EU employment between 1980 and the year under investigation.

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[7] For example, both the service and the manufacturing sector account each for about 46% of all 615 4-digit industries of the European NACE (Rev. 2) industry classification system, even though services accounted for more than 70% and manufacturing for less than 25% of total (EU-15) employment in 2008, when the NACE (Rev. 2) classification was enacted.

Another puzzle discussed in several papers is the relationship between concentration and specialization. On the one hand, using specific types of absolute measures of concentration and specialization, Aiginger and Davies (2004)[8] show that the average (or "typical") specialization of EU countries within the manufacturing sector increased since the mid-1980s while the average concentration of manufacturing industries across EU countries decreased. On the other hand, concentration and specialization moving into opposite directions is often considered counterintuitive as they are evidently two sides of the same coin. In fact, relative localization measures as those used in Cutrini (2010) or in the present paper are measures of both average concentration and average specialization. Thus, for these measures, average relative concentration and specialization can not diverge from each other by definition. The present paper solves this puzzle by showing that the increases of average specialization measures of the kind used by Aiginger and Davies are driven predominantly by the *aggregate* structural change from mature to modern industries. We also show that there is no such dominance of aggregate structural change for their average concentration measures as there is actually very little aggregate regional structural change between regions or countries in the data. Thus, the average concentration measure of Aiginger and Davies is not dominated by shifts of aggregate employment across regions but by changes in the relative concentration patterns of the individual industries.

III. Data and Methodology

1. Data

The aim of this paper is to derive stylized facts on the evolution of localization in Europe. For these stylized facts to be robust against medium-term variations in the data, we should, on the one hand, use a time period that is as long as possible, and, on the other hand, cover as many of the current EU member countries as possible. There is a trade-off between these two requirements, however. Extending our analysis back into the 1980s requires excluding Eastern European countries, whereas extending our analysis to include Eastern European countries requires excluding the years before 1993. In this study, we opt for the former. We derive our stylized facts on the evolution of localization in Western Europe for the years 1980 to 2003, the last year before the EU's Eastern enlargement. The advantage of this option is that we are able to identify a structural break in the evolution of localization in the early 1990s, which would not have been possible, had we opted for including the Eastern European countries. We leave the analysis of localization in the enlarged Europe to future research.

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[8] See also Aiginger and Rossi-Hansberg (2006).

Europe-wide consistent long-run data on levels of economic activity (output or employment) by industries and regions are scarce. We are aware of only a single data source that provides this data, Cambridge Econometrics. The Cambridge Econometrics database reports annual estimates of employment and value added by 15 industries across all EU member states plus selected European non-EU members from 1980 onwards. Even though the quality of this data has not gone undisputed, we use the Cambridge Econometrics database for our analysis. We focus on employment rather than value added because we expect the employment figures to be more reliable. The official national statistics that underlie this data are usually more detailed for employment than for value added, and the employment figures are not biased by exchange rate fluctuations (or non-fluctuations).

More specifically, the dataset we use comprises 195 regions (mostly at the NUTS 2 level) from the 15 EU member states as of 2003 (excluding East Germany), 15 industries from all three sectors—agriculture (1 industry), manufacturing (8 industries, including energy supply and construction), and services (6 industries, including public services)—and the 24 years from 1980 to 2003. Tables A1 and A2 in the Appendix provide a complete list of industries and regions.

2. Measuring and Decomposing Localization

In the present study, we choose the Theil index as our workhorse for measuring localization and deriving our stylized facts. We prefer the Theil index over other indices, such as other members of the class of generalized entropy (GE) indices, the Gini coefficient, the coefficient of variation (CV), the Ellison-Glaeser (EG) index or the K density, for three reasons. First, it is, unlike the Gini, the CV, the EG or the K density, straightforwardly decomposable, which is important here because we would like to trace aggregate developments back to sectors or industries and to countries or regions. Second, the within-component resulting from the decomposition of the Theil index is easy to interpret. It is just a weighted average of Theil indices. For other GE indices the within-component is a still weighted sum of GE indices, but the weights do not sum up to one and are more difficult to interpret economically. And third, the Theil index is less sensitive to outliers than other GE indices of higher order. It is worth noting, however, that the Theil index has, like other indices borrowed from the income equality literature (see Bickenbach and Bode 2008), a couple of shortcomings. Collapsing the entire distribution of economic activity into a single number, it draws a highly aggregate and thus simplified picture of the distribution of employment across region-industries. And it is subject to the modifiable areal unit problem and the checkerboard problem (Arbia 1989) in both the regional and the industrial dimension (Bickenbach and Bode 2008). Any measure, however, that has been developed so far to avoid these shortcomings lacks at least some of the useful properties of GE measures, most notably decomposability. In addition to this, many of the alternative measures have data requirements that cannot be met at the European scale.

They may thus be able to contribute to the patchwork of detailed results on the concentrations of individual industries (or the specializations of individual regions) but are of limited help when it comes to exploring the general patterns of the evolution of structural cohesion in Europe. From this perspective we expect the Theil index to do a reasonable though certainly not perfect job for the purpose of the present study.

The Theil index of localization across industries and regions of EU-15 employment for year t can generally be defined as (see Bickenbach and Bode 2008)

$$(1) \qquad T^{\theta}_{\bullet\bullet t}(ir) = \sum_{i \in \mathbf{I}} \sum_{r \in \mathbf{R}} w_{ir\theta} \frac{\dfrac{L_{irt}}{\Pi_{ir\theta}}}{\displaystyle\sum_{i \in \mathbf{I}} \sum_{r \in \mathbf{R}} w_{ir\theta} \frac{L_{irt}}{\Pi_{ir\theta}}} \ln\left(\frac{\dfrac{L_{irt}}{\Pi_{ir\theta}}}{\displaystyle\sum_{i \in \mathbf{I}} \sum_{r \in \mathbf{R}} w_{ir\theta} \frac{L_{irt}}{\Pi_{ir\theta}}} \right).$$

$\mathbf{I}$ denotes the set of our 15 industries, indexed by i, and $\mathbf{R}$ the set of our 195 regions, indexed by r. The suffixes of the measure T, (ir), define the units of analysis in the industrial and the spatial dimension, here industries i and regions r. The first two subscripts, $\bullet\bullet$, define the range of industries and regions covered by the index, here the sets of all industries $i \in \mathbf{I}$ (represented by the first $\bullet$) and the set of all regions $r \in \mathbf{R}$ (represented by the second $\bullet$). The third subscript t defines the year of analysis. The superscript, θ, characterizes the choice of references and weights, which will be detailed below.[9] L_{irt} denotes employment in region-industry ir in year t, $\Pi_{ir\theta}$ denotes the reference for region-industry ir, and $w_{ir\theta}$ the (relative) weight of region-industry ir in the localization index, with $\Sigma_i \Sigma_r . w_{ir\theta} = 1$. Obviously, T = 0 if the proportionality factor $L_{irt}/\Pi_{ir\theta}$ is the same for all region-industries (ir). The complete set of references $(\Pi_{ir\theta}$: $i \in \mathbf{I}, r \in \mathbf{R})$ may thus be thought of as reflecting (up to a common scalar) the region-industry employment levels $(L_{irt}$: $i \in \mathbf{I}, r \in \mathbf{R})$ considered to represent the situation of "no localization".

A complete specification of (1) requires the definition of references and weights. The appropriate choice of references and weights depends on the specific research question or purpose of the investigation (Bickenbach and Bode 2008). In this paper we will use two different sets of references and weights, which by equation (1) lead to two different measures of localization of EU-15 employment, a relative and an absolute measure. For the most part of the analy-

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[9] With industries grouped into a set $\mathbf{S}$ of (three) mutually exclusive sectors, indexed by s, and regions grouped into a set $\mathbf{C}$ of (fifteen) mutually exclusive countries, indexed by c, we may also take sectors (s) or countries (c) as alternative units of analysis (suffixes) and/or restrict coverage (subscripts) to a single sector (s) or industry (i) in the industrial dimension, and a single country (c) or region (r) in the regional dimension. For example, $T^{\theta}_{\bullet ct}(ir)$ is the Theil index of localization of country c across all industries and regions in this country, $T^{\theta}_{\bullet ct}(sr)$ is the Theil index of localization of country c across all sectors and regions, $T^{\theta}_{sct}(ir)$ the Theil index of localization of sector s in country c across all industries and regions, $T^{\theta}_{s \bullet t}(i)$ the Theil index of specialization of sector s at the EU level across all industries in this sector, and $T^{\theta}_{sct}(r)$ the Theil index of concentration of sector s in country c across all regions in this country.

sis we choose "relative" or contemporaneous references and weights (indexed by $\theta = t$), which we define as $\Pi_{irt} = L_{i\bullet t}L_{\bullet rt}/L_{\bullet\bullet t}$ and $w_{irt} = L_{i\bullet t}L_{\bullet rt}/L_{\bullet\bullet t}^2$, where $L_{i\bullet t} := \Sigma_r L_{irt}$ denotes the total employment of industry i in the EU-15 as a whole in year t, $L_{\bullet rt} := \Sigma_i L_{irt}$ the total employment of region r in year t, and $L_{\bullet\bullet t} := \Sigma_i \Sigma_r L_{irt}$ the total employment in the EU-15 in year t. This choice corresponds to the definition of relative measures of concentration and specialization that have frequently been used in the literature. For some parts of our analysis (see Section IV.2) we also use a second, complementary set of references and weights, which we call "absolute" or initial-year references and weights and which we index by $\theta = 1980$. These absolute references and weights are defined as $\Pi_{ir1980} = L_{i\bullet1980}L_{\bullet r1980}/L_{\bullet\bullet1980}$ and $w_{ir1980} = L_{i\bullet1980}L_{\bullet r1980}/L_{\bullet\bullet1980}^2$. Absolute references and weights are thus defined in a way similar to our relative references and weights, except that they are based, for every year t, on the distribution of employment in the initial year of our analysis, 1980, rather than the contemporaneous year t. While this definition does **not** correspond to the usual definitions of absolute measures of concentration and specialization as found in the literature, which are based on the uniform distribution, it does share important properties with these measures, which in our view justifies the denotation "absolute". [10]

Our choice of *relative* references, $\Pi_{irt} = L_{i\bullet t}L_{\bullet rt}/L_{\bullet\bullet t}$, is justified by the fact that the "no localization" benchmark it implies represents perfect structural cohesion. We consider employment in the EU-15 to be not localized, if all regions are, irrespective of their aggregate employment sizes, perfectly similar in the sense that they all have the same industry composition as the EU-15 on aggregate in the year under study, that is, if $L_{irt}/L_{\bullet rt} = L_{i\bullet t}/L_{\bullet\bullet t}$ for all i, r, or, equivalently, if all industries are, again irrespective of their aggregate sizes, perfectly similar in the sense that they are all distributed across regions in the same way as total employment, that is, if $L_{irt}/L_{i\bullet t} = L_{\bullet rt}/L_{\bullet\bullet t}$ for all i, r. In this case of perfect similarity of industrial or regional employment patterns the Theil index of relative localization $T^t_{\bullet\bullet t}(ir)$ will be zero, otherwise (no perfect similarity) it will be greater than zero.

In calculating the index, any deviation of the industry-region employment L_{irt} from the reference Π_{irt} will be weighted by w_{irt}. Our choice of relative weights, $w_{irt} = L_{i\bullet t}L_{\bullet rt}/L_{\bullet\bullet t}^2$, amounts to weighting each industry and region by its contemporaneous share in total employment in the EU-15. We consider this the most appropriate choice of weights for our relative Theil index, as these weights assign each observed worker the same weight, irrespective of her or his industrial or regional affiliation. In the terminology of Bickenbach and Bode (2008), we choose the individual workers to be the basic units of our analysis.

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[10] Some scholars would possibly prefer classifying our absolute measure as a "relative" measure because its reference is non-uniform. We still prefer classifying it as an absolute measure because the main feature of absolute measures (as to their evolution over time) is the time-invariance of their references in our view.

Substituting these relative references and weights into (1) simplifies the measure to

$$(2) \qquad T^t_{\bullet\bullet t}(ir) = \sum_{i\in\mathbf{I}}\sum_{r\in\mathbf{R}} l_{irt} \ln\left(\frac{l_{irt}}{l_{it}l_{rt}}\right),$$

where $l_{irt} := L_{irt} / L_{\bullet\bullet t}$ denotes the share of the region-industry (ir) in total EU-15 employment in year t, $l_{it} := L_{i\bullet t} / L_{\bullet\bullet t}$ the share of industry i in total EU-15 employment in year t, and $l_{rt} := L_{\bullet rt} / L_{\bullet\bullet t}$ the share of region r in total EU-15 employment in year t. [11, 12]

The relative Theil index of localization across industries and regions of EU-15 employment in (2) plays a pivotal role in this paper. Its changes over time, which summarize all the information available about the changes in the similarity of the specialization or concentration patterns, can be interpreted as increases or decreases in structural cohesion.[13] By decomposing the localization measure in various ways by sectors, industries, countries or regions we are able to trace back these changes to changes within and between sectors, industries, countries or regions. We thereby do not only explore to what extent the concentrations or specializations of individual sectors, industries, countries and regions changed over time, as has been done extensively in the literature so far. We also explore to what extent the concentration or specialization patterns *between* these sub-divisions changed over time, and, even more importantly, to what extent the combined effects of changes within and changes between these sub-divisions contributed to the changes of total relative localization of EU-15 employment. To be able to do so, we derive consistent and economically meaningful aggregation rules from applying the well-known decomposition properties of the Theil index (cf. Bickenbach and Bode 2008) to our localization measure (2).

Decomposing the localization measure (2) by industries gives, for example,

$$(3) \qquad T^t_{\bullet\bullet t}(ir) = \sum_{i\in\mathbf{I}} l_{it} T^t_{i\bullet t}(r) + T^t_{\bullet\bullet t}(i),$$

where the first term on the right-hand side is the within-industries component and the second the between-industries component.[14] The within-industries component is the weighted aver-

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[11] Notice that the log term in (2) is the location coefficient of region-industry ir, that is the ratio between region r's share in total employment of industry i and in aggregate employment, $l_{irt}/(l_{it}l_{rt})=(L_{irt}/L_{i\bullet t})/(L_{\bullet rt}/L_{\bullet\bullet t})$.

[12] Compared to (2), (1) looks like being unnecessarily blown up by reference and weights, which eventually cancel out. Still, (1) helps in understanding the role of the references and weights in this measure, and opens up a wide variety of opportunities for choosing alternative references and weights. We will come back to (1) when we discuss our version of the absolute measure.

[13] Due to the choice of contemporaneous, aggregate employment as references, the relative Theil index is affected by shifts in the distribution of aggregate EU-15 employment across industries only to the extent that these shifts affect regions asymmetrically. Likewise, it is affected by shifts in the distribution of aggregate EU-15 employment across between regions only insofar as it affects the industries in these regions asymmetrically.

[14] We will make use of this decomposition in Section IV.2 (see Figure 4).

age of the relative Theil indices of concentration across regions of all individual industries, $T_{i\bullet t}^{t}(r) = \sum_{r \in \mathbf{R}}(l_{irt}/l_{it})\ln(l_{irt}/(l_{it}l_{rt}))$, and the between-industries component is the relative Theil index of specialization across industries of EU-15 aggregate employment, $T_{\bullet\bullet t}^{t}(i)$. This between-industries component is zero for our specific choice of (relative) references and weights because the size distribution of industries at the aggregate EU level is identical to the reference distribution. Equation (3) shows that our measure of relative EU-15 localization summarizes the corresponding industry-specific concentration measures. Rather than aggregating the concentration measures for the individual industries in an ad hoc fashion, we aggregate them consistently, using the weights implied by the decomposition in (3). These weights of the industry-specific concentration measures are the contemporaneous employment shares of the respective industries at the level of the EU-15, l_{it}.[15] In Section IV we will see that a good deal of the changes over time of the localization in the EU-15, as measured by (2), can actually be attributed to changes of these weights. Industries with decreasing weights tend to be more concentrated than those with increasing weights in our data. This highlights the importance of consistently and economic meaningfully defined weights (aggregation rules) for our analysis.[16]

Alternatively, decomposing (2) by regions gives

(4) $\qquad T_{\bullet\bullet t}^{t}(ir) = \sum_{r \in \mathbf{R}} l_{rt} T_{\bullet rt}^{t}(i) + T_{\bullet\bullet t}^{t}(r)$,

where the within-regions component is the weighted average of the relative Theil indices of specialization of the individual regions, $T_{\bullet rt}^{t}(i) = \Sigma_{i \in \mathbf{I}}(l_{irt}/l_{it})\ln(l_{irt}/(l_{it}l_{rt}))$, and the between-regions component is the relative Theil index of concentration of aggregate employment across regions, $T_{\bullet\bullet t}^{t}(r)$, which, again, is zero for our choice of relative references and weights.[17] Equation (4) shows that our measure of localization of the EU summarizes the

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[15] Note that the sum of these weights equals 1, as is always the case for the within component of a Theil index.

[16] In Section IV.2 (see Figure 3), we will also make use of the decomposition of (2) by sectors, which gives $T_{\bullet\bullet t}^{t}(ir) = \sum_{s \in \mathbf{S}} l_{st} T_{s\bullet t}^{t}(ir) + T_{\bullet\bullet t}^{t}(s)$, where $T_{s\bullet t}^{t}(ir) = \Sigma_{i \in s}\Sigma_{r \in \mathbf{R}}(l_{irt}/l_{st})\ln[l_{irt}l_{st})/(l_{it}l_{rt})]$ denotes the relative Theil index of localization of sector s, and $T_{\bullet\bullet t}^{t}(s)=0$ denotes the relative Theil index of specialization across sectors of the aggregate EU-15 employment (which, again, equals zero for our specific choice of reference). The weight l_{st} of each sector's localization in the within-sectors component equals the sectors share in total EU-15 employment of year t ($l_{st} := \Sigma_{i \in s}l_{it}$).

[17] We will use this decomposition as well as that of (2) by countries in Section IV.3. The decomposition by countries gives $T_{\bullet\bullet t}^{t}(ir) = \sum_{c \in \mathbf{C}} l_{ct} T_{\bullet ct}^{t}(ir) + T_{\bullet\bullet t}^{t}(c)$, where $T_{\bullet ct}^{t}(ir) = \Sigma_{i \in \mathbf{I}}\Sigma_{r \in c}(l_{irt}/l_{ct})\ln[l_{irt}l_{ct})/(l_{it}l_{rt})]$ denotes the relative Theil index of localization of country c, and $T_{\bullet\bullet t}^{t}(c)$, denotes the relative Theil index of concentration of aggregate employment across countries which is again equal to zero. The weight l_{ct} of each country's localization in the within-countries component equals the country's share in total EU-15 employment of year t ($l_{ct} := \Sigma_{r \in c}l_{rt}$).

corresponding region-specific specialization measures. These measures are consistently aggregated across regions by weighting them by the relative sizes of the regions.[18]

Several of the stylized facts from Section IV will be derived from additional and often more complex decompositions of our relative localization measure (2). For example, to investigate the Krugman hypothesis, we derive from (2) measures of the *average* relative concentrations of industries *across* countries and the *average* relative concentrations of industries *within* countries. To do so, we decompose (2) by industries and countries,[19] which gives

$$(5) \qquad T_{\bullet\bullet t}^{t}(ir) = \sum_{i\in\mathbf{I}}\sum_{c\in\mathbf{C}} l_{ict} T_{ict}^{t}(r) + \sum_{i\in\mathbf{I}} l_{it} T_{i\bullet t}^{t}(c).$$

In order to interpret (5), note first that $T_{ict}^{t}(r)$ is the relative Theil index of concentration of industry i across regions in country c, and $T_{i\bullet t}^{t}(c)$ is the relative Theil index of concentration of industry i across countries. The first term on the right-hand side of (5), the within-country-industries component, is thus the weighted average of the 225 (15 countries times 15 industries) country-industry-specific Theil indices of concentration across regions, $T_{ict}^{t}(r) = \Sigma_{r\in c}(L_{irt}/L_{ict})\ln[(L_{irt}/L_{ict})/(L_{\bullet rt}/L_{\bullet ct})]$, with $L_{ict}:=\Sigma_{r\in c}L_{irt}$ and $L_{\bullet ct}:=\Sigma_{i}L_{ict}$. This *average* concentration of industries within the EU-15 countries captures all the heterogeneity in the spatial distributions of the individual industries within the individual countries. It is therefore our preferred measure for assessing the "Krugman hypothesis" with respect to changes of the concentration of industries within countries. The second term on the right-hand side of (5), the between-country-industries component, $\Sigma_{i\in\mathbf{I}}l_{it}T_{i\bullet t}^{t}(c)$, is the weighted average of the 15 industry-specific Theil indices of concentration across countries, $T_{i\bullet t}^{t}(c) = \Sigma_{c\in\mathbf{C}}(L_{ict}/L_{i\bullet t})\ln[(L_{ict}/L_{i\bullet t})/(L_{\bullet ct}/L_{\bullet\bullet t})]$. This *average* concentration of industries between the EU-15 countries captures all the heterogeneity between industries as to their spatial distributions across countries. It is thus our preferred measure for assessing the Krugman hypothesis with respect to changes of the concentration of industries across countries. Since our two measures of industrial concentrations within and across countries add up to our measure of overall localization in the EU-15, we can straightforwardly assess to what extent the changes of the one and the other contributed to the evolution of overall localization (see Section IV).

In addition to assessing the average concentration of all industries within and between countries, we will also assess the concentration of individual industries as well as the sector-spe-

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[18] We will see in Section IV that the sizes of the regions have been remarkably stable over time. The changes of overall localization in the EU-15, as measured by (1), are thus mainly due to changes in the specialization of regions.

[19] Decomposing (2) by industries and countries in just one step gives us the same result as a two step procedure in which we first decompose (2) by industries as in (3) and then decompose the resulting relative concentration indices by countries. See Bickenbach and Bode (2008).

cific averages of industry concentrations within and between countries (Section IV.2). For an individual industry i, measures for the within and between countries concentration are obtained from a standard decomposition of the industry's relative Theil index of concentration across regions by countries: $T_{i\bullet t}^t(r) = \Sigma_{c\in\mathbf{C}}(l_{ict}/l_{it})T_{ict}^t(r) + T_{i\bullet t}^t(c)$. From this the sector-specific average concentration measures can be obtained as the weighted sum over the industries of the respective sectors, with weights equal to the shares of the individual industries in total sector employment, $l_{it}/l_{st} = L_{i\bullet t}/\Sigma_{i\in s}L_{i\bullet t}$. This gives:

(6) $\qquad T_{s\bullet t}^t(ir) = \sum_{i\in s}\sum_{c\in\mathbf{C}}(l_{ict}/l_{st})T_{ict}^t(r) + \sum_{i\in s}(l_{it}/l_{st})T_{i\bullet t}^t(c)$.

The two terms on the rights hand side of (6) measure the sector-specific *average* concentration of industries *within* countries and the sector-specific *average* concentration of industries *across* countries, respectively.[20] The weighted sum over all sectors of these sector specific relative Theil indices of localization brings us back to our overall measure of localization in (2): $T_{\bullet\bullet t}^t(ir) = \sum_{s\in\mathbf{S}}l_{st}T_{s\bullet t}^t(ir)$.[21]

Our second measure of localization, which complements the relative Theil index in (2), is a specific absolute Theil index. Like the relative Theil index, our absolute Theil index of localization can be derived from our general definition (1) by inserting the appropriate (absolute) references and weights. More specifically, for our absolute measure we choose $\Pi_{ir1980} = L_{i\bullet1980}L_{\bullet r1980}/L_{\bullet\bullet1980}$ as the reference and $w_{ir1980} = L_{i\bullet1980}L_{\bullet r1980}/L_{\bullet\bullet1980}^2$ as the weight of region-industry (ir) in year t. This gives

(7) $\qquad T_{\bullet\bullet t}^{1980}(ir) = \sum_{i\in\mathbf{I}}\sum_{r\in\mathbf{R}}l_{irt}\ln\left(\dfrac{l_{irt}}{l_{i1980}l_{r1980}}\right)$,

where $l_{i1980} := L_{i\bullet1980}/L_{\bullet\bullet1980}$ and $l_{r1980} := L_{\bullet r1980}/L_{\bullet\bullet1980}$.

Our choice of the *absolute* references, Π_{ir1980}, implies that by applying the absolute Theil index of localization we consider employment in the EU-15 in year t to be not localized, if the employment in each region-industry ir in that year t, L_{irt}, is equal to the aggregate (over all regions) employment in industry i in the initial year 1980, $L_{i\bullet1980}$, times the share of region r in aggregate employment of 1980, $L_{\bullet r1980}/L_{\bullet\bullet1980}$ —or, equivalently, if it is equal to the aggre-

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[20] Similar to (5), (6) can also be directly obtained from a decomposition of the sector specific relative Theil indices of localization, $T_{s\bullet t}^t(ir)$, by industries and countries.

[21] In Section IV.3 we also use a decomposition and aggregation strategy similar to that just described but with the role of regions and sectors replaced by that of industries and countries. This allows us to explore the extent to which changes of the overall localization (of specific countries or of the EU-15 as a whole) can be attributed to changes in the specializations of regions across sectors and across industries within sectors, respectively (see Figure 5 in Section IV.3).

gate (over all industries) employment in region r in 1980, $L_{\bullet r1980}$, times the share of industry i in aggregate employment of 1980, $L_{i\bullet1980}/L_{\bullet\bullet1980}$. The choice of the initial-year weights, w_{ir1980}, implies that we choose individual workers in 1980 to be the basic units of our analysis. The contribution of each region-industry (ir) to our absolute localization measure for year t is weighted by its relative employment size in 1980, irrespective of its relative size in year t.[22]

Our absolute reference controls for the specifics of the underlying industry and region classification systems by taking the size differences between industries and regions in 1980 into account. Different from our relative reference, our absolute reference does not control, however, for changes of the relative sizes of industries and regions after 1980. As a consequence, our absolute localization measure (7) is identical to our relative measure in (2) for the initial year 1980, but differs from this measure for subsequent years $t > 1980$ by the more, the faster the contemporaneous reference of the relative measure in t has diverged from the initial-year reference of the absolute measure. This divergence reflects the cumulated changes in distributions of aggregate EU-15 employment across industries and across regions between 1980 and year t.

We show formally in Bickenbach et al. (2010) that, for any year t, our absolute measure (7) exceeds our relative measures (2) by the sum of the absolute Theil index of concentration of total employment across regions in the EU-15 and the absolute Theil index of specialization of total employment EU-15 employment across industries:[23]

(8) $T_{\bullet\bullet t}^{1980}(ir) = T_{\bullet\bullet t}^{t}(ir) + T_{\bullet\bullet t}^{1980}(r) + T_{\bullet\bullet t}^{1980}(i)$.

The first term on the right-hand side of (8) is our relative measure (see equation 2). The second term, $T_{\bullet\bullet t}^{1980}(r) = \Sigma_{r\in\mathbf{R}} l_{rt}\ln(l_{rt}/l_{r1980})$, is the absolute Theil index of concentration of aggregate EU-15 employment across regions.[24] It measures the aggregate regional structural change

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[22] As mentioned above, our absolute Theil index of localization differs from the "standard" definition of absolute measures as used in the literature. (The more standard "absolute" measures based on references and weights taken from the uniform distribution could be obtained from equation (2) by choosing references $\Pi_{ir\theta} = 1$ and weights $w_{ir\theta} = 1/(IR)$, where I is the number of industries and R is the number of regions.) Instead of deriving references and weights from the uniform distribution, as virtually all earlier studies did, we draw references and weights from the distribution of employment in the initial year of our study, 1980. Like the uniform reference, this initial-year reference is time-invariant. Unlike the uniform reference, it does control, however, for the peculiarities of the underlying industry and region classification systems by taking the size differences between industries and regions in 1980 into account. It prevents the absolute localization measure from being biased upwards by the sheer fact that some industries and regions are smaller than others.

[23] The equality in (8) holds only for the localization measures at the highest level of aggregation (the level from which the reference is taken). For measures at lower levels of aggregation, such as the Theil index of localization of a single sector in a single country, the expression is somewhat more complex. In this case, two additional terms, the relative Theil indices of specialization and of concentration of this country-sector, have to be subtracted from the right-hand side in this case. The corresponding relative indices are zero at the aggregate EU level but not at the the level of a specific sector and country. See Bickenbach et al. (2010) for the details.

[24] This absolute Theil index of concentration of total employment across regions in the EU-15 is identical to the between-regions component of a decomposition of (7) by regions. Notice that this between-regions component

in the EU-15 between 1980 and t. The third term, $T_{\bullet\bullet t}^{1980}(r) = \Sigma_{i \in \mathbf{I}} l_{it} \ln(l_{it}/l_{i1980})$, is the absolute Theil index of specialization of aggregate EU-15 employment across industries.[25] It measures the aggregate regional structural change in the EU-15 between 1980 and t. In addition to the dissimilarities in the specialization patterns of the different regions (and thus in the concentration patterns of the different industries), which are captured by our relative measure, our absolute measure thus also captures the cumulated changes in distributions of aggregate EU-15 employment across industries and across regions between 1980 and year t

Equation (8) solves the dichotomy between absolute and relative measures that plagued earlier attempts to explore concentration or specialization (see Section II) by expressing the difference between the absolute and the relative measure as the sum of (absolute) concentration and specialization measures that reflect the deviations of the relative from the absolute references and that have an intuitive interpretation as measures of regional and industrial structural changes in *aggregate* EU-15 employment.

We will henceforth call changes in the first component on the right-hand side of (8), the relative localization index, "internal structural change", and consider a decrease (increase) of this index an increase (decrease) of structural cohesion in the EU-15. And we will call changes in the second and third components, the absolute indices of concentration and of specialization of aggregate EU-15 employment, "aggregate structural change across regions" or "across industries", respectively. The sum of the changes in all three components, reflected by changes of our absolute localization index, will be called "overall structural change".[26]

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is, unlike its relative counterpart in (4), not zero by construction for all t. It is zero by construction only for $t = 1980$ but will be positive for subsequent years, if the EU-15 experienced regional structural change. In Section IV (Figure 2) we further decompose this concentration measure by countries to distinguish between the aggregate structural change across the EU-15 countries from that across regions within these countries. This decomposition yields $T_{\bullet\bullet t}^{1980}(r) = \Sigma_{c \in \mathbf{C}} l_{ct} T_{\bullet ct}^{1980}(r) + T_{\bullet\bullet t}^{1980}(c)$, where $T_{\bullet ct}^{1980}(r)$ is the absolute Theil index of concentration of total employment across regions in country c and $T_{\bullet\bullet t}^{1980}(c)$ the absolute Theil index of concentration of total employment across the EU-15 countries.

[25] This absolute Theil index of specialization is identical to the between-industries component of a decomposition of (7) by industries. Notice that this between-industries component is, unlike its relative counterpart in (3), not zero by construction for all t. It is zero by construction only for $t = 1980$ but will be positive for subsequent years, if the EU-15 experienced industrial structural change. In Section IV (Figure 2) we further decompose this specialization measure by sectors to distinguish between the aggregate structural change across sectors and that across industries within these sectors. This decomposition yields $T_{\bullet\bullet t}^{1980}(i) = \Sigma_{s \in S} l_{st} T_{s\bullet t}^{1980}(i) + T_{\bullet\bullet t}^{1980}(s)$, where $T_{s\bullet t}^{1980}(i)$ is the absolute Theil index of specialization of sector s across industries in the EU-15 on aggregate and $T_{\bullet\bullet t}^{1980}(s)$ the absolute Theil index of specialization of the EU-15 on aggregate across sectors.

[26] We will use equation (8) for deriving our first two stylized facts in Section IV.1. In this context, we will also reinterpret the measures of "typical concentration" and "typical specialization" defined by Aiginger and Davies (2004). Even though Aiginger and Davies use uniform rather than initial-year references, their measure of "typical specialization" is closely related to the sum of the first and third terms on the right-hand side of (8), $T_{\bullet\bullet t}^{t}(ir) + T_{\bullet\bullet t}^{1980}(i)$. Typical specialization thus captures the sum of internal structural change and aggregate structural change across industries. And their measure of "typical concentration" is related to the sum of the first and

A final issue to be discussed in this methodology section is statistical inferences. Following Brülhart and Träger (2005), several authors have constructed bootstrap confidence intervals around the differences between measures at specific points in time or around changes of a measure over time in order to assess whether or not these differences or changes can be considered as being statistically significantly different from zero. While these bootstrap tests are easy to implement, we have serious doubts about their reliability. As Bickenbach and Bode (2008) argue, the reliability of the tests appears to be generally quite sensitive to the specific sources of uncertainty and characteristics of distributions for fairly small numbers of observations like that used in the present study. They may be far too conservative, rejecting the null hypothesis of equality in far too few cases, if the number of observations and the measurement errors are rather small. We will therefore take the changes over time of the Theil indices presented in this paper at face value, acknowledging that this is not a perfect way of dealing with potential measurement errors either.

IV. Localization of EU-15 employment 1980–2003

This section develops and discusses the stylized facts about structural cohesion in the European Union. We start from the most aggregate level, the EU-15 as a whole, in order to explore the overall internal and aggregate structural changes in the EU-15 (Section IV.1). With these overall patterns of structural change in mind, we then proceed to more disaggregate levels in order to systematically trace the total internal structural change back to sectors, industries, countries and regions. We focus on sectors and industries in Section IV.2, and on countries and regions in Section IV.3. In Section IV.4, finally, we discuss the characteristics and origins of a structural break in the evolution of overall localization in the EU-15 that occurred in the early 1990s. Single features of this structural break show up repeatedly in the preceding sections IV.1 – IV.3. For the sake of clarity, we point briefly to these features whenever they show up but postpone the detailed exploration of the structural break to Section IV.4.

1. European-wide trends

Figure 1 depicts our measure of absolute localization in the EU-15 between 1980 and 2003 as well as its three components, the measure of the internal structural cohesion and the two measures of aggregate structural changes in the industrial and the regional dimension (see equation 8).[27] It shows that the overall structural change led to an increase of the absolute

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second terms, $T_{\bullet\bullet t}^{t}(ir) + T_{\bullet\bullet t}^{1980}(r)$. Typical concentration thus captures the sum of internal structural change and aggregate structural change across regions.

[27] The respective numerical values are given in Table A3 in the Appendix.

Figure 1: Structural cohesion and aggregate structural change in the EU-15, 1980-2003
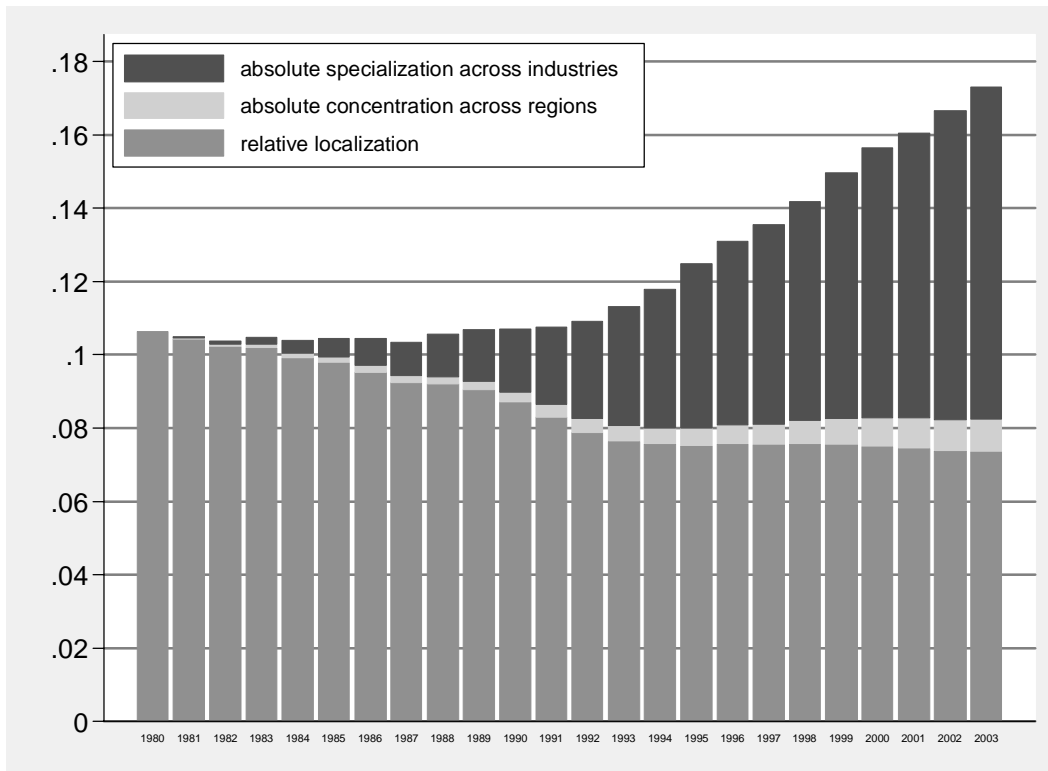
Notes: Theil indices and decomposition as described in equation (8).
Sources: Cambridge Econometrics; own calculations.

localization in the EU-15 (aggregate bars in Figure 1). The absolute Theil index of localiza-tion, $T_{\bullet\bullet t}^{1980}(ir)$, increased by more than 60% from about 0.11 in 1980 to about 0.17 in 2003. By contrast, the internal structural change alone led to a decrease of relative localization (lower part of the bars), i.e. a reduction of the dissimilarities in industrial specialization between the 195 EU-15 regions or, equivalently, of the dissimilarities in regional concen-tration between the 15 industries (increase of structural cohesion). The relative Theil index of localization in the EU-15, $T_{\bullet\bullet t}^{t}(ir)$, decreased by about 30% from about 0.11 to about 0.07.[28]

Both the increase of absolute measures and the decrease of relative measures have been observed in the literature for concentration or specialization indices of individual industries or regions, respectively (see Section II). Increasing absolute measures have usually been inter-preted as an indication of increasing structural imbalances between regions or industries, which may call for more effective cohesion policies. At the same time, decreasing relative measures have been interpreted as an indication of decreasing structural imbalances, which

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[28] For the discussion of the structural break in Section IV.4 we note from Figure 1 that the decrease of relative localization came almost to a halt in the early 1990s. Even though it is not too obvious from Figure 1, Figure 2 below shows that there were, by contrast, no trend breaks in the aggregate structural changes across industries or regions in the EU-15 (as measured by the evolution of the absolute concentration and absolute specialization of EU-15 employment).

render additional regional or cohesion policy measures unnecessary. Our decomposition of the absolute measure into internal and aggregate structural changes clarifies that increases in the absolute specialization of regions (or concentration of industries) should not be misinterpreted as a decreasing structural cohesion as these increases contain—and may possibly be dominated—by changes that are common to all regions or industries. Such common or aggregate structural changes may put workers and firms under great adjustment pressure. Nonetheless, it is not the aggregate but the internal structural change, and in particular an increase in the relative specialization of regions, that should be of concern from a cohesion policy perspective. Figure 1 shows, however, that the relative localization of employment has actually decreased in the EU-15 after 1980, which is an indication of increasing structural cohesion in Europe.

The decreasing relative localization of EU-15 employment indicates that regional and industrial employment patterns in Europe converged towards each other. With reference to the two sides of localization, concentration and specialization, we can interpret the decreasing relative localization as both a convergence of the industries' concentration patterns—the industries' distributions of employment across regions have on average become more similar to the regional distribution of aggregate EU-15 employment—and a convergence of the regions' specialization patterns—the regions' distributions of employment across industries have on average become closer to the industrial distribution of aggregate EU-15 employment. Even though there are, of course, exceptions from this pattern that are hidden behind these aggregate figures, this overall tendency towards structural convergence is pretty much in line with what EU cohesion policy is, or should be, aiming at. From this, we obtain our first stylized fact:

> ***Stylized Fact 1: Structural convergence within the EU-15.***
>
> Structural cohesion across industries and regions increased in the EU-15 between 1980 and 2003. Both the concentration patterns of industries and the specialization patterns of regions converged towards the respective concentration or specialization patterns of aggregate EU-15 employment.

We also observe from Figure 1 that there was, on top of the *internal* structural change, a considerable amount of *aggregate* structural change. This aggregate structural change is reflected by the two upper parts of the bars in Figure 1. Equaling zero in 1980 by definition, it accounts for more than 50% of the value of our absolute localization measure in the 2000s. Aggregate structural change occurred mainly in the form of employment shifts between industries while there was hardly any change in the distribution of EU-15 employment across regions since 1980: The absolute specialization of the EU-15 across industries ($T_{\bullet\bullet t}^{1980}(i)$ in equation (8), and top part of the bars), that reflects the aggregate structural change between industries, accounts for the lion's share of the overall structural change. Its value increased from zero in 1980 to

0.09 in 2003 (see column 2 in Table A3), which is higher than the value of relative Theil index of localization (0.07), our indicator of the internal structural imbalances.

Decomposing this absolute specialization measure further by sectors (Figure 2a), we observe that about two thirds of the aggregate structural change between industries results from structural change between sectors (lower part of bars in Figure 2a). The EU-15 has in fact experienced a profound reallocation of employment across sectors since 1980. The employment share of agriculture more than halved from 8.5% in 1980 to 3.8% in 2003, that of manufacturing dropped by almost one third (36% to 25%), and that of services increased by almost 30% (55% to 71%). By contrast, only about one third of aggregate structural change between industries results from shifts of employment between industries within sectors (upper part of bars in Figure 2a).[29]

Compared to the aggregate structural change across industries, the aggregate structural change across regions—represented by the absolute Theil index of concentration of total EU-15 employment across regions, $T_{\bullet\bullet t}^{1980}(r)$ —was only marginal (Figure 2b, see also middle part of the bars in Figure 1). Even though there were some remarkable changes in the relative sizes of some of the smaller countries in the EU-15 between 1980 and 2003,[30] the change in the distribution of employment across countries was overall quite small (lower part of the bars in Figure 2b). The change in the distributions of employment across regions within countries

Figure 2: Aggregate structural change in the EU-15 within and across sectors, and within and across countries, 1980-2003
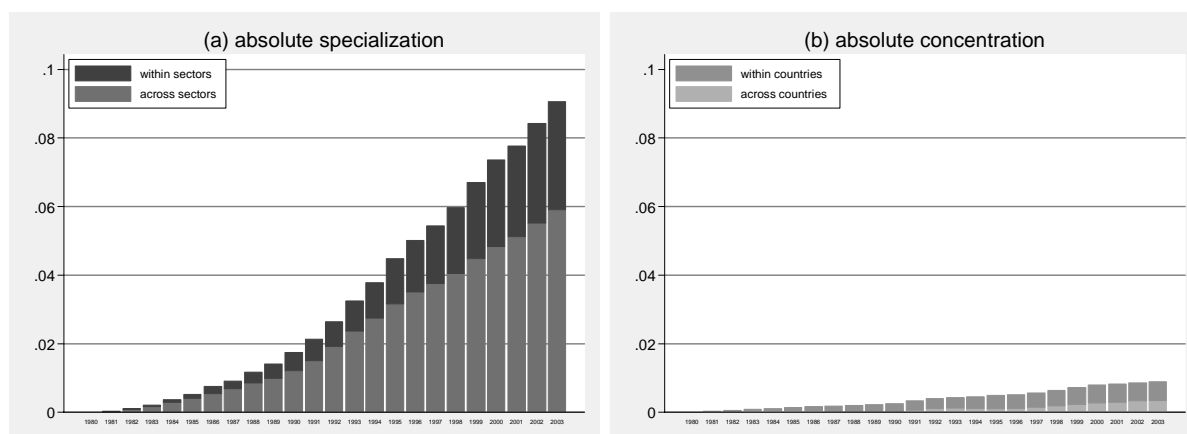
Notes: Absolute Theil indices and decompositions as described in footnotes 24 and 25.
Sources: Cambridge Econometrics; own calculations.

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[29] Additional calculations, not presented here in detail, show that these aggregate intrasectoral changes took place mainly within the service sector.

[30] For example, the share of Luxemburg in total EU-15 employment increased by more than 58%, and those of Ireland, the Netherlands and Spain by 37%, 21%, and 17%, respectively. And the shares Finland and Sweden decreased by 15% and 11%, respectively.

was numerically somewhat larger (see the upper part of the bars in Figure 2b) but still tiny compared to the changes in the allocation of employment across sectors.[31] Summarizing the observations about aggregate structural change we get

> ***Stylized Fact 2: Rapid aggregate structural change between industries, very little aggregate structural change between regions.***
>
> The aggregate structural change, which overlaid the internal structural convergence in the EU-15, was mainly industrial, not regional. The aggregate specialization pattern of the EU-15 changed considerably since 1980, which was mainly due to shifts of employment from agriculture and manufacturing to services. In contrast, there was very little change in the distribution of EU-15 employment across regions or countries.

Taken together, Stylized Facts 1 and 2 clarify why studies that have used absolute measures, such as Aiginger and Davies (2004), have frequently found specialization to increase but concentration to decrease. This is irrespective of whether the reference for the absolute measure is the uniform distribution, as in Aiginger and Davies (2004), or the distribution of the initial year, as in the present paper. These absolute measures capture, in addition to the internal structural change, aggregate structural changes that are usually much larger in the industrial than in the spatial dimension.[32] Aiginger and Davies' measure of "typical specialization", for example, corresponds to the sum of our measures of internal structural cohesion and of aggregate structural change across industries. This sum increased over time only because of the rapid industrial structural change from mature to modern industries. And, Aiginger and Davies' measure of "typical concentration" corresponds to the sum of our measures of internal structural cohesion and of aggregate structural change across regions. As there was virtually no structural change across regions, this sum was dominated by the internal structural convergence.

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[31] For numerical values see Table A3 columns (5)-(7).

[32] Aggregate structural changes are larger in the industrial dimension because employment is typically more mobile across industries than across regions. This is especially true for Europe where migration of workers across countries is inhibited by significant language and cultural barriers, and where people arguably feel the social costs of migration to be fairly high even within countries. In addition, the structural change in the industrial dimension will, in practice, almost always lead to an increase of absolute specialization (in particular for absolute measures with references and weights based on the uniform distribution), while structural change in the regional dimension may well lead to a decrease of absolute concentration if references and weights are based on the uniform distribution. The very strong tendency of absolute specialization to increase relative to the uniform distribution is due to a statistical artifact resulting from the characteristics of prevailing industry classifications, which, for mainly historical reasons, tend to be finer for the relatively small and still shrinking manufacturing sectors than for the large and growing service industries (for more on this argument see Bickenbach et al. 2010).

2. Sectors and industries

In this subsection we will address two main questions. Which of the three sectors and which industries within these sectors contributed to the internal structural convergence within the EU-15, evidenced by the decrease of the relative localization (Stylized fact 1)? And was this structural convergence driven by structural convergence within countries or between countries? To answer these questions, we use our decompositions in equations (5) and (6), which yield measures of the (weighed) *average* over all industries of the industries' concentrations within countries and across countries (see equation 5) as well as their sector-specific counterparts, the (weighed) *averages* over the industries in a specific sector of the industries' concentrations within countries and across countries (see equation 6).[33] Figure 3 depicts all these measures of average concentrations within and between countries. Panel 3(a) depicts the average across all industries, which sums up to our measure of internal structural cohesion in the EU-15 (see bottom parts of Figure 1), and panels 3(b) – (d) the corresponding sector-specific averages for agriculture, manufacturing and services. Complementing Figure 3, Figure 4 depicts the relative concentrations of the individual industries—also decomposed by countries—over which the measures in Figure 3 are averaged (see equations 5 and 6).

To answer the first question, which focuses on the contributions of the sectors and industries to the internal structural convergence, we focus on the total bars in Figures 3 and 4, ignoring the decompositions by countries. From Figure 3, we observe, first, that agriculture is the most and services the least localized sector.[34] Given the large differences in the levels of localization of the three sectors the aggregate structural change from agriculture and manufacturing to services accounts for the lion's share of the observed internal structural convergence in the EU-15. More than 75% of the observed decline of EU-15 localization is due employment shifting from the highly concentrated agricultural and manufacturing sector industries to the highly dispersed service sector industries. Or, in other words, even if the localizations (average industry concentrations) of each of the three sectors had remained constant over time, our indicator of internal structural convergence had decreased by more than 75% of its actual decrease. We consider this worth a separate stylized fact.

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[33] Remember from equations 5 and 6 that the sum of these weighted averages of industries' concentrations within countries and across countries correspond to the relative localization of the EU as a whole and of the individual sectors, respectively.

[34] As agriculture comprises only one industry, the localization of the sector across regions and industries is equivalent its concentration across regions. The comparatively high concentration of agriculture is, of course, due to our choice of total regional employment (rather than, e.g., the geographic size of the region) as the regional reference. Agriculture is typically clustered in rural areas where manufacturing and service industries and thus overall employment are relatively sparse.

Figure 3: Relative localizations and average concentrations of industries within and across countries in the EU-15, total and by sectors, 1980-2003
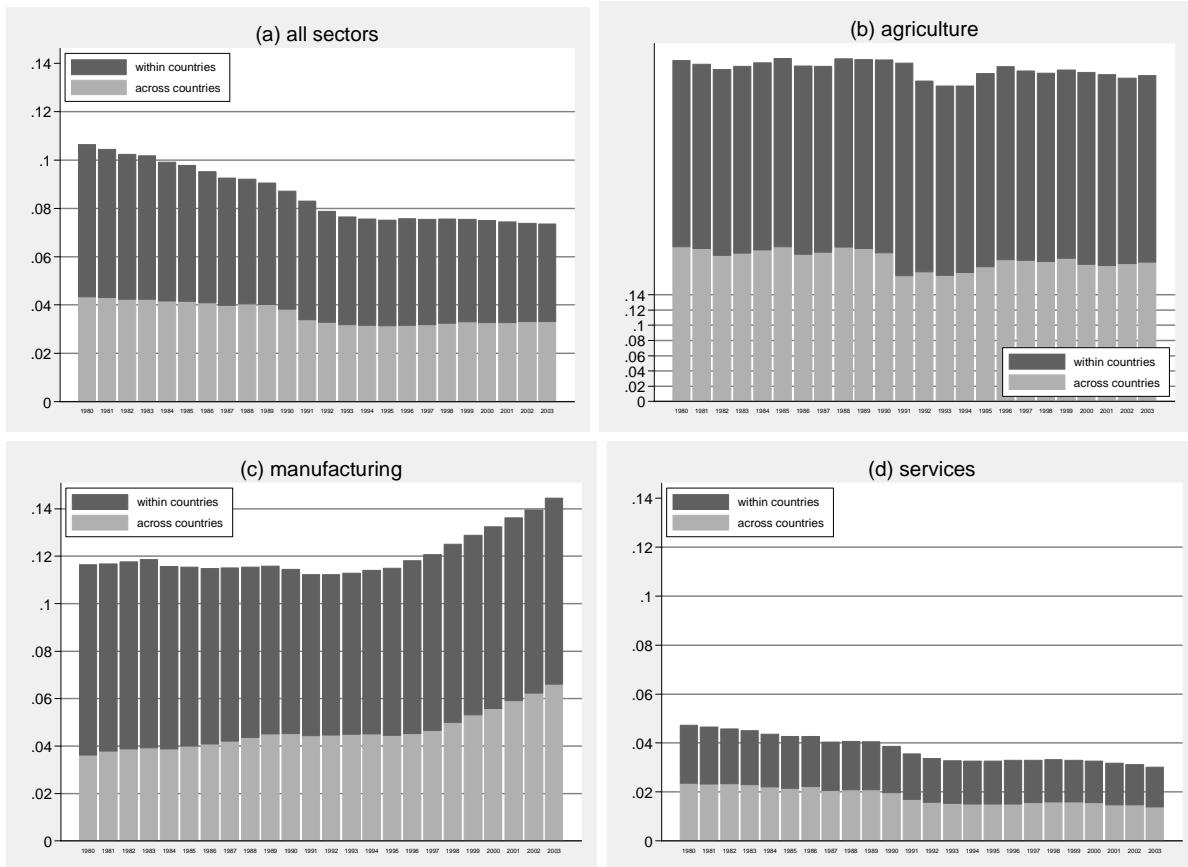
Notes: Relative Theil indices of localization and decompositions as described in equations (5) and (6).
Source: Cambridge Econometrics; own calculations.

Figure 4: Concentrations of the individual industries within and across countries, 1980-2003
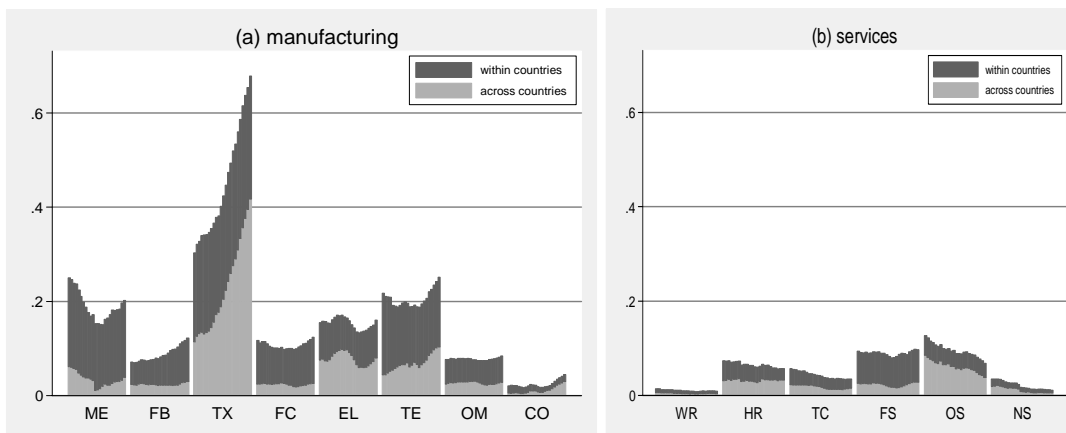
Notes: Relative Theil indices of concentration and decompositions as described in text above equation (6). See Table A1 in the Appendix for the industry labels.
Sources: Cambridge Econometrics; own calculations.

Stylized Fact 3: Structural convergence in the EU-15 driven mainly by tertiarization.

The internal structural convergence within the EU-15 has been driven mainly (to more than 75%) by sectoral structural change. The fairly dispersed service sector grew disproportionately at the expense of the highly concentrated manufacturing and agricultural sectors.

And second, we observe from Figure 3 that the localization of the manufacturing sector increased considerably (+24%) whereas the localization of the service sector decreased considerably (–36%).[35] The European-wide shrinking of the manufacturing sector thus went along with a substantial increase of the average regional concentration of its industries while the European-wide expansion of the service sector went along with a substantial decrease of the average regional concentration of its industries.[36]

Stylized Fact 4: Services contributed to, manufacturing worked against structural convergence within the EU-15.

The service sector contributed to structural convergence within the EU-15 by a further regional dispersion of its industries' employment, while the manufacturing sector worked against this convergence by a further regional concentration of its industries' employment.

Various studies have documented the increase of the concentration of manufacturing industries for the EU as a whole (see Section II).[37] The present study reveals, however, that this increase of the concentration of manufacturing tells only a small part of the whole story and is, even more importantly, not representative of the evolution of concentration in the European economy as a whole. Rather than by changes within the manufacturing sector, this evolution is dominated by sectoral changes away from (agriculture and) manufacturing towards the service sector and declining concentrations of service industries. Both worked towards the internal structural convergence in the EU-15.

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[35] The localization (concentration) of agriculture did not change much during the period under study.

[36] For the discussion in Section IV.4 we note from Figure 3 that there was a trend break in the early 1990s in the evolution of the average concentrations of both, the manufacturing and the service industries. At that time the average concentration of industries started increasing in manufacturing and stopped declining in the service sector.

[37] The results of most studies that have focused on the concentration of manufacturing industries only are not directly comparable to those of the present study because they have usually drawn their regional references from manufacturing totals rather than from total across all sectors. Additional calculations, not presented here, show that the average concentration of manufacturing industries also increase if we draw the regional reference from aggregate manufacturing employment.. Localization and concentration measures with sector references can be derived from our measures with references based on aggregate employment by applying the decomposition technique proposed in Bickenbach et al. (2010).

The differences between the manufacturing and the services sector obvious from Figure 3 are, more or less, mirrored by similar differences between their respective industries (Figure 4). On the one hand, manufacturing industries are generally substantially more concentrated than service industries—exceptions among the manufacturing industries are construction (CO) and food, beverages and tobacco (FB), whose products are subject to fairly high transport costs. And on the other hand, the concentrations of most manufacturing industries increased over time, whereas those of almost all service industries decreased. A notable exception from this general rule is financial services (FS), whose concentration increased after the early 1990s. A particularly strong increase of concentration can be observed for textiles and clothing (TX), which lost most of its employment in northern Europe during the period under study and concentrated in some southern European countries.[38]

We now turn to the second question, which is about the development of industry concentrations within countries as opposed to that of industry concentration between countries. This is directly related to the Krugman hypothesis, which holds that the progress of economic integration in Europe should have led to an *increase* in the concentrations of industries *across* countries but not necessarily of their concentrations *within* countries. In Figures 3 and 4, the increasing concentration across countries should show up as an increase of the lower parts of the bars, which depict the (average) concentrations of the industries across countries. Proceeding, as before, from general to specific, we observe that there is little support for the Krugman hypothesis from the average concentrations across all industries (Figure 3a). On average, industries became less rather than more concentrated across countries between 1980 and 2003. There is at best some weak support for the Krugman hypothesis insofar as the average concentrations between countries decreased less than those within countries (upper parts of the bars).[39]

At the sectoral level, there is support for the Krugman hypothesis from the manufacturing sector but not from the other sectors. The average concentration of manufacturing industries across countries (lower art of the bars in Figure 3c) increased considerably by more than 80% (from 0.036 in 1980 to 0.066 in 2003) while that of agriculture remained constant and that of

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[38] For the discussion of the structural break in Section IV.4 we note from Figure 4 that in the early 1990s there was a trend break in the development of industry concentrations that occurred almost simultaneously in almost all manufacturing industries as well as in several service industries. All manufacturing industries displayed increasing concentration after the early 1990s. In those manufacturing industries where concentration had declined or stagnated during the 1980s (e.g., mining and energy supply, ME, or construction CO), it started to grow in the early 1990s. And where it had grown already in the 1980s (e.g., food beverages and tobacco, FB, or textiles and clothing, TX), it grew even faster. In most of the service industries, by contrast, concentration continued to decline, if often slower than in the 1980s. An exception was financial services (FS) where concentration started to increase in the early 1990s.

[39] One may also consider it as supportive to the hypothesis that the decline of the average concentration across countries came to a halt in the early 1990s when the European integration process gained momentum. See Section IV.4 for more on this.

service industries decreased considerably.[40] Even though technological progress and the Single Market have arguably facilitated trade not only in manufacturing but also in many service industries during the past decades, the average concentration of service industries did, unlike that of manufacturing industries, not increase.[41]

At the industrial level (Figure 4), finally, we observe that actually only three of the eight manufacturing industries show a clear-cut increase of their concentrations across countries, textiles and clothing (TX, +270%), transport equipment (TE, +134%) and construction (CO, +577%). Textiles and clothing and in particular transport equipment may arguably be considered to be examples of the increasing returns, differentiated product industries that Krugman likely had in mind when formulating his hypothesis. It should be noted, however, that the employment shares of both these industries are strongly declining and that at least the textiles and clothing industry is not concentrating in the Northern European core countries but in the comparatively low wage countries of the Southern European periphery like Greece or Portugal. The increasing concentration across countries of the construction industry is to a good deal due to the housing booms on the Iberian peninsula and Ireland during the 1990s and 2000s[42] which has arguably little to do with decreasing trade cost. Among the service industries, only financial services (FS) exhibited a notable increase of concentration across countries—at least after the mid-1990s. Part of the explanation for this may be that financial services are, relative to other services, comparatively easy to trade internationally and that the sector is arguable characterized by comparatively strong agglomeration economies.[43] In summary, we thus note:

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[40] We obtain similar results for the concentration of the aggregate employment of the sectors (not documented here in detail). The concentration across countries of the manufacturing sector as a whole increased while that of the service sector decreased.

[41] For the discussion in Section IV.4 we note from Figure 3 that the trend break of the early 1990s manifests itself mainly in the average concentrations of manufacturing and service industries *across* countries. The average concentration of manufacturing industries across countries (lower part of the bars in Figure 3c) increased at an accelerated pace after the early 1990s, and that of service industries (lower part of bars in Figure 3d) which had fallen during the 1980s tended to stagnate after the early 1990s. Again, these trend breaks may be considered evidence in favor of the Krugman hypothesis (see footnote 39). There is also a trend break in the evolution of the average concentration of manufacturing industries within countries (upper part of the bars in Figure 3c) which decreased until the early 1990s and slightly increased thereafter. (This latter break is not too obvious from Figure 3).

[42] The location coefficient of construction increased from 1.13 to 1.62 in Spain, from 1.23 to 1.42 in Portugal, and from 1.01 to 1.56 in Ireland between 1980 and 2003.

[43] For the discussion in Section IV.4 we note from Figure 4 that there was a trend break in the evolution of the concentration *across* countries for a majority of manufacturing and service industries. Within manufacturing this trend break of the early-mid 1990s was particularly strong in mining and energy supply (ME), where concentration across countries started to increase, as well as in construction (CO) and in textiles and clothing (TX) where it started to increase at an accelerated rate in the early 1990s. Among the service industries, it was financial services (FS), transport and communication services (TC), non-market services (NS) and wholesale and retail trade (WR), where concentration across countries ceased decreasing or started increasing in the early 1990s. As to the concentration *within* countries the break can be observed *only* in the manufacturing sector. In the early (or mid) 1990s the concentrations within countries started to increase or to increase at an accelerated rate in almost all manufacturing industries (textiles and clothing (TX) being the exception).

Stylized Fact 5: The "Krugman hypothesis" holds only for manufacturing but not for services or the aggregate economy.

The Krugman hypothesis, according to which the concentration of industries across countries should increase as the European countries become economically more integrated, holds for the manufacturing sector but not for the service sector. For several manufacturing industries, most notably textiles and clothing, construction and transport equipment, there has been an increasing division of labor between European countries. Among the service industries, only financial services experienced a notable increase in the international division of labor between European countries.

3. Countries and regions

Turning to the other side of the coin of internal structural change, the evolution of *specializations* of countries and regions, we employ similar decompositions as those in equations (5) and (6) but switch the roles of industries (sectors) and regions (countries) (see footnote 21). These decompositions yield measures of the *average* (over all regions) of the regions' specializations within sectors and across sectors as well as their country-specific counterparts, the averages over the regions in a specific country of the regions' specializations within sectors and across sectors. Figure 5 depicts these average specializations of regions and their decompositions by sectors for the EU-15 as a whole as well as for each of the 15 countries.[44]

Figure 5: Relative localizations and average specializations of regions within and across sectors, EU-15 and individual countries, 1980–2003
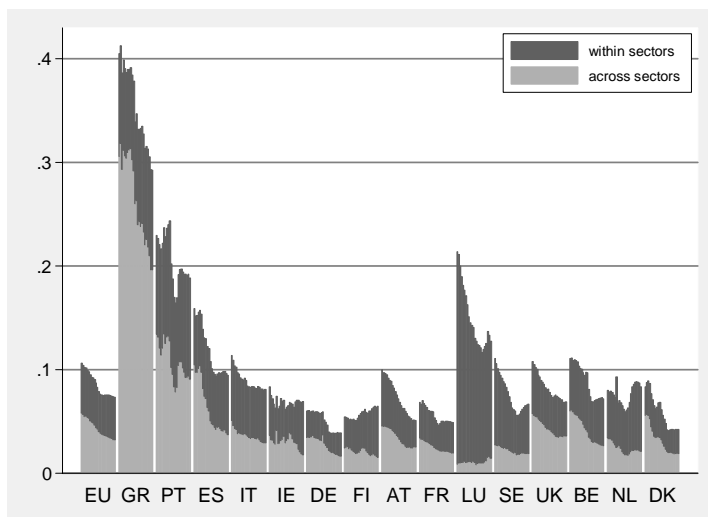
Notes: Relative Theil indices of localization and decompositions as described in footnote 21.
Sources: Cambridge Econometrics; own calculations.

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[44] Remember from Section 2 that the sum of these weighted averages of regions' specializations within countries and across countries correspond to the relative localization of the EU as a whole and of the individual countries, respectively.

Ignoring for a moment the decompositions by sectors, we observe from Figure 5, first, that, while the specialization levels differ considerably across countries, virtually all countries experienced a decreasing average specialization of their regions.[45] This decrease was particularly strong in the poorer South European countries, Greece, Spain and Portugal, whose regions were (on average) the most specialized in the 1980s.[46] The only countries whose regions did not, on average, experience a decrease of specialization were Finland and the Netherlands, where the average specialization or regions was actually higher in 2003 than in 1980.[47] Table 1, which depicts the numbers of regions with decreasing specialization across industries from 1980 to 2003 by countries, shows that specialization across industries decreased in more than three quarters (76.4%, 149 regions) of all 195 regions in our sample (column 1).[48] It decreased in the majority of regions in all countries except Finland (20%) and the Netherlands (36.4%).[49]

The decompositions of the average specialization measures in Figure 5 by sectors indicate whether the decreases of specialization were due mainly to intersectoral or intrasectoral changes. The lower parts of the bars reflect average regional specializations across the three sectors, and the upper parts average regional specializations across industries within the sectors. A decrease of the average specializations across (within) sectors indicates that the regions of the EU-15 or those of a specific country became, on average, more similar to the EU-15 aggregate in this respect. In addition, Table 1 depicts the numbers of regions with decreasing specialization across and within sectors (columns 2 and 3), and those of regions with decreasing specialization within the manufacturing and within the service sector (columns 4 and 5).

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[45] Additional calculation, not presented here, show that for a large majority of countries there has also been a convergence of the country's aggregate national industrial employment structures towards the EU aggregate structure. For all countries with the exception of Finland, Italy and the Netherlands there has been a decrease in the relative specialization of national aggregate employment across industries, $T_{\bullet ct}^{t}(i)$.

[46] Luxembourg, the richest of the EU countries, is also characterized by very high but strongly decreasing localization. Luxembourg is a special case in so far as it consists of only one, comparatively small, region. The localization of Luxembourg is consequently equal to its specialization.

[47] For the discussion of the structural break we note from Figure 5 that the structural convergence slowed down considerably or even came to a halt in most EU-15 countries in the 1990s. The average regional specialization across industries, which had decreased considerably in most countries during the 1980s stagnated or even increased after the early 1990s. Notable exceptions were Greece (GR), Austria (AT) and the UK.

[48] The results on the shares of regions with decreasing specialization depicted in Table 1 change only marginally, if we weight the regions by their employment sizes.

[49] Additional calculations (not presented here) show that the average specialization patterns of regions converged not only towards the EU-average specialization patterns but also towards the respective national specialization patterns in almost all countries. Notable exceptions are the Netherlands and Sweden where regional specialization patterns diverged on average from the respective national specialization patterns. In Portugal there was almost no difference between 1980 and 2003. The convergence of regional specialization towards the respective national specialization patterns corroborates the findings of various country studies that use national rather than EU industry structures as references.

Table 1: Numbers of regions with decreasing specialization across industries, by countries,
1980 – 2003

Country	Total no of regions	Numbers of regions with decreasing specialization (in % of all regions)				
		across industries	across sectors	within sectors	within manufacturing	within services
		(1)	(2)	(3)	(4)	(5)
Denmark	3	100.0	100.0	66.7	33.3	66.7
Ireland	2	100.0	100.0	0.0	0.0	100.0
Austria	9	100.0	88.9	88.9	77.8	88.9
Sweden	8	100.0	75.0	100.0	50.0	87.5
Luxembourg	1	100.0	0.0	100.0	100.0	0.0
United Kingdom	37	94.6	81.1	89.2	64.9	73.0
Belgium	11	90.9	90.9	63.6	63.6	54.5
Italy	20	85.0	70.0	80.0	40.0	85.0
Spain	18	77.8	83.3	38.9	55.6	33.3
Greece	13	69.2	76.9	53.8	38.5	61.5
France	22	68.2	86.4	45.5	36.4	31.8
Germany	30	60.0	90.0	40.0	3.3	90.0
Portugal	5	60.0	80.0	80.0	60.0	100.0
The Netherlands	11	36.4	72.7	27.3	36.4	18.2
Finland	5	20.0	100.0	0.0	20.0	0.0
EU-15	195	76.4	82.6	60.5	43.1	63.6

Sources: Cambridge Econometrics; own calculations.

These decompositions by sectors show that the decreases of the average specializations of the EU-15 and most of its member countries were mainly due to intersectoral changes.[50] For the EU-15 as a whole, the specialization *across* sectors (lower part of the first bar in Figure 5) decreased by 45%, from 0.058 in 1980 to 0.032 in 2003.[51] It decreased in virtually all countries (lower parts of the country-specific bars), and in more than four fifth (82.6%) of all regions (Table 1, column 2). By contrast, the average specializations of regions *within* sectors decreased only slightly from 0.048 to 0.042 for the EU-15 on aggregate (upper part of the first bar in Figure 5), and show a rather mixed picture for the individual countries and regions (upper part of the country-specific bars in Figure 5, columns 3 – 5 in Table 1). These specializations decreased over the whole period in Italy, Austria, and the UK, increased throughout in

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[50] The internal structural convergence in the EU-15 highlighted in Stylized Fact 1 is thus mainly due to the fact that the majority of regions became, on average, more similar to each other in terms of their sectoral compositions.

[51] Recall from Section IV.1 that for the EU as a whole there was considerable sectoral change from agriculture and manufacturing to services during the period under study (see the lower parts of the bars in Figure 2b). The result from Figure 5 just mentioned implies that this aggregate structural change between sectors was accompanied by an average convergence of the sectoral specialization patterns of the 195 regions.

Finland, and show a U-shaped pattern in Greece, Ireland, the Netherlands, and Sweden. Over-all, about 60% of the EU-15 regions converged to the EU-15 average in terms of their specializations within sectors (Table 1, column 3). Only a minority of 43.1% of the regions became less specialized within the manufacturing sector (column 4)[52], while 63.6% of the regions became less specialized within the service sector (column 5). Here again, we recognize the opposing sectoral trends within the service and the manufacturing sector that we have already observed for the average concentration of industries in Section IV.2. In Stylized Fact 4 we noted that the average concentration of industries decreased in the service but increased in the manufacturing sector. This increasing concentration of manufacturing industries coincides with a larger number of regions displaying an increasing specialization within the manufacturing sector.[53, 54]

From the results displayed in Figure 5 and Table 1 we did not find any clear-cut geographical (e.g., Northern versus Southern European countries) or economic (e.g., rich versus poor countries) pattern in the distribution of those regions that have not followed the general trend towards decreasing relative specialization. Still, two types of regions could be suspected to be likely to exhibit increasing specialization: the most peripheral and often most backward regions of the poorer Southern EU-15 countries on the one hand and capital regions and large agglomerations in the EU-15 on the other hand. Additional examinations show that these conjectures are not supported by the data.[55] Most of the supposedly most backward regions from Greece, Portugal, Spain and Southern Italy displayed very high deviations from average EU-15 employment structures in the early 1980s. For most of these regions, however, the relative specialization decreased, and often very substantially so, between 1980 and 2003. Most of these regions thus converged towards the EU-15 average in terms of their industrial employment patterns. There were a few exceptions to this however, particularly for some of the Greek and Spanish "island regions".[56] Mainly due to their strong focus on tourism, their specialization patterns differed considerably from those of mainland regions, and they showed

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[52] For only 7 out of the 15 countries, specialization within the manufacturing sector decreased in a majority of the country's regions. There seem to be no simple, e.g., geographical pattern of countries having a large or a low share of regions with a decreasing specialization within the manufacturing (or the service) sector.

[53] The specialization within the manufacturing sector increased even in many of those 149 regions (76.4%, see column 1 of Table 1) that experienced a decrease of their overall specialization across all industries. In about one third of the 149 regions, the specialization within manufacturing increased by more than 10% between 1980 and 2003. The detailed figures, which are not reported here, are available from the authors upon request.

[54] For the discussion of the structural break in Section IV.4 we note from Figure 5 that the slowdown of convergence observed for most of the countries in the early 1990s manifests itself mainly in an increase of the average specialization of regions within sectors (upper part of the bars), which decreased until the early 1990s and increased thereafter. It can be shown that this originated mainly from within manufacturing.

[55] To save space, we refrain from presenting the numerical evidence that underpins the following statements. These figures are available from the authors upon request.

[56] Examples are *North Aegean* and *South Aegean* as well as *Crete* in Greece, and *the Canarias* and *the Baleares* in Spain. Much of the following is also true for island regions of other countries such as *Corse* (France) and *Åland* (Finland).

little or no convergence towards the EU-average specialization patterns. Yet, as the persistence of the very high specialization levels of these regions seems to be a consequence of their specific comparative advantages in tourism, it should not be considered a problem of cohesion policy.

Capital regions and large agglomerations are often more specialized in services than other regions of their countries. As a consequence, the specialization patterns of such regions tend to be more similar to the EU-average specialization pattern in the case of "structurally lagging" countries of the South, but more dissimilar to the EU average in the case of "structurally leading" countries of the North.[57] The industry structures of almost all these agglomerations from both the North and the South tended to converge to the EU-average structures. An exception is London whose specialization remained fairly constant between 1980 and 2003. In summary, we have:

> ***Stylized Fact 6: Most countries and regions participated in the structural convergence within the EU-15.***
>
> Most countries and regions in the EU-15 participated in the internal structural convergence between 1980 and 2003. They became more similar to each other in terms of their industrial specializations. This convergence in industry structures was driven more by convergence among the countries' and regions' specialization patterns across sectors than by those across industries within these sectors. In many regions, decreasing specialization between sectors and within the service sector coincided with increasing specialization within the manufacturing sector. There is no indication of a systematic divergence in industry structures of Southern or Northern European regions, or of peripheral or agglomerated regions.

While there has been broad structural convergence between regions and countries, the differences between "leading" and "lagging" countries in terms of their sectoral employment structures are still quite large. We analyze these differences by examining the evolution of countries' specialization *across sectors*[58] from four different perspectives, i.e., for four different references: (i) the relative reference used in most of this paper, (ii) the time-invariant reference from 1980 employed in our absolute measures, (iii) a time-invariant reference from 1990, and (iv) a time-invariant reference from the last year under study, 2003. The three latter references represent three snapshots of the sectoral compositions of the EU as a whole, characterized by progressive tertiarization. We select three "representative" countries, Greece,

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[57] Helsinki, which is less specialized than other Finish regions, is an exception. The terms "structurally lagging" and "structurally leading", which essentially refer to the relative size of the service sector, will be discussed below in more detail.

[58] We use the sectoral specializations of aggregate national employment here rather than the (weighted) averages of the sectoral specializations of the countries' regions used above. Due to the variation in sectoral structures across regions within countries the former is always smaller than the latter—except for Luxembourg, which has only one region.

Spain and the UK. Greece represents a structurally lagging country in the EU-15. It had the lowest share of services in total employment during the period under study. The UK represents a structurally leading country with a service sector share that was among the highest of all EU-15 countries. And Spain represents an intermediate country with a service sector share between those of Greece and the UK. Figure 6 depicts the evolutions of sectoral specialization in these three countries for each of the four references.

Using the relative, contemporaneous reference (Figure 6a), we observe a pattern of structural convergence that corresponds to the one described above. The relative specializations decreased in all three countries between 1980 and 2003. Using the absolute reference from 1980 (Figure 6b), which is characterized by a still comparatively low size of services in the EU as a whole, we observe that Greece converged towards this 1980 reference while the UK diverged from it during the whole period under study. Spain passed by this 1980 reference by around 1990. Its sectoral composition became more similar to the 1980-sectoral composition

Figure 6: Relative and absolute specializations across sectors of aggregate country employment for three selected countries, 1980 – 2003
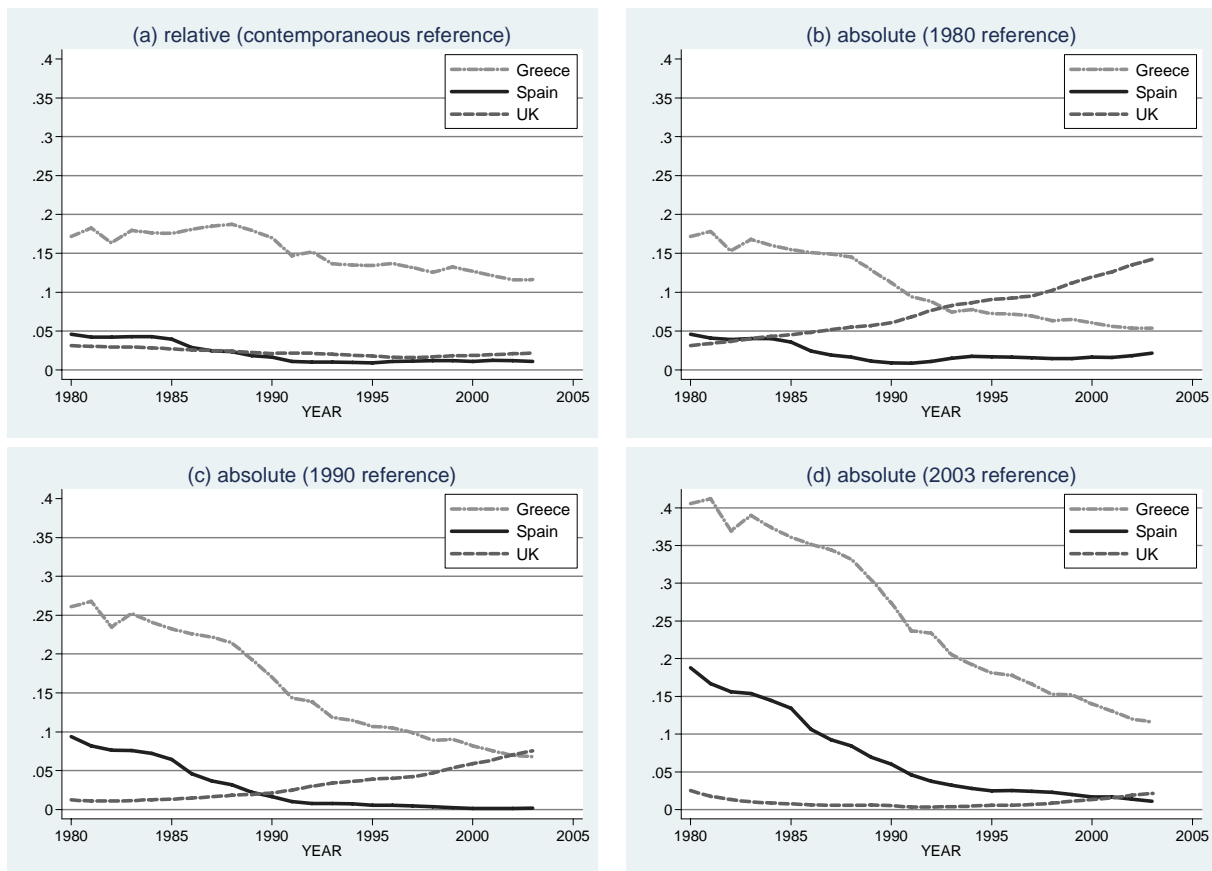
Notes: Theil indices of specialization of aggregate employment across sectors with relative references and weights $T_{\bullet ct}^{t}(s)$ (Figure 6a), absolute references and weights $T_{\bullet c1980}^{t}(s)$ (Figure 6b), and with corresponding time-fixed references taken from distribution of employment in 1990 (Figure 6c) and 2003 (Figure 6d).
Sources: Cambridge Econometrics; own calculations.

of the EU-15 until the late 1980s and then started becoming more dissimilar. If we switch from the 1980 to the 1990 benchmark (Figure 6c), which is characterized by a somewhat higher share of services, we observe that the UK passed by this benchmark already in the early 1980s while Spain came closest to it in the 2000s. Greece was still further away from this 1990 reference than from the 1980 reference, as indicated by the higher value of the specialization measure, and converged to it during the whole period. And if we switch to the 2003 benchmark (Figure 6d), which is characterized by a still higher share of services, we observe that the UK passed by this benchmark in the early 1990s while Spain is still converging towards it. Greece is still further away and converging. These regularities suggest that the sectoral composition of a country can be evaluated by means of its "closeness" to a time-invariant EU reference. Greece can be said to lag structurally far behind the EU on aggregate because it has not even passed the 1980 benchmark, while the UK is far ahead the EU on aggregate because it has passed the 2003 benchmark already around a decade before.

Under the assumption that the speed of sectoral structural changes is constant over time in the EU-15 on aggregate and in the individual countries, we could infer from this exercise that the UK has been about ten years ahead of the EU-15 on aggregate in terms of the sectoral composition of its economy while Spain has been about 10 and Greece more than 20 years behind. A similar exercise for the other EU-15 countries indicates that the Netherlands, Luxembourg and Sweden have, like the UK, been about ten years ahead of the EU-15 by the end of the period under study, and Denmark and Belgium about five years. France has been evolving along with the EU-15 aggregate. Finally, Austria, Germany and Italy have been three to five years behind, Finland and Ireland eight to ten years, and Portugal about 20 years. These figures are rather tentative, of course. They indicate, however, that significant structural differences have remained in the EU-15 in spite of the structural convergence since the early 1980. Countries like Greece or Portugal would still need several decades to catch up to the EU-15 average in terms of their sectoral compositions even if their sectoral compositions continued to converge towards the EU-15 average at the same average speed as during the period under study. We summarize this in

> **Stylized Fact 7: Large differences in sectoral structures persist among the EU-15 countries in spite of sectoral convergence.**
>
> In spite of widespread sectoral convergence after 1980, large differences persist among the EU-15 countries in terms of their sectoral compositions. Structural "laggards" like Greece and Portugal are still about 20 or more years behind the EU-15 average while structural "leaders" like the Netherlands, Luxembourg, Sweden and the UK are about ten years ahead of the EU average.

4. Structural break in the early 1990s

The figures in Sections IV.1 − IV.3 clearly reveal that there has been a trend break in the evolution of the localization of economic activity in the EU-15 in the early or early-mid 1990. We have already described various aspects of that structural break in a series of notes. We can summarize these notes as follows:

(i) In the early 1990s, the internal structural convergence of employment patterns across region and industries came almost to a halt in the EU-15 as a whole. There were no corresponding trend breaks in the evolutions of aggregate structural changes across industries or across regions in the EU-15.

(ii) The trend break in the internal structural convergence of the EU-15 is reflected in most of the EU-15 countries and can also be observed for the specialization of a majority of the 195 EU-15 regions, though there is, generally, substantial heterogeneity among the regions. The average specialization of regions across industries had decreased considerably in most countries during the 1980s but stagnated or even increased after the early 1990s. This trend break manifests itself mainly in an increase of the average specialization of regions *within* sectors—particularly within the manufacturing sector, where specialization tended to decrease during the 1980s but started to increase again in the early 1990s.

(iii) In the sectoral dimension, the break in internal structural convergence manifests itself in the average concentrations of both manufacturing and service industries. After the early 1990s, the average concentration of industries started to increase in the manufacturing sector and stopped declining in the service sector. The trend break for industry concentrations occurred almost simultaneously in almost all manufacturing industries, as well as in several service industries. In those manufacturing industries where concentration declined or stagnated during the 1980s (such as in mining and energy supply and in construction), concentration started to grow in the early 1990s. In those manufacturing industries where concentration was growing already in the 1980s (such as in food, beverages and tobacco, and in textiles and clothing), there was an acceleration of that process. As a consequence, all manufacturing industries displayed increasing concentration after the early 1990s. In most of the service industries, by contrast, concentration continued to decline, if often slower than in the 1980s. An exception was the financial services industry where concentration started to increase in the mid-1990s.

(iv) The break in the evolution of industry concentrations manifests itself mainly in the average concentrations of manufacturing and service industries *across* countries: The average concentration of manufacturing industries across countries increased at an accelerated pace after the early-mid 1990s, and that of service industries, which has fallen during the 1980s stagnated after the early-1990s. Within manufacturing this trend break was par-

ticularly strong in mining and energy supply, in construction, and in textiles and clothing. Among the service industries, concentration across countries ceased decreasing or started increasing in financial services, in transport and communication services, in non-market services and in wholesale and retail trade. As to the concentration of industries *within* countries the break is generally less pronounced and can be observed only in the manufacturing sector: in almost all manufacturing industries (textiles and clothing being the exception) the concentration within countries started increasing or increasing at an accelerated rate in the early or mid-1990s.

The exploratory nature of this paper is certainly not suited for *explaining* the evolution of localization in Europe in general or the observed trend break in localization in the early 1990s more specifically. Still, some of the characteristics of this break may be interpreted as being supportive of the Krugman hypothesis. First, the break occurred at a time when the European integration process re-gained momentum, as exemplified by the completion of the single market and the Maastricht Treaty. Second, the slowdown of structural convergence in the EU-15 can be attributed to a large extend to an increase in the average concentrations of industries *across* countries, and only to a minor extend to an increase of concentration within countries. And third, the industries with the most pronounced increase in concentration across countries were mainly manufacturing industries that produce tradable goods (and the financial services industry whose goods became more easily tradable between countries during the recent decades). This interpretation is consistent with models of the new economic geography that predict an increasing agglomeration of increasing returns, differentiated product industries as trade costs decrease.

Still, the characteristics of those manufacturing industries that displayed the strongest break raise some doubts about this interpretation. The goods produced by industries like mining and energy supply, construction, and textiles and clothing are not exactly among those industries new economic geographers have in mind when thinking of tradable, differentiated products that are subject to increasing returns to scale in production. This is either because these goods are, due to significant transport costs, still traded locally for the most part (energy supply, construction), or because the industries may rather be classified as constant-returns industries, as is arguably the case for the textiles and clothing industry. Even if the textiles and clothing industry were to be considered a "Krugman-type" industry, the fact that its employment share (in the EU-15) is strongly declining and that it is not concentrating in the Northern European core countries but in the comparatively low wage countries of the Southern European periphery makes it a dubious choice for supporting the Krugman hypothesis. We need to be cautious here, however, because our industry classification is quite coarse. There may be branches within these industries (or within other industries) that fit well into the group of increasing returns industries, experienced significant reductions of transport costs, and contributed notably to the break in the early 1990s. We therefore have to leave it to future research to provide

a more substantive appraisal of the Krugman hypothesis and, more generally, to assess the extent to which the increased momentum of EU integration of the 1990s—or alternative events such as the fall of the iron curtain and the integration of eastern European countries into the EU—have actually contributed to the break in structural convergence within Western Europe. We just establish:

> ***Stylized Fact 8: Trend break in structural convergence within the EU-15 in the early 1990s.***
>
> The speed of structural convergence slowed down considerably in the EU-15 as a whole as well as in most of its member states in the early 1990s. In virtually all manufacturing industries as well as the financial services industry concentration started to increase or to increase at an accelerated pace at that time. In general this break was more pronounced for the concentration across countries than for the concentration within countries. Within the manufacturing sector several countries and regions started to increasingly specialize on a subset of industries.

V. Conclusion

In this paper, we derive eight stylized facts on the evolution of the industrial and regional distribution of employment in the EU-15 since 1980. We show that important and new insights can be gained from linking systematically measures of concentration and measures of specialization to each other through measures of localization. We show, for example, that the manufacturing sector, which has been the focus on most existing studies, is not representative of the economy as a whole. Many studies that have focused solely on manufacturing industries, where better data are available, found concentration or specialization to have increased. We show that these findings do not carry over to the whole economy for two reasons. The first reason is sectoral structural change towards more dispersed industries. In the course of economic development, economic activity has been shifting to a significant extent from the highly concentrated agricultural and manufacturing sectors to the more dispersed service sector. The second reason is that the growing service sector became even more dispersed during the past decades. These two dispersion forces have overcompensated the concentration forces within manufacturing.

From a policy perspective, our results do not indicate a need for intensifying cohesion policies towards economically or structurally lagging countries or regions in Western Europe. We find that the majority of regions, including most of the structurally most backward regions of Southern Europe converged towards the EU-15 average in terms of their industry structures. Significant structural differences remain, though, between Northern and Southern Europe. Most notably, Greece has been estimated to be more than 20 years behind the EU-15 average

in terms of its transition towards a service economy. And there has been a significant slow-down of internal structural convergence in the early or mid 1990s.

There are at least three avenues for future research. First, our stylized facts on Western Europe should be complemented by stylized facts on the evolution of the industrial and regional distribution of employment between Eastern and Western Europe. Convergence in industry structures between Eastern and Western Europe may put a different, broader per-spective on the slowdown of structural convergence that we observe within Western Europe since the early 1990s. Second, additional insights can be expected from the analyses of more disaggregate industry data. There is certainly a whole lot of heterogeneity buried within the 15 industry aggregates analyzed in the present paper. More disaggregate data may generally help substantiate hypotheses about the forces driving structural cohesion by exploring the joint characteristics of those industries that show similar changes in location patterns over time. And they may in particular help substantiate hypotheses about the relative importance of integration within Western Europe and between Western and Eastern Europe for the break in cohesion trends in the early 1990s. There is still much to be done on the data front here since this data is not comparable across European countries yet. And third, studies that seek to *explain* the locational preferences and patterns of industries, such as Devereux et al. (2004) or Ellison et al. (2010), should not confine themselves to manufacturing industries only. Due to their higher—and further growing—structural relevance and their increasing tradability, ser-vice industries are more relevant from both an economic and a political perspective.

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Appendix

Table A1: Industries by Sectors

No	ID	*Sector*/Industry
	1	***Agriculture***
1	AG	Agriculture, Forestry & Fishing
	2	***Manufacturing***
2	ME	mining and energy supply
3	FB	food, beverages & tobacco
4	TX	textiles and clothing
5	FC	fuels, chemicals, rubber & plastic products
6	EL	electronics
7	TE	transport equipment
8	OM	other manufacturing
9	CO	construction
	3	***Services***
10	WR	wholesale and retail
11	HR	hotels and restaurants
12	TC	transport and communication
13	FS	financial services
14	OS	other market services
15	NS	non-market services

Source: Cambridge Econometrics.

Table A2: List of Regions by Country

ID	Country/Region	ID	Country/Region	IDo	Country/Region
AT	*Austria (9 regions)*	66	Com. Valenciana	131	Calabria
1	Burgenland	67	Baleares	132	Sicilia
2	Niederosterreich	68	Andalucia	133	Sardegna
3	Wien	69	Murcia	*LU*	*Luxembourg (1)*
4	Karnten	70	Ceuta y Melilla	134	Luxembourg
5	Steiermark	71	Canarias	*NL*	*The Netherlands (11)*
6	Oberosterreich	*FI*	*Finland (5)*	135	Groningen
7	Salzburg	72	Itä-Suomi	136	Friesland
8	Tirol	73	Etelä-Suomi	137	Drenthe
9	Vorarlberg	74	Länsi-Suomi	138	Overijssel
BE	*Belgium (11)*	75	Pohjois-Suomi	139	Gelder+Flevoland
10	Bruxelles-Brussel	76	Åland	140	Utrecht
11	Antwerpen	*FR*	*France (22)*	141	Noord-Holland
12	Limburg	77	Ile de France	142	Zuid-Holland
13	Oost-Vlaanderen	78	Champagne-Ard.	143	Zeeland
14	Vlaams Brabant	79	Picardie	144	Noord-Brabant
15	West-Vlaanderen	80	Haute-Normandie	145	Limburg
16	Brabant Wallon	81	Centre	*PT*	*Portugal (5)*
17	Hainaut	82	Basse-Normandie	146	Norte
18	Liege	83	Bourgogne	147	Centro
19	Luxembourg	84	Nord-Pas de Calais	148	Lisboa e V.do Tejo
20	Namur	85	Lorraine	149	Alentejo
DE	*Western Germany (30)*	86	Alsace	150	Algarve
21	Stuttgart	87	Franche-Comte	*SE*	*Sweden (8)*
22	Karlsruhe	88	Pays de la Loire	151	Stockholm
23	Freiburg	89	Bretagne	152	Ostra Mellansverige
24	Tubingen	90	Poitou-Charentes	153	Sydsverige
25	Oberbayern	91	Aquitaine	154	Norra Mellansverige
26	Niederbayern	92	Midi-Pyrenees	155	Mellersta Norrland
27	Oberpfalz	93	Limousin	156	Ovre Norrland
28	Oberfranken	94	Rhone-Alpes	157	Smaland med oarna
29	Mittelfranken	95	Auvergne	158	Vastsverige
30	Unterfranken	96	Languedoc-Rouss.	*UK*	*United Kingdom (37)*
31	Schwaben	97	Prov.-Alpes-Cote d'Azur	159	Tees Valley and Durham
32	Bremen	98	Corse	160	Northumb. et al.
33	Hamburg	*GR*	*Greece (13)*	161	Cumbria
34	Darmstadt	99	Anatoliki Makedonia	162	Cheshire
35	Giessen	100	Kentriki Makedonia	163	Greater Manchester
36	Kassel	101	Dytiki Makedonia	164	Lancashire
37	Braunschweig	102	Thessalia	165	Merseyside
38	Hannover	103	Ipeiros	166	East Riding
39	Luneburg	104	Ionia Nisia	167	North Yorkshire
40	Weser-Ems	105	Dytiki Ellada	168	South Yorkshire
41	Dusseldorf	106	Sterea Ellada	169	West Yorkshire
42	Koln	107	Peloponnisos	170	Derbyshire
43	Munster	108	Attiki	171	Leicestershire et al..
44	Detmold	109	Voreio Aigaio	172	Lincolnshire
45	Arnsberg	110	Notio Aigaio	173	Hereford et al.
46	Koblenz	111	Kriti	174	Shropshire & Staffordshire.
47	Trier	*IE*	*Ireland (2)*	175	West Midlands (county)
48	Rheinhessen-Pfalz	112	Border	176	East Anglia
49	Saarland	113	Southern and Eastern	177	Bedfordshire & Herfordsh.
50	Schleswig-Holstein	*IT*	*Italy (20)*	178	Essex
DK	*Denmark (3),*	114	Piemonte	179	Inner London
51	Hovedstadsreg.	115	Valle d'Aosta	180	Outer London
52	O. for Storebaelt	116	Liguria	181	Berkshire et al.
53	V. for Storebaelt	117	Lombardia	182	Surrey et al.
ES	*Spain (18)*	118	Bolzano-Bozen/Trento	183	Hampshire & Isle of Wight
54	Galicia	119	Veneto	184	Kent
55	Asturias	120	Fr.-Venezia Giulia	185	Gloucestershire et al.
56	Cantabria	121	Emilia-Romagna	186	Dorset and Somerset
57	Pais Vasco	122	Toscana	187	Cornwall & Isles of Scilly
58	Navarra	123	Umbria	188	Devon
59	Rioja	124	Marche	189	West Wales & The Valleys
60	Aragon	125	Lazio	190	East Wales
61	Madrid	126	Abruzzo	191	North Eastern Scotland
62	Castilla-Leon	127	Molise	192	Eastern Scotland
63	Castilla-la Mancha	128	Campania	193	South West Scotland
64	Extremadura	129	Puglia	194	Highlands and Islands
65	Cataluna	130	Basilicata	195	Northern Ireland

Source: Cambridge Econometrics.

Table A3: Localization, Specialization, and Concentration of EU-15 employment

	Absolute (1980 reference)							Relative (contemporaneous reference)				
	Localization	Specialization			Concentration			Localization	Average specialization		Average concentration	
Year	regions and industries	industries	industries w/in sectors	sectors	regions	regions w/in countries	countries	regions and industries	industries w/in sectors	sectors	regions w/in countries	countries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	=(2)+(5)+(8)	= (3)+(4)			= (6)+(7)			= (9)+(10) = (11)+(12)				
1980	.1063	0	0	0	0	0	0	.1063	.0484	.0579	.0629	.0434
1981	.1049	.0003	.0001	.0003	.0003	.0001	.0002	.1043	.0477	.0566	.0611	.0432
1982	.1038	.0011	.0002	.0008	.0005	.0003	.0003	.1022	.0475	.0547	.0599	.0423
1983	.1047	.0021	.0004	.0017	.0009	.0004	.0004	.1017	.0468	.0550	.0595	.0422
1984	.1039	.0037	.0008	.0029	.0011	.0007	.0004	.0991	.0451	.0540	.0575	.0415
1985	.1045	.0053	.0013	.0040	.0014	.0009	.0005	.0978	.0447	.0531	.0563	.0414
1986	.1045	.0076	.0022	.0054	.0017	.0012	.0005	.0952	.0446	.0506	.0544	.0407
1987	.1034	.0092	.0023	.0069	.0018	.0015	.0004	.0924	.0432	.0492	.0527	.0398
1988	.1057	.0117	.0031	.0086	.0020	.0016	.0003	.0920	.0433	.0487	.0517	.0403
1989	.1068	.0142	.0042	.0100	.0022	.0019	.0003	.0904	.0439	.0466	.0504	.0401
1990	.1071	.0174	.0054	.0120	.0026	.0022	.0003	.0870	.0430	.0440	.0489	.0382
1991	.1076	.0213	.0063	.0150	.0033	.0026	.0007	.0830	.0406	.0424	.0490	.0339
1992	.1091	.0264	.0073	.0191	.0040	.0028	.0012	.0787	.0389	.0398	.0458	.0329
1993	.1132	.0325	.0087	.0237	.0043	.0029	.0013	.0764	.0383	.0381	.0445	.0319
1994	.1178	.0378	.0104	.0274	.0045	.0033	.0012	.0756	.0383	.0373	.0439	.0316
1995	.1249	.0448	.0132	.0316	.0049	.0038	.0011	.0751	.0387	.0364	.0439	.0313
1996	.1309	.0501	.0151	.0350	.0051	.0040	.0012	.0757	.0394	.0362	.0441	.0316
1997	.1355	.0544	.0169	.0375	.0057	.0042	.0015	.0754	.0398	.0356	.0436	.0319
1998	.1417	.0597	.0192	.0405	.0064	.0045	.0019	.0756	.0406	.0350	.0432	.0324
1999	.1496	.0670	.0223	.0447	.0073	.0049	.0024	.0754	.0409	.0345	.0424	.0330
2000	.1564	.0735	.0252	.0484	.0079	.0052	.0028	.0749	.0415	.0334	.0422	.0328
2001	.1604	.0777	.0266	.0511	.0083	.0053	.0030	.0744	.0415	.0330	.0417	.0328
2002	.1666	.0842	.0290	.0553	.0086	.0054	.0032	.0737	.0416	.0321	.0405	.0333
2003	.1731	.0906	.0316	.0590	.0089	.0055	.0034	.0735	.0416	.0319	.0403	.0333

Notes: Absolute and relative Theil indices of localization, specialization, or concentration.

Sources: Cambridge Econometrics. – Own calculations.