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**Closing the Gap between  
Absolute and Relative Measures of  
Localization, Concentration or  
Specialization**

**by Frank Bickenbach,  
Eckhardt Bode,  
Christiane Krieger-Boden**

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## **Closing the Gap between Absolute and Relative Measures of Localization, Concentration or Specialization**

Frank Bickenbach, Eckhardt Bode, Christiane Krieger-Boden

**Abstract:** This paper solves one of the puzzles in the analysis of regional and industrial distributions of economic activity, the discrepancy between absolute and relative measures. It shows that the difference between an absolute and a relative Theil index of localization can be expressed in terms of absolute and relative concentration and specialization measures. This helps understand and explore why absolute and relative measures frequently evolve in opposite directions. The paper shows for the EU-15 and for UK manufacturing that this divergence originates mainly from the industrial dimension and is largely a statistical artifact inherited from the characteristics of industry classifications.

**Keywords:** Localization, Concentration, Specialization, Theil index

**JEL classification:** C43, R12

### **Frank Bickenbach**

Kiel Institute for the World Economy  
Hindenburgufer 66  
D-24105 Kiel, Germany  
Email: [frank.bickenbach@ifw-kiel.de](mailto:frank.bickenbach@ifw-kiel.de)

### **Eckhardt Bode** (Corresponding author)

Kiel Institute for the World Economy  
Hindenburgufer 66  
D-24105 Kiel, Germany  
Email: [eckhardt.bode@ifw-kiel.de](mailto:eckhardt.bode@ifw-kiel.de)

### **Christiane Krieger-Boden**

Kiel Institute for the World Economy  
Hindenburgufer 66  
D-24105 Kiel, Germany  
E-mail: [christiane.krieger-boden@ifw-kiel.de](mailto:christiane.krieger-boden@ifw-kiel.de)

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## 1. Introduction

Statistical measures of the regional *concentration* of an industry or of the industrial *specialization* of a region or country have been used frequently in the literature to explore the evolution of the spatial or industrial distributions of economic activity in the European Union (EU) or other parts of the world. They have been used, among others, to explore whether or not there is a tendency of innovative, dynamic industries to concentrate in some regions, leaving other regions with aging, torpid industries.<sup>1</sup> More recently, Bickenbach and Bode (2008) have shown that measures of concentration and specialization explore two sides of the same coin, and can be nested in measures of the *localization* of an economy, which capture both concentration and specialization simultaneously.

Most of the statistical measures of localization, concentration and specialization are borrowed directly or indirectly from the income inequality literature.<sup>2</sup> These measures quantify, in one way or another, the differences between the distribution of economic activity (employment, value added) across regions and/or industries observed from the data and a—possibly hypothetical—reference distribution, which is the distribution of economic activity considered to represent no localization, concentration or specialization. They map these differences into a scalar measure, the localization, concentration or specialization measure.

There has been confusion in this literature arising from the fact that the two types of references used most frequently, absolute and relative references, have frequently led to opposite results with respect to the evolutions of localization, concentration or specialization. For example, Krieger-Boden and Traistaru-Siedschlag (2008) have found that localization in the EU decreased for a relative reference but increased for an absolute reference. Even though measures with absolute and those with relative references differ fundamentally from each other in terms of what is considered to represent no localization, concentration or specialization,<sup>3</sup> the evaluation and explanation of why they change over time in opposite directions is not trivial. Most studies that have found absolute and relative measures to evolve in opposite directions have failed to explain their result intuitively.

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<sup>1</sup> This literature is reviewed in Combes and Overman (2004), Brakman et al. (2005), and Cutrini (2010).

<sup>2</sup> Examples of such inequality measures are the Theil index, the Gini coefficient, the coefficient of variation, and the relative mean deviation (Krugman index). In addition, dartboard measures (Ellison and Glaeser 1997, Ellison et al. 2010), and statistics related to on Ripley's K (Duranton and Overman 2005, Marcon and Puech 2010) have been used to measure concentration.

<sup>3</sup> For relative measures, the reference has usually been drawn from contemporaneous higher-level aggregates. The actual industry compositions of all regions in a specific year are compared to the composition of the economy at large (country or EU) in this same year, or, equivalently, the regional distributions of all industries are compared to the regional distribution of total economic activity. For absolute measures, the reference has generally been chosen to be the uniform distribution. In this case, the actual distribution is compared to a situation where all region-industries are of the same size.

The present paper solves this dichotomy between absolute and relative measures by showing, for the example of the Theil index, that the difference between an absolute and a relative localization measure can itself be expressed in terms of absolute and relative concentration and specialization measures.

Calculating the difference between an absolute and relative localization measure requires employing a specific, unconventional “decomposition” of the two measures into three components each. The first component, which we label a measure of “internal” localization, is the same for the two localization measures. This similarity constitutes the bridge between the two localization measures. The second component is an absolute or relative, respectively, concentration measure, which is the same as the between-regions component obtained by conventional decomposition of the localization measures by regions. And the third component is an absolute or relative specialization measure, which is the same as the between-industries component obtained by conventional decomposition of the localization measures by industries. In contrast to the second and third components, the first component, the measure of “internal” localization, can usually not be obtained by conventional decomposition. It is equal to the within component of a conventional decomposition in special cases, though.

The next section introduces the methodology of the specific decomposition that facilitates calculating the difference between absolute and relative measures, taking the Theil index, one of the measures used frequently in the literature, as an example. Extending this methodology to other decomposable measures, including the whole class of generalized entropy (GE) measures is left to future research.<sup>4</sup> Section 3 provides an illustration for the evolution of localization across 15 industries and 195 NUTS2 regions in the EU 15 from 1980 – 2003, and Section 4 concludes.

## 2. The link between absolute and relative measures

Consider an economy such as the EU that comprises a set  $\mathbf{I}$  of industries, indexed by  $i = 1, \dots, I$ , and a set  $\mathbf{R}$  of regions, indexed by  $r = 1, \dots, R$ . Let the variable of interest be employment in each region-industry,  $L_{ir}$ . The industries can be aggregated to a set  $\mathbf{S}$  of mutually exclusive sectors, indexed by  $s = 1, \dots, S$  (with  $I_s$  being the number of industries in  $s$ ), or to the aggregate economy, indexed by a dot ( $\bullet$ ). Likewise, the regions can be aggregated to a set  $\mathbf{C}$  of mutually exclusive countries, indexed by  $c = 1, \dots, C$  (with  $R_c$  being the number of regions in  $c$ ), or to the EU economy, indexed by a dot. For any point in time, indexed by  $t$ , we can quantify the degree of localization of employment across all industries and regions by

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<sup>4</sup> This methodology may also be used to compare pairs of measures with other references and weights to each other. For example, Bickenbach et al. (2010) use it to evaluate the differences between measures based on initial-year and measures based on contemporaneous references and weights.

the Theil index (T) of localization, which is generally defined as (see Bickenbach and Bode 2008)

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

$\Pi_{ir\theta}$  denotes the reference that can be thought of as reflecting the value of  $L_{irt}$  considered to represent “no localization”, and  $w_{ir\theta}$  the weight of region-industry  $ir$  in the localization measure.<sup>5</sup> The index  $\theta$  characterizes the reference, which we take to be either uniform for the absolute Theil index of localization ( $\theta=1$ ), in which case we set  $\Pi_{ir\theta} = \Pi_{ir1} = 1$ , or the product of contemporaneous industry and region totals for the relative Theil index of localization ( $\theta=t$ ), in which case we set  $\Pi_{ir\theta} = \Pi_{irt} = L_{i\bullet t} L_{\bullet r t} / L_{\bullet\bullet t}$ .<sup>6</sup>  $L_{i\bullet t} := \sum_r L_{irt}$  denotes total employment in industry  $i$ ,  $L_{\bullet r t} := \sum_i L_{irt}$  total employment in region  $r$ . and  $L_{\bullet\bullet t} := \sum_i \sum_r L_{irt}$  is total employment across all industries and regions. The methodology we propose requires the weights,  $w_{ir\theta}$ , to be proportional to the reference. We consequently set  $w_{ir\theta} = w_{ir1} = 1/IR$  for the absolute measure, or  $w_{ir\theta} = w_{irt} = L_{i\bullet t} L_{\bullet r t} / (L_{\bullet\bullet t})^2$  for the relative measure. Note that the  $w_{ir\theta}$  always sum up to one, and therefore  $T_{\bullet\bullet t}^\theta(ir) = 0$  if  $L_{irt}/\Pi_{ir\theta}$  is the same for all  $ir$ . T denotes the Theil index. Its suffixes  $(ir)$  define the units of analysis in the industrial and the spatial dimension, its subscripts the sets of these units (all industries and all regions) and its superscripts the reference and weights (1 for absolute measures,  $t$  for relative measures).

As references and weights are proportional to each other, (1) can be simplified to the absolute Theil index ( $\theta=1$ ) of localization

$$(2) \quad T_{\bullet\bullet 1}^1(ir) = \sum_{i \in \mathbf{I}} \sum_{r \in \mathbf{R}} \frac{L_{irt}}{L_{\bullet\bullet 1}} \ln \left( IR \frac{L_{irt}}{L_{\bullet\bullet 1}} \right),$$

or to the relative Theil index ( $\theta=t$ ) of localization

$$(3) \quad T_{\bullet\bullet t}^t(ir) = \sum_{i \in \mathbf{I}} \sum_{r \in \mathbf{R}} \frac{L_{irt}}{L_{\bullet\bullet t}} \ln \left( \frac{1}{\frac{L_{i\bullet t} L_{\bullet r t}}{L_{\bullet\bullet t}}} \frac{L_{irt}}{L_{\bullet\bullet t}} \right).$$

Observe that (2) and (3) differ from each other only in a single term, the first term in the logs. This term is equal to the inverse of the weights  $w_{ir\theta}$ , or, equivalently, proportional to the

<sup>5</sup> All weights are standardized such that they sum up to unity across the  $I$  industries and  $R$  regions under study.

<sup>6</sup> Since the ratios  $L_{ir}/\Pi_{ir}$  are standardized by the denominators in (1), the scale of  $\Pi_{ir\theta}$  may differ arbitrarily from that of  $L_{irt}$ .

inverse of the references  $I_{ir\theta}$ . In the following, we will essentially show that localization measures like (2) and (3) can be decomposed in a specific way into a term that is the same for both indices, and two additional terms that pick up these first terms in the respective logs. The term that is the same for both indices is a Theil index of “internal” localization, and the remaining two terms are equal to the between-industries and between-regions components obtained from conventional decompositions of (2) and (3) by industries or regions (see Bickenbach and Bode 2008). We do not derive this specific decomposition for the localization indices for the economy as a whole because the between-industries and between-regions components of the relative measure are zero in this special case. Instead, we derive this decomposition for the more general case of Theil indices of localization of a single sector  $s$  (with  $I_s$  industries) in a single country  $c$  (with  $R_c$  regions), where none of the between components is zero. We obtain these country-sector-specific absolute and relative localization measures from (2) and (3) (see Bickenbach and Bode 2008) as

$$(4) \quad T_{sct}^1(ir) = \sum_{i \in s} \sum_{r \in c} \frac{L_{irt}}{L_{sct}} \ln \left( I_s R_c \frac{L_{irt}}{L_{sct}} \right),$$

and

$$(5) \quad T_{sct}^t(ir) = \sum_{i \in s} \sum_{r \in c} \frac{L_{irt}}{L_{sct}} \ln \left( \frac{1}{\frac{L_{i\bullet} L_{\bullet rt}}{L_{s\bullet} L_{\bullet ct}}} \frac{L_{irt}}{L_{sct}} \right).$$

$L_{irt}/L_{sct}$  is the share of region-industry  $ir$  in country-sector  $sc$ . Observe that the weights (and references) in the relative measure are still drawn from the economy as a whole.  $L_{i\bullet}/L_{s\bullet}$  is the share of industry  $i$  in sector  $s$  at the aggregate (rather than the country) level (e.g., EU),  $L_{\bullet rt}/L_{\bullet ct}$  the share of region  $r$  in total (rather than sectoral) employment of the country.

We now expand the logs in (4) and (5) by  $(L_{ict}/L_{sct}) \cdot (L_{srt}/L_{sct})$  and its inverse, which yields, after some reorganizations,

$$(6) \quad T_{sct}^1(ir) = \sum_{i \in s} \sum_{r \in c} \frac{L_{irt}}{L_{sct}} \ln \left[ \left( \frac{1}{\frac{L_{ict}}{L_{sct}} \frac{L_{srt}}{L_{sct}}} \frac{L_{irt}}{L_{sct}} \right) \left( I_s \frac{L_{ict}}{L_{sct}} \right) \left( R_c \frac{L_{srt}}{L_{sct}} \right) \right],$$

and

$$(7) \quad T_{sct}^t(ir) = \sum_{i \in s} \sum_{r \in c} \frac{L_{irt}}{L_{sct}} \ln \left[ \left( \frac{1}{\frac{L_{ict}}{L_{sct}} \frac{L_{srt}}{L_{sct}}} \frac{L_{irt}}{L_{sct}} \right) \left( \frac{1}{\frac{L_{i\bullet}}{L_{s\bullet}} \frac{L_{\bullet rt}}{L_{\bullet ct}}} \frac{L_{irt}}{L_{sct}} \right) \right].$$

We then split up (6) and (7) into three terms, which are

$$(8) \quad T_{sct}^1(ir) = \sum_{i \in s} \sum_{r \in c} \frac{L_{irt}}{L_{sct}} \ln \left( \frac{1}{\frac{L_{ict}}{L_{sct}} \frac{L_{srt}}{L_{sct}}} \frac{L_{irt}}{L_{sct}} \right) + \sum_{i \in s} \frac{L_{ict}}{L_{sct}} \ln \left( I_s \frac{L_{ict}}{L_{sct}} \right) + \sum_{r \in c} \frac{L_{srt}}{L_{sct}} \ln \left( R_c \frac{L_{srt}}{L_{sct}} \right)$$

$$= T_{sct}^*(ir) + T_{sct}^1(i) + T_{sct}^1(r),$$

and

$$(9) \quad T_{sct}^t(ir) = \sum_{i \in s} \sum_{r \in c} \frac{L_{irt}}{L_{sct}} \ln \left( \frac{1}{\frac{L_{ict}}{L_{sct}} \frac{L_{srt}}{L_{sct}}} \frac{L_{irt}}{L_{sct}} \right) + \sum_{i \in s} \frac{L_{ict}}{L_{sct}} \ln \left( \frac{1}{\frac{L_{i \bullet t}}{L_{s \bullet t}}} \frac{L_{ict}}{L_{sct}} \right) + \sum_{r \in c} \frac{L_{srt}}{L_{sct}} \ln \left( \frac{1}{\frac{L_{\bullet rt}}{L_{\bullet ct}}} \frac{L_{srt}}{L_{sct}} \right)$$

$$= T_{sct}^*(ir) + T_{sct}^t(i) + T_{sct}^t(r).$$

The first term on the right-hand sides of (8) and (9), which is the same for both indices, is the Theil index of *internal* localization of country-sector  $sc$ , which we denote by  $T_{sct}^*(ir)$ . It compares the variable of interest,  $L_{irt}$ , to the sector and country totals, represented by the product  $(L_{ict}/L_{sct}) \cdot (L_{srt}/L_{sct})$ , where  $L_{ict}/L_{sct}$  is the share of industry  $i$  in sector  $s$  in the country under study,  $c$ , and  $L_{srt}/L_{sct}$  is the share of region  $r$  in country  $c$  in the sector under study,  $s$ . This Theil index of internal localization differs from the relative Theil index of localization in (5),  $T_{sct}^t(ir)$ , only in its references and weights. While the relative localization index in (5) compares region-industries to the aggregates over all industries and regions, with  $\Pi_{irt} = L_{i \bullet t} L_{\bullet rt} / L_{\bullet \bullet t}$ , and  $w_{irt} = L_{i \bullet t} L_{\bullet rt} / (L_{\bullet \bullet t})^2$  in the notation of equation (1), the internal localization index in (8) and (9) compares them only to the aggregates over all industries and regions in the country-sector  $sc$  under study, with  $\Pi_{irt}^* = L_{ict} L_{srt} / L_{sct}$  and  $w_{irt}^* = L_{ict} L_{srt} / L_{sct}^2$ .

The second terms on the right-hand side of (8) and (9),  $T_{sct}^1(i)$  and  $T_{sct}^t(i)$ , are the absolute and the relative Theil index of specialization (across industries) of sector  $s$  in country  $c$ , respectively. They are equal to the between-industries components of the decomposition of the conventional localization indices in (4) and (5) by industries. And the third terms on the right-hand side of (8) and (9),  $T_{sct}^1(r)$  and  $T_{sct}^t(r)$ , are the absolute and the relative Theil index of concentration (across regions) of sector  $s$  in country  $c$ , respectively. They are equal to the between-regions components of the decomposition of the conventional localization indices in (4) and (5) by regions.

Substituting (9) into (8) via the common internal localization measure,  $T_{sct}^*(ir)$ , finally gives

$$(10) \quad T_{sct}^1(ir) = T_{sct}^t(ir) + [T_{sct}^1(i) - T_{sct}^t(i)] + [T_{sct}^1(r) - T_{sct}^t(r)],$$

which is the main result of this paper. (10) allows us to express the difference between the absolute and the relative localization measures,  $T_{sct}^1(ir) - T_{sct}^t(ir)$ , in terms of concentration and specialization measures. More specifically, it allows us to trace the difference between localization measures, which cover both the industrial and the regional dimension, back to a difference between specialization measures, which cover only the industrial dimension, and a difference between concentration measures, which cover only the regional dimension.

The insight that the difference between absolute and relative measures must have to do with the difference between their references is certainly not new. What is new, however, is the insight that, for localization measures, this difference can be expressed in terms of concentration and specialization measures. New is also that differently referenced (absolute and relative) localization measures have a common element, the internal localization measure. This helps understand, and explore in more detail why absolute and relative measures often evolve in opposite directions (see the following Section 3).

The localization measures for the economy as a whole (equations 2 and 3) can be decomposed in a similar way. The relative between-industries and between-regions components,  $T_{\bullet\bullet t}^t(i)$  and  $T_{\bullet\bullet t}^t(r)$ , are zero in this special case, however, so that the relative Theil index of localization in (3) is equal to the Theil index of internal localization, i.e.,  $T_{\bullet\bullet t}^t(ir) = T_{\bullet\bullet t}^*(ir)$ . As a counterpart to (10), we thus obtain for the economy as a whole

$$(11) \quad T_{\bullet\bullet t}^1(ir) = T_{\bullet\bullet t}^t(ir) + T_{\bullet\bullet t}^1(i) + T_{\bullet\bullet t}^1(r).$$

where  $T_{\bullet\bullet t}^1(i) = \sum_i (L_{i\bullet t} / L_{\bullet\bullet t}) \ln(I \cdot L_{i\bullet t} / L_{\bullet\bullet t})$  and  $T_{\bullet\bullet t}^1(r) = \sum_r (L_{\bullet r t} / L_{\bullet\bullet t}) \ln(R \cdot L_{\bullet r t} / L_{\bullet\bullet t})$ . Equation (11) shows that, for the special case of measures for the economy as a whole, the difference between the absolute and the relative measure is given by the sum of the absolute specialization across industries and the absolute concentration across regions.

### 3. Empirical illustration

We illustrate the (main) relationships between relative and absolute measures discussed in the previous section by an empirical example based on a panel data set of industrial and regional employment figures compiled by Cambridge Econometrics. The data set reports employment for 15 industries across 195 European NUTS-2 regions for the period 1980-2003. The 15 industries cover the full range of economic activity and are grouped into three sectors; “agriculture”, “manufacturing” and “services”.<sup>7</sup> The 195 regions cover the 15 member states

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<sup>7</sup> The three sectors comprise the following industries: Sector 1, agriculture, comprises just one industry, “agriculture, forestry and fishing”. Sector 2, manufacturing, comprises “mining and energy supply”, “food beverages and tobacco”, “textiles and clothing”, “fuels, chemicals, rubber, and plastic products”, “electronics”, “transport equipment”, “other manufacturing”, and “construction”. Sector 3, services,

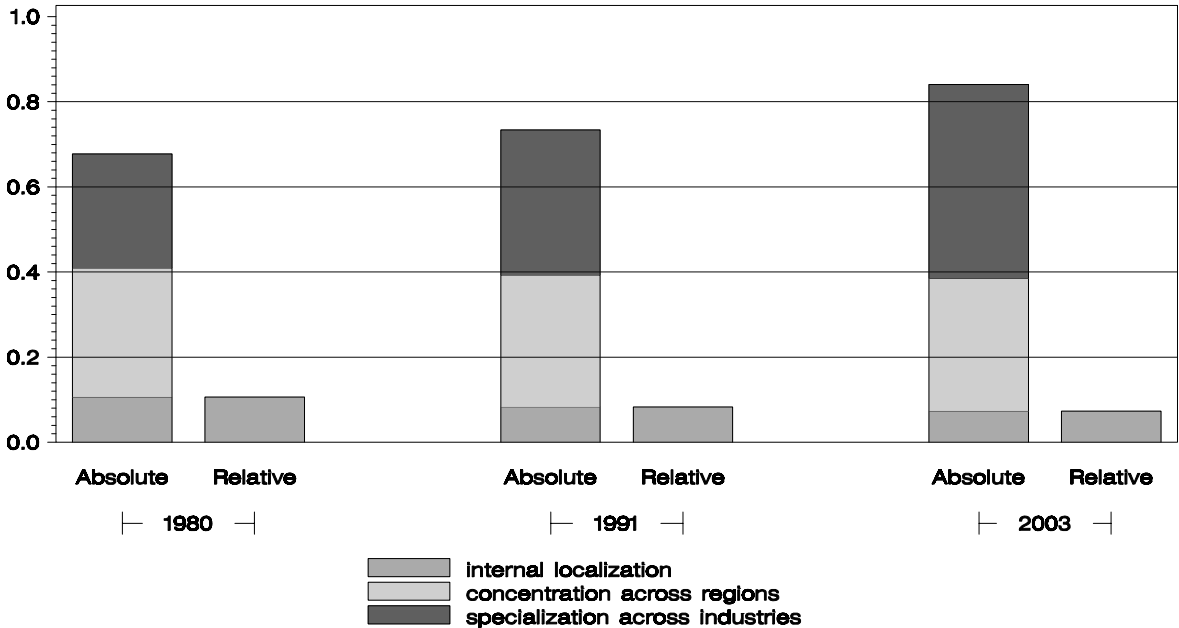


of the European Union as of 2003, excluding East-Germany.<sup>8</sup> For our illustration, we first consider the localization of overall EU-15 employment (all 15 industries and 195 regions) and then focus on a particular sector and country pair, namely the manufacturing sector (8 industries) in the United Kingdom (37 regions).

**Overall EU-15 localization**

The bars in Figure 1 depict, for three selected years, the absolute and the relative localization of EU-15 employment, as measured by the absolute and relative Theil indices  $T_{\bullet\bullet}^1(ir)$  and  $T_{\bullet\bullet}^r(ir)$ , respectively (see equations 2 and 3 in Section 2). The figure shows that the absolute localization increased while the relative localization decreased between 1980 and 2003. This divergence between absolute and relative measures has been observed frequently but left largely unexplained in studies like Krieger-Boden and Traistaru-Siedschlag (2008). To explore the reasons for this divergence, we decompose the two types of localization in the way described above into three components, internal localization of the EU-15 (lower parts of the bars), concentration of aggregate employment across regions (middle parts), and specialization of the EU-15 as a whole across industries (upper parts).

Figure 1: Absolute and relative localization in the EU-15



Note: Theil indices of localization, decomposed in the way described in Section 2.

comprises “wholesale and retail”, “hotels and restaurants”, “transport and communication”, “financial services”, “other market services”, and “non-market services”.

<sup>8</sup> The countries are Austria (9 NUTS2 regions), Belgium (11), Western Germany (30), Denmark (3), Spain (18), Finland (5), France (22), Greece (13), Ireland (2), Italy (20), Luxembourg (1), the Netherlands (11), Portugal (5), Sweden (8), and the United Kingdom (37).

The internal localization of the EU-15 ( $T_{\bullet\bullet, i}^*(ir)$ , lower parts) is the same for both types of localization, and it is equal to relative localization because all other components of this relative localization are zero. This internal localization has decreased from about 0.106 in 1980 to about 0.073 in 2003 in the EU-15, which indicates that the industrial specialization patterns of the regions converged (on average) towards the EU-average pattern, and thus towards each other. Equivalently, it indicates that the regional concentration patterns of the industries converged towards the regional concentration of aggregate employment.

The remaining two components, which are strictly positive only for the absolute localization measure, account for the difference between the absolute and the relative localization. It is obvious from Figure 1 that the divergence between the absolute and the relative localization of the EU-15 is exclusively due to the third component (upper parts), which represents the absolute specialization of EU-15 across industries ( $T_{\bullet\bullet, i}^1(i)$ ). This specialization increased considerably from 0.268 in 1980 to 0.455 in 2003, which indicates that the distribution of employment across industries diverged from the uniform distribution. Smaller industries that accounted for less than 1/15 of total employment tended to become even smaller while larger industries that accounted for more than 1/15 of total employment became even larger. The remaining, second component, the absolute concentration of aggregate employment across regions ( $T_{\bullet\bullet, r}^1(r)$ , middle parts), is of considerable magnitude, which is due to the fact that the regions differ in their employment sizes, but did not change much over time, which indicates that the size distribution of the 195 regions in the EU-15 was remarkably stable.

Even though the empirical observation that absolute specialization and, as a consequence, absolute localization increased over time may be interesting per se, it is of little use for identifying the economic forces that drive the evolution of the spatio-industrial distribution of economic activity. The reason for this is that the uniform distribution does not represent an economically reasonable reference (Combes and Overman 2004). Actually, the fact that structural change leads to an *increase* of absolute specialization is largely a measurement artifact. It is an immediate consequence of the characteristics of industry classifications, which are, ultimately for historical reasons, finer for the shrinking manufacturing industries than for the growing service industries.

As a consequence, the employment shares of manufacturing industries are typically below the shares given by the uniform distribution—and are further decreasing over time—while those of service industries are typically above those given by the uniform distribution—and are further increasing over time. The Cambridge Econometrics database used for this paper distinguishes eight manufacturing industries but only six service industries, even though manufacturing accounted for only about one third of total employment in the EU-15 in 1980 (one fourth in 2003) while services accounted for 55% (71%). All of the eight manufacturing industries witnessed decreasing shares in total employment between 1980 and 2003 while five

of the six service industries witnessed increasing shares between 1980 and 2003. This is not a problem specific to the Cambridge Econometrics database, but a problem inherent in most standard industry classifications. For example, in the European NACE (Rev. 2) industry classification, manufacturing and services account for about 46% of the 615 4-digit industries each even though services accounted for more than 70% and manufacturing for less than 25% of total employment (EU-15) in 2008.

One could of course aggregate over some of the smaller manufacturing industries to make industries more equally sized. But this would not remove the “arbitrariness” inherent in inferences drawn from absolute localization, specialization, or concentration measures. One should rather explicitly control for the size differences between the industries or regions by using relative measures. Even though these relative measures are not entirely immune to the delineation of industries or regions,<sup>9</sup> inferences drawn from relative localization, specialization, or concentration measures are significantly less affected by the arbitrariness of these delineations. However, by adopting contemporaneous references and weights, relative measures are unable to reflect aggregate employment shifts between industries or regions, including, for instance, the general EU-wide trend away from agriculture and manufacturing industries towards services industries. As an alternative one may therefore use measures with references and weights that are time-invariant and still control for industry and region sizes. Bickenbach et al. (2010), for example, use the observed industrial and regional distributions of employment in the initial year as time-invariant references and weights for all years under study. This allows them to explore the extent of aggregate industrial and regional structural changes in the EU while accounting for the arbitrariness of the industry and region classifications.

### ***Localization of UK manufacturing***

As shown in Section 2, our specific decomposition of localization becomes slightly more complicated if we focus on a single sector in a single country. The difference between absolute and relative localization measures depends on four rather than two terms in this case (see equation 10). In addition to this, the measure of internal localization common to both measures is a particular localization measure that features country-sector-specific rather than EU-wide references and weights.

Figure 2, which has a similar shape as Figure 1, depicts the absolute and the relative localization of UK manufacturing for three selected years, 1980, 1991 and 2003. It shows that absolute and relative localization generally changed in opposite directions in UK

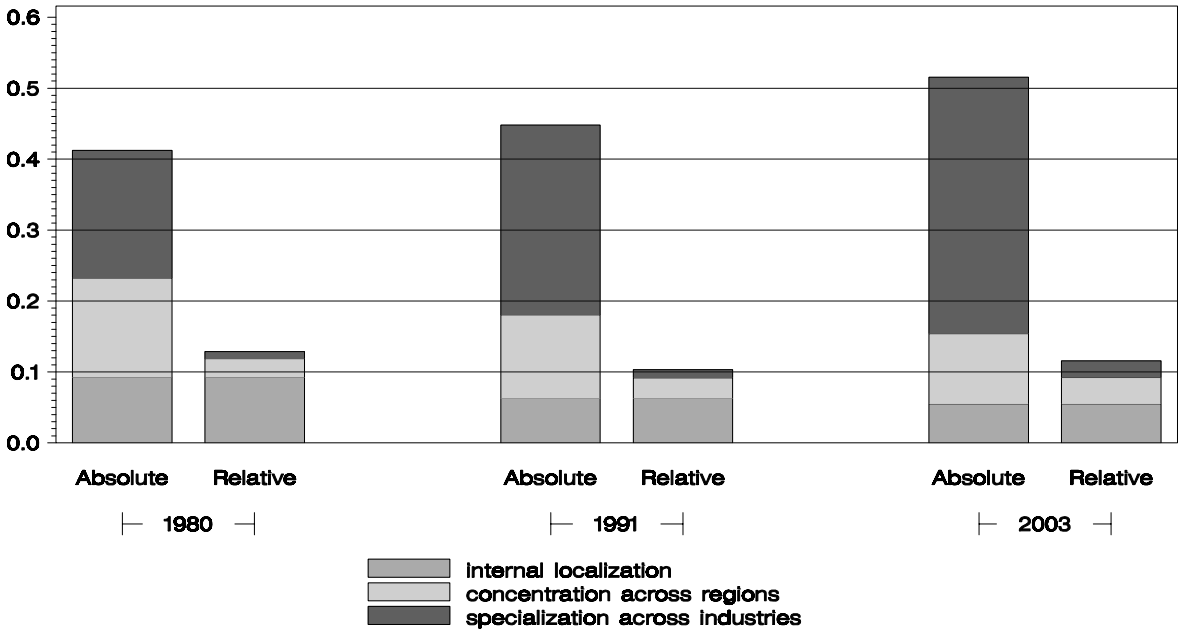
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<sup>9</sup> These relative measures are, among others, subject to the modifiable areal unit problem (Arbia 1989, Combes and Overman 2004) in general and aggregation biases more specifically. Industry or region aggregates may be delineated improperly, and may bury the existing variety within these aggregates.

manufacturing. Absolute localization increased from 0.41 in 1980 to 0.51 in 2003, whereas relative localization decreased from 0.128 to 0.116.<sup>10</sup> Like in Figure 1, absolute and relative localization are decomposed into the three components introduced in Section 2 (see equations 8 and 9): the internal localization of UK manufacturing (lower parts of the bars), which is common to the absolute and the relative measure, the concentration of UK manufacturing across regions (middle parts), and the specialization of UK manufacturing across industries (upper parts).

The internal localization in the lower parts of the bars is equivalent to the relative localization *within* UK manufacturing. It evaluates the distribution of employment across regions and manufacturing industries relative to total *manufacturing* employment in the *UK* (rather than to total employment in all sectors and countries in the EU-15). This internal localization decreased from about 0.09 in 1980 to just above 0.05 in 2003, which indicates that, on average, the UK regions became more similar to each other with respect to the industrial compositions of their manufacturing sectors, or, equivalently, that the manufacturing industries became more similar to each other with respect to their regional distributions in the UK.

Figure 2: Absolute and relative localization of UK manufacturing



Note: Their indices of localization, decomposed in the way described in Section 2.

<sup>10</sup> The relative localization decreased only during the 1980s while it increased slightly during the 1990s, though.

The concentration of UK manufacturing as a whole across regions (middle parts)<sup>11</sup> contributes to a notable extent to the difference in levels between the absolute and the relative localization. It does, however, not contribute to the divergence between these two measures over time. While the absolute concentration decreased (from 0.14 in 1980 to 0.10 in 2003), the relative concentration increased (from 0.026 to 0.037), implying a declining difference between the two. In contrast, the absolute localization increased and the relative localization decreased, implying an increasing difference between the two.

It is thus the third component of the localization measures, the specialization of UK manufacturing across industries (upper parts), that was responsible for the divergence between absolute and relative localization. This component was not only much larger for the absolute than for the relative measure already in 1980. It also expanded much faster for the absolute measure. Absolute specialization increased from 0.18 in 1980 to 0.36 in 2003 while relative specialization increased from 0.01 to 0.024. Absolute specialization was so much higher than relative specialization because it does not take into account the specifics of the underlying industry classification. The size distribution across the UK manufacturing industries differs much stronger from the uniform distribution than from the size distribution across manufacturing industries in the EU-15. And it grew so much faster over time because several of the smaller industries, such as mining and textiles, contracted stronger than larger industries, such as construction. The relative measure accounts for these general long-term changes in the size distribution across industries.

#### **4. Conclusion**

By uncovering the reasons for the discrepancy between absolute and relative localizations measures this paper solves one of the puzzles in the exploratory analysis of the localization of economic activity. Using the Theil index of localization as an example, it shows that the difference between an absolute and a relative localization measure can be expressed in terms of absolute and relative concentration and specialization measures. This helps understand, and explore in more detail why absolute and relative measures frequently evolve in opposite directions. For two examples where absolute localization increased while relative localization decreased, the paper shows that the divergence between absolute and relative localization originates mainly from the industrial dimension, i.e., from a stronger increase of the absolute as compared to the relative specialization. This stronger increase of the absolute specialization is largely due to a statistical artifact inherited from the specifics of traditional industry classifications. Most industry classifications are, ultimately for historical reasons, much

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<sup>11</sup> The concentration of UK manufacturing as a whole across regions evaluates the deviations of the regional distribution of manufacturing from the uniform distribution (absolute measure) or from the regional distribution of total employment (relative measure).

coarser within the service sector or for modern industries, such as trade or finance, than within the manufacturing sector or for mature industries, such as mining or textile industries. As a consequence of this, smaller industries diverge from the uniform reference because they tend to become even smaller, and larger industries also diverge from the uniform reference because they tend to become even larger, at least in developed countries. Thus, at least if both manufacturing and services industries are included into the analysis and standard industry classifications are used, we can be almost certain a priori to find absolute specialization of employment to increase for essentially all developed countries.

This paper introduces the methodology for comparing localization measures with different references for only one pair of references, absolute and relative references, and for only one projection function, that of the Theil index. Extending this methodology to Theil indices with other references, such as the topographic reference (Brühlhart and Träger 2005) or the initial-year reference (Bickenbach et al. 2010), is straightforward. Extending it to other decomposable projection functions, such as those of the generalized entropy class of measures, may be less trivial, by contrast, and is left to future research.

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