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Zoom in, Zoom out: A Shift-share Analysis of Productivity in Switzerland Based on Micro Data

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Abstract

Using novel data on value added in Switzerland we propose to use a growth rate decomposition technique, in the spirit of shift-share analysis, to analyze the patterns of regional competitiveness over the 2011-2015 period. The growth differential of a region (or canton) depends on four terms, three structural effects and one competitive effect. The competitive effect turns out to be the dominant force at a high level of aggregation. An interesting pattern of structural effects unveils when working at a lower level of aggregation, allowing for identification of the leaders and laggers across regions and sectors.

JEL Classification: R11, R32
Keywords: firm-level, productivity, shift-share, structural and competitive effects, Switzerland

1 Introduction

Productivity growth is key in estimating the economic performance of the industrial landscape and its geographical distribution across different jurisdictions. It is of particular interest in a country like Switzerland, which combines a highly diversified industrial structure with a large variety of economic and social policies across cantons and municipalities.

Unfortunately, Swiss productivity data at the microeconomic level are almost impossible to find. The value added survey (Wertschöpfungsstatistik, WS) provides yearly information on monetary variables. However, it does not allow to address productivity issues as it does not report employment figures. On top of that, the sample is limited to firm-level (not plant-level) data and it is biased towards large firms (more than 50 employees).

This paper exploits a novel database created by the matching between the WS survey and the yearly census of production units (STATENT database), which provides employment data. Moreover, as explained in a companion paper (Tissot-Daguette and Grether, 2021), multiple imputation techniques are used to enlarge the dataset towards

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smaller productive units. As a result, the enriched database we use in the present paper is both suitable for productivity analysis and representative of the Swiss industrial structure and geographical dispersion.

We follow and extend simple decomposition techniques inspired from the shift-share analysis literature to characterize productivity performance across geographical units over the 2011-2015 period. Apart from providing interesting results for specific regions or cantons, the paper proposes a progressive "zoom" into the Swiss industrial landscape. This allows first to identify general trends at the highest level of aggregation (7 major regions and 13 NACE+ categories), second to generate richer results by extending the number of geographical units (26 cantons) or industrial sectors (460 NOGA4 sectors [2]). In particular, productivity performance at the cantonal level can be explained by the combination between three structural forces (affecting either incumbent or emerging or absent sectors) plus a competitive effect.

The paper is structured as follows. Section 2 presents the literature background. Section 3 presents the growth rate decomposition method which is applied to value added, employment and productivity figures. Section 4 comments the data and section 5 presents the basic results. An alternative database is discussed in Section 6 and Section 7 concludes.

2 Literature Review

We provide first general references on micro-based productivity studies. Then we turn to productivity estimates for Switzerland in recent years. Finally we briefly review the basic fundamentals of shift-share analysis.

2.1 Plant-based productivity measurement

Since the seminal contribution of Foster et al. (2001), a bulk of empirical studies have bolstered our understanding of the links between national-level and firm-level productivity performance. Much attention has been devoted to explaining the so-called "productivity puzzle" i.e. the slowdown of productivity growth in OECD countries since the mid-2000s (e.g. Bauer et al. (2020) or Sharpe and Nicoletti (2017)). A number of determinants have emerged, among them market rigidities, time lag between invention and adoption of new technologies, or imperfect integration into global value chains. These concerns remain very much present today, and motivate further efforts on how to promote productivity improvements (see citeVanarxandvenables2020.

Most of these contributions adopt a similar methodology to measure productivity at the plant level and to relate plant-level estimates with more aggrgated productiv-

2. Number of NOGA4 sectors present in our database over 615 NOGA4 sectors in total.

ity figures. Whether based on production or value-added figures, plant performance is measured either as the labor productivity ratio or the (production function estimated) total factor productivity (TFP) index. Aggregate productivity at the sector level can be decomposed *à la* Olley and Pakes (1996) into a within-plant and a between plant component, the latter capturing rationalization effects (i.e. more productive firms gaining market shares). Additional decomposition techniques allow to account for the contribution of entering, exiting and incumbent firms (see Griliches and Haim (1995) or Melitz and Polanec (2015)). In general, the choice of the appropriate analytical framework is much dependent on the quality and availability of micro data. This sustains ongoing international efforts to establish firm-level databases which are both reliable and comparable across countries (e.g. the CompNet base for the EU, the firm-level projects of the OECD, or private sources like the FactSet or Orbis databases)

2.2 Empirical evidence for Switzerland

The origin of the low level of productivity growth in Switzerland dates back to the 90s. Early contributions were mostly macro-based (e.g. Brunetti and Zurcher (2002) or Kohli (2005)). More recent studies tend to rely on micro-evidence, although appropriate firm-level data are difficult to obtain for Switzerland, and their coverage is not satisfactory.[3]

Given these limitations, apart from a few studies on specific sectors[4] most authors have relied on two major sources of labour productivity at the level of the production unit: the Swiss Earnings Structure Survey (ESS) from the Federal Statistical Office (FSO) and the Swiss Innovation Survey (SIS) of the KOF Economics Institute of the ETH Zurich. In particular, the SIS has been used by Arvanitis et al. (2013) to provide an extensive analysis of labour productivity determinants at the firm and sector level over the 1990-2010 period, by Siegenthaler and Stucki (2015) to explain the surprising stability of the Swiss labour share of income in recent decades, and by Kaiser and Siegenthaler (2015) to analyse the slow productivity growth in knowledge-intensive business services. Marti et al. (2017) used the ESS to provide a thorough shift-share analysis of the variety of productivity growth patterns across Swiss regions. These studies have all contributed to identify sources of low productivity in Switzerland and the needs for corrective actions, as recently advocated by the OECD (OECD, 2017).

In spite of these advances it is fair to say that the microeconomic basis to evaluate

3. Swiss data have only been recently included in CompNet, and they are only available for a limited number of sectors and for large regions. Ollivaud (2017) mentions the notable exception of the STATENT database, which has allowed to perform interesting international comparisons (Mattmann et al., 2016). However, it is not suitable to address productivity issues as this database does not report information on monetary variables.

4. e.g. Bolli and Farsi (2015) on Swiss universities, Lewrick et al. (2018) on manufacturing industries or Grass et al. (2017) on the pharmaceutical industry.

the fine patterns of productivity growth in Switzerland remains slim. The ESS database does not report measures for value added, while the SIS database does not report full time equivalent and excludes firms with less than 5 employees. Meanwhile the low productivity problem persists, with macro measures (whether total factor productivity or labour productivity) suggesting that Swiss productivity growth has almost vanished since the big recession (e.g.Tille (2018)). Thus, there is a need for further empirical evidence based on more comprehensive datasets.

This is the main objective of the present paper. It is based on a novel and unexploited dataset over the 2011-2015 period, with an unprecedented coverage of the geographical distribution of firms within Swiss industries. The construction and characteristics of the database are described in section 4. As the data are imputed and do not cover capital stock variables, the analysis is limited to labour productivity rather than TFP.

2.3 Shift-share analysis

Shift-share analysis is a descriptive method, which aims to analyze regional performance (see Dunn, 1960; Fuchs, 1962; Ashby, 1962). It has been widely used and discussed in the regional economics literature and is still in use today (see e.g. Erkus-Ozturk and Terhorst, 2015). The simplest form of this method decomposes the change in a variable in a specific location (typically employment of a given industry (Esteban-Marquillas, 1972), but also value added (Oguz and Knight, 2010) or even energy demand (Otsuka, 2016)), into a national growth (NE), a industry-mix (or structural, SE) and a competitive effect (CE).

Let ΔX_{ij} be the change of employment in location j, in industry i, that occurs between two given time periods. The "classical" decomposition is as follow [5]:

$$\Delta X_{ij} = \underbrace{X_{ij} r}_{\text{NE}} + \underbrace{X_{ij}(r_i - r)}_{\text{SE}} + \underbrace{X_{ij}(r_{ij} - r_i)}_{\text{CE}}$$

where r is the national employment growth rate of growth, r_i the national employment growth rate of industry i, r_j region j employment growth rate and r_{ij} the region j employment growth rate in industry i. The contribution of the overall economy to the growth rate in the given location and industry is captured by the NE term. The contribution of the specialization of region j in sector i is given by the SE term, while the CE term captures the specific dynamism of region j regarding the growth rate in industry i.

This simple framework has been extended in several dimensions in the literature. Some have criticized the overlap between the CE and the SE effects in the original expression, as the X_{ij} part of the CE term also captures the industrial structure of the

5. The notation is the one used in Mayor and López (2007). We abstract from period indices to simplify expressions.

region. For this reason, Esteban-Marquillas (1972) and others have proposed to introduce further decomposition terms to allow for a better disentanglement between the CE and the SE effects. Others have focused on how best to capture the true dynamics of the underlying variable, discussing the length of the time period over which growth rates are calculated, and the choice between the initial or the final employment levels (or still a combination of the two) in the above expression (e.g. Barff and Knight (1988), Selting and Loveridge (1994)). Another source of concern is to incorporate neighbouring effects, by allowing one region to influence another one in other ways than through the national average (e.g. Nazara and Hewings (2004), Mayor and López (2007)).

These refinements are worth considering in an in-depth analysis of the regional change of a single variable such as employment. In this paper our focus is on productivity, i.e. the ratio between two variables, and our firm-level database [6] allows considering various degrees of regional aggregation. This makes it more appropriate to stick to a standard SE-CE decomposition close to the original formula. As described in the next section, this allows us to focus on growth rates rather than changes in levels, and to extend the expression to capture the impact of new entrants or absent sectors over the sample period.

3 Methodology

We adjust the basic shift-share analysis expression to growth rates of employment and value added, extend it to account for new entrants and absent sectors, and apply it to productivity growth.

3.1 Structural and competitive effects for growth rates

We assume first that region j is active (i.e. with positive levels of both employment and value-added) in all sectors across the sample period. Let us consider the growth rate of variable X (employment or value added) either at the national level (r), or at the level of region j (r_j), or at the level of industry i, region j (r_{ij}). By definition, the national growth rate (r) is the X-weighted sum of regional growth rates (r_j, while the regional growth rate is the X-weighted sum of sectoral regional growth rates (r_{ij}). In other words we can write,

$$r_j = \sum_i (\frac{\theta_{ij}}{\theta_j}) r_{ij}$$

$$r = \sum_i \theta_i r_i$$

where $\theta_{ij} = \frac{X_{ij}}{X}$ are the shares in the initial period, $X = \sum_j \sum_i X_{ij}$, $\theta_j = \frac{X_j}{X}$ and $X_j = \sum_i X_{ij}$. Taking the difference between the two above expressions, adding $\sum_i (\frac{\theta_{ij}}{\theta_j}) r_i$-$\sum_i (\frac{\theta_{ij}}{\theta_j}) r_i$ on the right-hand side and rearranging one gets

6. "Firm" is here defined as an unique municipality/NOGA4/legal form combination.

$$r_j - r = \underbrace{\sum_i (\frac{\theta_{ij}}{\theta_j} - \theta_i) r_i}_{SE_j} + \underbrace{\sum_i (r_{ij} - r_i) \frac{\theta_{ij}}{\theta_j}}_{CE_j} \quad (1)$$

where,

$\sum_i (\frac{\theta_{ij}}{\theta_j} - \theta_i) r_i$ **is the structural effect** (SE_j)**.** Abstracting from growth differences (i.e. $r_{ij} = r_i$), this indicates the contribution to growth of the industrial structure of region j. If this effect is positive, this means that the region is biased towards nationally growing sectors.

$\sum_i (r_{ij} - r_i) \frac{\theta_{ij}}{\theta_j}$ **is the competitive effect** (CE_j)**.** Abstracting from structural differences (i.e. $\frac{\theta_{ij}}{\theta_j} = \theta_i$), this is the contribution to growth of the regional growth rate of region j. If this effect is positive, this means that the region exhibits on average stronger growth rates than at the national level.

3.2 Accounting for absent and emerging sectors

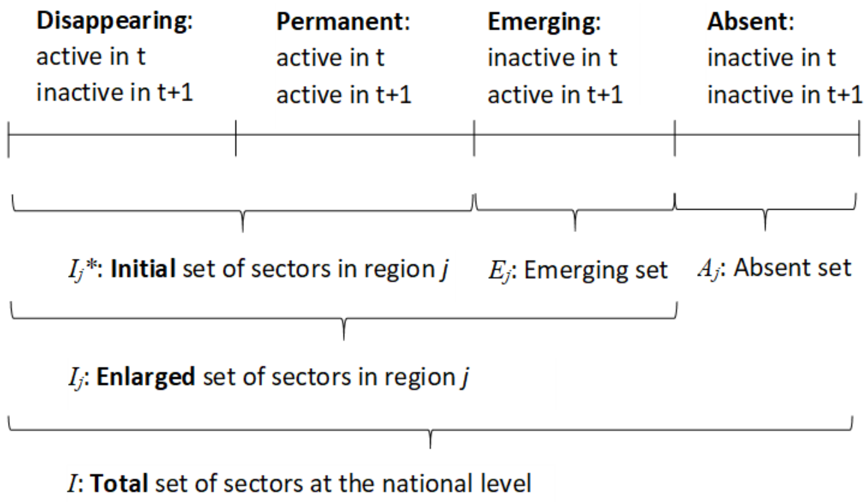
To become operational, the above decomposition framework must be extended to account for the fact that some regions are only active in a subset of sectors. Figure 1 makes the crucial distinction between the *initial* set of active sectors in region j, I_j^*, and the *enlarged* set of sectors in region j, I_j, which includes the set of *emerging* sectors appearing in the second period, E_j, but which excludes those sectors that are *absent* both periods, A_j.

Equation 1 only applies to the initial set of sectors, I_j^*, which is common to the regional and national level .[7]

To clarify notation, we now define growth rates according to the sector set they are based on. For example, $r_j \equiv r_j(I_j)$ denotes the growth rate in region j on the enlarged set, while $r_j(I_j^*)$ denotes the corresponding growth rate on the initial set. The same conventions apply to growth rates at the national level, e.g. total growth rate $r \equiv r(I)$ or the growth rate of absent sectors for region j, $r(A_j)$. As usual, growth rates are obtained as the ratio between the final and the initial value minus one. As the denominators of $r_j(I_j)$, $r_j(I_j^*)$ are identical while the numerator of $r_j(I_j)$ includes emerging sectors, we will always have $r_j(I_j) > r_j(I_j^*)$. However, this inequality does not necessarily apply at the national level i.e. $r(I_j)$ may be larger, smaller or equal to $r(I_j^*)$.

7. Strictly speaking this is not true, as we should also define a $final$ set which excludes the disappearing sectors from the enlarged set. However, to simplify the decomposition formula, we assume that the disappearing sectors are still there in the second period, but do not hire anybody nor produce anything.

Figure 1 – Initial, enlarged and total sets of sectors



Note: To ease presentation, the **final** set of sectors in region j (enlarged set minus disappearing sectors) is not considered in the calculations.

Absent sectors in region j generate a distinction between the enlarged set and the total set of sectors at the national level. The national growth rate, r, can be written as a weighted average between the growth rate on the extended set, $r(I_j)$ and the growth rate on the absent sectors, $r(A_j)$, i.e. $r = (1 - \theta_{A_j})r(I_j) + \theta_{A_j} r(A_j)$, where θ_{A_j} is the initial share of absent sectors at the national level.

The impact of *emerging* sectors on region j's growth rate is denoted by δ_j^j, and defined as the difference between the growth rate on the enlarged set $(r_j(I_j))$, and the growth rate on the initial set $(r_j(I_j^*))$, i.e. $\delta_j^j \equiv r_j(I_j) - r_j(I_j^*)$. A similar term is defined at the national level i.e. $\delta^j \equiv r(I_j) - r(I_j^*)$. Given the above-mentioned properties, we know that δ_j^j is positive, while δ^j may be positive, null or negative.

Combining the weighted average expression for r with the definitions of δ^j and δ_j^j, Equation 1 rewrites,

$$r_j - r = ASE_j + ESE_j + SE_j^* + CE_j^* \tag{2}$$

where $r_j \equiv r_j(I_j)$, $r \equiv r(I)$, $ASE_j = \theta_{A_j}(r(I_j) - r(A_j))$, $ESE_j = \delta_j^j - \delta^j$, $SE_j^* = \sum_{i \in I_j^*} \left(\frac{\theta_{ij}}{\theta_j} - \frac{\theta_i}{(1 - \theta_{E_j} - \theta_{A_j})} \right) r_i$, $CE_j^* = \sum_{i \in I_j^*} (r_{ij} - r_i) \frac{\theta_{ij}}{\theta_j}$ and θ_{E_j} is the initial share of emerging sectors at the national level.

In the above expression, the interpretations of the structural (SE_j^*) and competitive (CE_j^*) effects are similar to Equation 1. The novelty comes from the two additional effects:

The absent sectors effect ($\boldsymbol{ASE_j}$). The net impact of absent sectors on the growth gap of region j is proportional to the initial share of absent sectors at the national level (θ_{A_j}), and is positive (negative) if those sectors are lagging behind (running ahead) at the national level, i.e. if $r(I_j) > r(A_j)$ (if $r(I_j) < r(A_j)$).

The emerging sectors effect ($\boldsymbol{ESE_j}$). The net impact of emerging sectors on the growth gap of region j is positive (negative) if their impact on the regional growth rate (δ_j^j) is larger (smaller) than their impact on the national growth rate (δ^j).

3.3 Productivity growth decomposition

We first perform decomposition 2 on value added and employment data. As the growth rate of a ratio is approximately equal to the growth rate of the numerator minus the growth rate of the denominator, it is tempting to assume that decomposition 2 simply applies by analogy to productivity growth, with each decomposition effect being equal to the difference between the corresponding effects for value added and employment. However there is an error term and we have to slightly adjust the definition of the decomposition effects.

Let us denote value-added by V, employment by L and productivity by P. The value-added growth rates at the regional and national level are given by:

$$r_j^P = r_j^V - r_j^L - \epsilon_j$$
$$r^P = r^V - r^L - \epsilon$$

where $\epsilon_j = (r_j^V - r_j^L)(\frac{r_j^L}{1+r_j^L})$ and $\epsilon = (r^V - r^L)(\frac{r^L}{1+r^L})$ are the error terms. By subtracting the two expressions we get,

$$r_j^P - r^P = (r_j^V - r^V) - (r_j^L - r^L) - (\epsilon_j - \epsilon)$$

In the above expression, we substitute $r_j^V - r^V$ and $r_j^L - r^L$ by their respective decompositions and spread the combined error term homogeneously across the decomposition effects to obtain,

$$r_j^P - r^P = ASE^P + ESE^P + SE^{*P} + CE^{*P} \tag{3}$$

where $ASE^P = (ASE^V - ASE^L) - (\frac{1}{4})(\epsilon_j - \epsilon)$, $ESE^P = (ESE^V - ESE^L) - (\frac{1}{4})(\epsilon_j - \epsilon)$, $SE^{*P} = (SE^{*V} - SE^{*L}) - (\frac{1}{4})(\epsilon_j - \epsilon)$, and $CE^{*P} = (CE^{*V} - CE^{*L}) - (\frac{1}{4})(\epsilon_j - \epsilon)$.

4 Data

We first describe the origin of the datasets used to decompose productivity growth. Then we provide a graphical representation of employment and value-added growth over a selected number of regions and sectors in Switzerland across the 2011-2015 period.

4.1 Data sources

We match two data sources from the Federal Statistical Office over the period 2011-2015, the employment data from the STATENT census (Statistique Structurelle des Entreprises) and the value-added data obtained from the WS survey (Wertschöpfungsstatistik). The WS survey is at the firm level, excludes the primary sector and the banking and financial services sector, and is limited to firms with three or more employees. Small firms (below 50 employees) are sampled according to sectoral and size categories, and remain in the sample for five years only. Combined with non-response and the necessity to aggregate the data at the level of pseudo-firms (i.e. a given combination of NOGA-4digit sector, municipality and legal form) for confidentiality reasons, these characteristics makes it particularly challenging to ensure that the final sample is sufficiently representative of the whole population.

We address these issues into detail in a companion paper (Tissot-Daguette and Grether, 2021). Our basic strategy is to construct two types of samples. On the one hand, a *restricted* sample is obtained by trimming out all firms that are replaced, do not respond, or regroup establishments spread across pseudo-firms (i.e. municipality-sector-legal form combinations). This considerably reduces the size of the sample, to less than 3'000 observations per year (starting from around 22'000 initial observations per year in the WS survey). Although we propose an original method to adjust sampling weights, the matching with the distribution of employment in the (STATENT-based) reference population is imperfect, and the representativeness of the *restricted* sample is therefore limited. On the other hand, we construct a series of *imputed* samples using either proportionality conventions (*naive* imputations) or econometric techniques (*multiple* imputations). Both imputation routes allow to avoid losing information from the original survey and achieve a far better matching with the whole population. The *naive* imputation route is not appropriate in the context of the present paper as the basic assumption to reconstruct missing data is that productivity remains constant over years or over establishments of the same firm. Thus, we will focus here on the databases obtained through multiple imputation techniques, which account for a bit less than 18'000 observations per year and are more representative of the entire population of Swiss firms than the *resricted* sample.[8]. As there are 20 runs of imputations performed to address two sources of missing data (first rollover and non-response of small firms, second multiplant spreading), this leads to 400 different imputed datasets per year. We report here the average results across these 400 datasets and a confidence interval based on their

8. See the companion paper for descriptive statistics on the alternative datasets obtained.

standard deviation.

In order to simplify the presentation of results, the main text will focus on aggregate results obtained from the *imputed* sample on average over the 2011-2015 period, for the seven large regions and thirteen NACE+ sectors. Unless otherwise specified, all calculations involve weights so the identified patterns apply to the population as a whole, not only the selected samples. Results at the NOGA4 classification level, for cantons and for the *restricted* sample are discussed subsequently. Per-year detailed results are reported in the Appendix.

4.2 Broad trends in employment and value-added

We report below the yearly average growth of employment (full-time equivalent) and value-added over the 2011-2015 period for either large regions or large sectors.[9] The definitions of these broad categories, along with basic shares and growth rate figures, are provided by table 1.

For ease of interpretation, growth rates are plotted in Figure 2 (for regions) and Figure 3 (for sectors). Horizontal and vertical dotted lines in both figures represent national average growth rates, and the location of a dot above (below) the 45 degree line indicates an increase (decrease) in productivity over the sample period for that particular region or sector.

A striking feature for regions is that they are very homogeneous in terms of employment growth rates, as most dots are vertically aligned along the national growth rates of slightly more than 1%, with the notable exception of Zentralschweiz (more than 2%). The variance is a lot stronger for value-added, with extreme cases represented by Ticino (more than 4%) and Mittelland (less than -1%). Between these extremes, productivity increases in Zurich and Région lémanique, and decreases in Ost, Nordwest and Zentralschweiz. Section 5 below will help us to understand what hides between these contrasted results.

The overall picture for large sectors is contrasted, with the majority of sectors pretty much aligned along the diagonal, which means a productivity that remains quite stable on average. Sectors with decreasing productivity are basically Food, Textiles and Wood (with a decrease of around -2% in value-added and almost stable employment), and Public administration (with an increase of +5% in employment which is not matched

9. Large regions are those defined by the Federal Statistical Office. Large sectors are based on the nine NACE+ categories where categories 2a (manufacturing industries) and 4 (services) have been split into subcategories as they jointly represent around two-third of employment. Unless otherwise specified, all reported yearly growth rates over 2011-2015 correspond to the total growth rate between 2011 and 2015 divided by 4. This in order to remain consistent with the decomposition formulas discussed in Section 3.

Table 1 – Large regions and large sectors in Switzerland

Code	Name	Share			Average growth	
		Pseudo-firms	Employment	Value added	Employment	Value added
ML	Espace Mittelland	23.5%	21.4%	19.4%	1.06%	-0.98%
ZH	Zürich	15.3%	19.3%	20.0%	1.05%	1.76%
NW	Nordwestschweiz	15.4%	17.2%	19.7%	1.09%	0.71%
LE	Région lémanique	17.1%	17.1%	21.1%	1.55%	2.33%
OS	Ostschweiz	16.6%	14.9%	11.6%	0.94%	0.78%
ZS	Zentralschweiz	9.7%	8.1%	6.6%	2.22%	1.16%
TI	Ticino	2.4%	2.0%	1.6%	0.94%	4.41%
2a3	Metal and machines manufacturing industries	13.7%	20.2%	19.8%	-0.38%	-0.13%
41	Whole and retail sales	21.8%	14.9%	21.9%	0.76%	0.83%
8	Scientific and technical activities, administrative services	12.8%	13.1%	11.6%	2.12%	2.98%
3	Building sector	8.0%	11.0%	8.2%	1.95%	1.11%
9	Public administration, defense, teaching, health and social activities	7.5%	7.1%	3.7%	4.75%	2.73%
2a1	Food, textiles and wood manufacturing industries	8.4%	6.9%	6.7%	0.41%	-1.60%
2a2	Chemicals and Pharmaceuticals manufacturing industries	4.4%	6.3%	10.7%	0.10%	1.38%
42	Transport and storage	4.7%	5.9%	5.3%	1.05%	1.25%
43	Accomodation and food services	3.5%	5.2%	2.6%	1.40%	0.52%
44	Communication and information services	5.3%	5.0%	6.3%	1.50%	2.48%
10	Other services	5.4%	2.5%	1.4%	2.76%	1.65%
7	Real estate	3.2%	1.3%	1.2%	2.69%	1.76%
2	Extraction and other industries	1.3%	0.6%	0.6%	1.83%	0.88%

by a corresponding increase in value-added). Conversely, Scientific equipment, Communication and Information, and Chemicals and Pharmaceuticals do exhibit an increase in productivity.

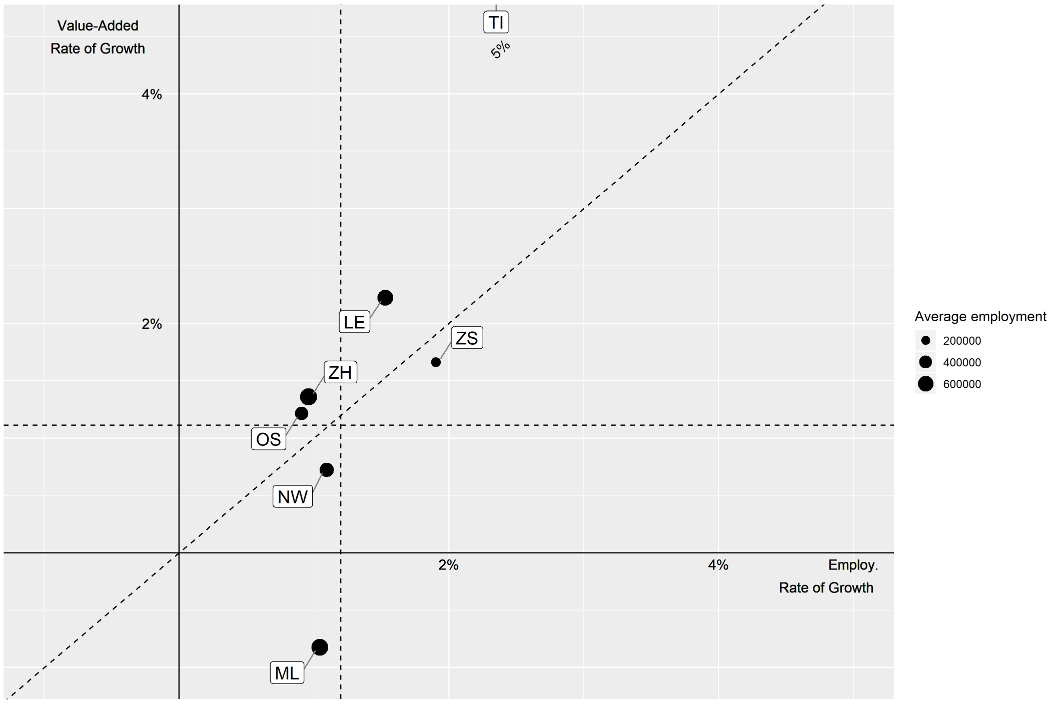
Although informative, these average trends over the whole period may hide important year-to-year differences. To conclude that section, Figure 4 reports five maps of productivity growth for Switzerland. The far-right panel, which covers the whole 2011-2015 period, confirms the pattern identified in Figure 1, with a strong increase in productivity for Ticino and a decrease for Mittelland. However, the other four panels show that results may change quite importantly from one year to the other, as often discussed in the literature (e.g. Selting and Loveridge (1994)). This is why we generally complement the results by yearly indicators in the Appendix.

5 Results

We discuss the results of the shift-share decomposition exercise combining two types of figures.

Two-dimensional plot diagrams. These plots allow to identify at a single glance the main sources of employment growth (or value-added, or productivity) along the

Figure 2 – Average growth of employment and value-added by major regions 2011-2015

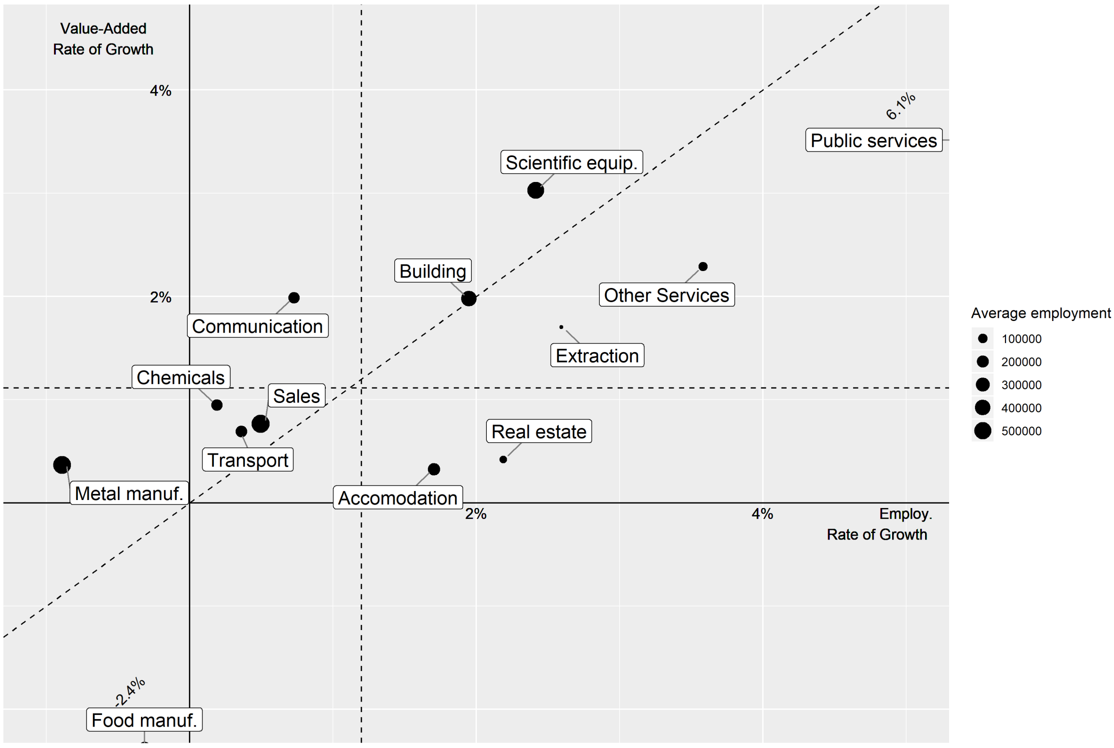


Note: Annual growth over the 2011-2015 period; employment measured in full time equivalents; the size of dots is proportional to the average regional employment; see Table 1 for names of (and basic statistics on) major regions.

lines of expression (2). More precisely, we report on the horizontal axis the sum of the first three terms (ASE, ESE and SE*) and call this sum the (combined) *structural* effect, while we report the CE* term on the vertical axis, representing the *competitive* effect. This is done in figures 5 (employment), 6 (value-added) and 7 (productivity), which also reports the negatively sloped 45 degree line as a reference locus. Any point above (below) that diagonal indicates a positive (negative) growth differential with respect to the national average, and the larger the orthogonal distance from the diagonal, the larger the absolute growth differential.

Bar-diagrams. The second type of figures are bar-diagrams presenting precisely the detailed decomposition of expression (2) namely the growth differential $(r_j - r)$, the absent sectors effect (ASE), the emerging sectors effect (ESE), the (pure) structural effect (SE*) and the competitive effect (CE*). These more precise diagrams also report the national growth rate (r) and a confidence interval derived from the 400 imputed datasets. Figure 8 reports the average results for employment, value-added and productivity over the whole sample period 2011-2015, while year-to-year

Figure 3 – Average growth of employment and value-added by large sectors 2011-2015



Note: Annual growth over the 2011-2015 period; employment measured in full time equivalents; the size of dots is proportional to the average industrial employment; see Table 1 for names of (and basic statistics on) major sectors.

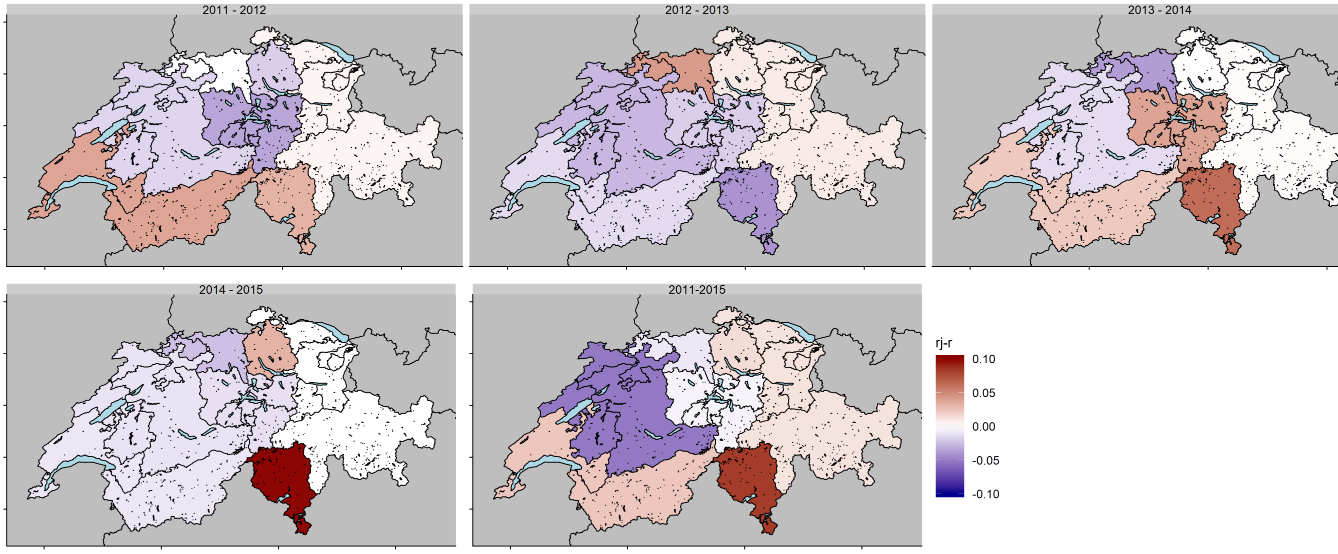
results are reported in figures A1, A2 and A3 in the Appendix.

For each one of the three variables, the logic of the discussion is to start with the quicker-to-read two-dimensional plot and then look at the bar-diagram figure for more in-depth explanations of the observed patterns. We first discuss the results for major regions, then report and comment results at the cantonal level.

5.1 Results for major regions and NACE+ sectors

Starting with employment, figure 5 suggests that effects are rather small (dots are close to the origin) and that most regions have a small differential with respect to the national average (distance to the dotted line). The only region that stays apart from that pattern is Zentralschweiz, for a CE effect larger than 1%. This is confirmed by the upper panel of figure 8, which also shows that the (weak) SE effects for Région lémanique (positive) and Ostschweiz (negative) are due to a "pure" structural effect, as the ESE and

Figure 4 – Regional productivity growth in Switzerland 2011-2015



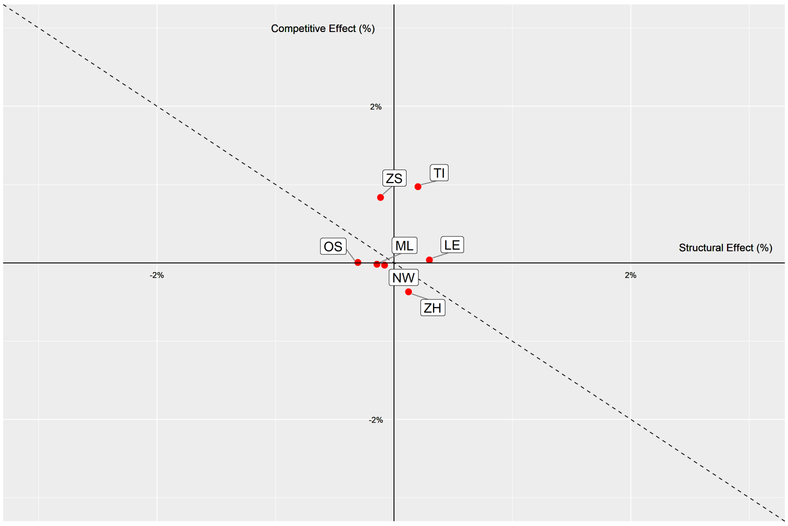
Note: Growth rate of the average value-added per full time equivalent in each major region; annual equivalent for the 2011-2015 period.

ASE terms are zero at this level of aggregation. In short, employment growth has been low and homogeneous across regions. The exception comes from Zentralschweiz where the positive differential is mainly due to the dynamism of that specific region. A look at figure A1 in the Appendix suggests that the first (2011-2012) and the last subperiod (2014-2015) are the main drivers of that specific pattern.

Results are a more contrasted for value-added. Figure 6 shows roughly three different groups: first, low-growth differential regions, close to the origin (Zentral, Nordwest and Ostschweiz), second a group of three major regions with a weak structural effect but a large competitive one, either positive for Zurich and Région lémanique or negative for Mittelland; and third an outlier represented by Ticino, with a strong competitive effect. This pattern is confirmed by the middle panel of figure 8, which shows that the larger growth achieved by Région lémanique with respect to Zurich is mostly due to its strong competitive effect, while Zurich relies on both effects. These average patterns over the whole sample period hide important variations across years as illustrated by Figure A2 in the Appendix. It shows for example that the relatively small net change for Zentralschweiz is the combination of a sharply negative differential in 2011-2012 followed by an opposite positive one in 2013-2014. Overall, the competitive effect is the main driver of the net outcome.

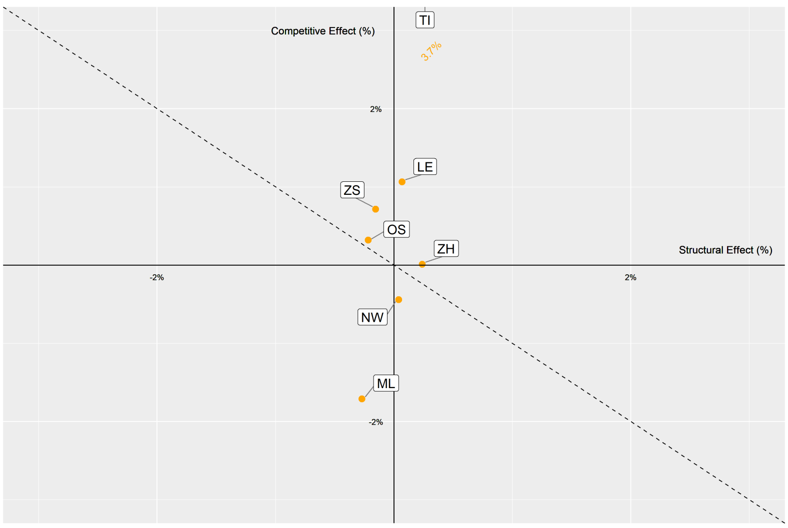
As differential growth effects are smaller for employment than for value-added, it is expected that the decomposition results for productivity will broadly mimic the value-

Figure 5 – Structural+competitive effects, employment, regions 2011-2015, NACE+



Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

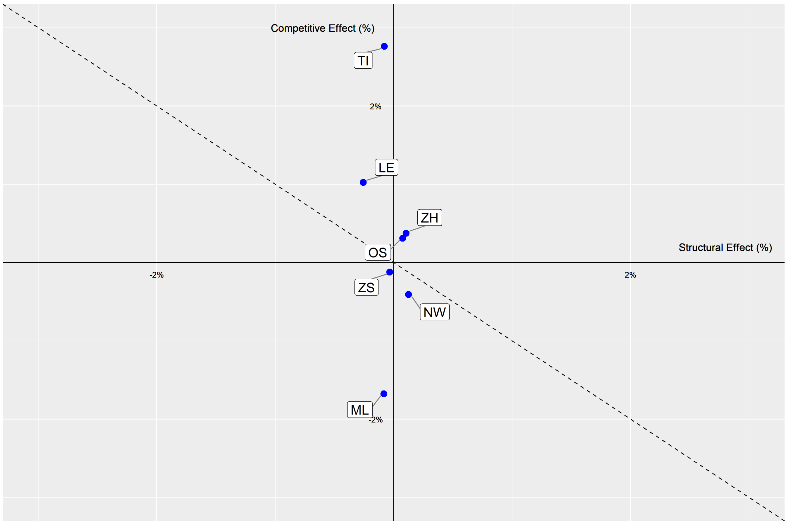
Figure 6 – Structural+competitive effects, value-added, regions 2011-2015, NACE+



Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

added ones. Figure 7 (or the lower panel of figure 8) confirms that this is the case, with a pattern which is very similar to Figure 6 (or the middle panel of figure 8). There are

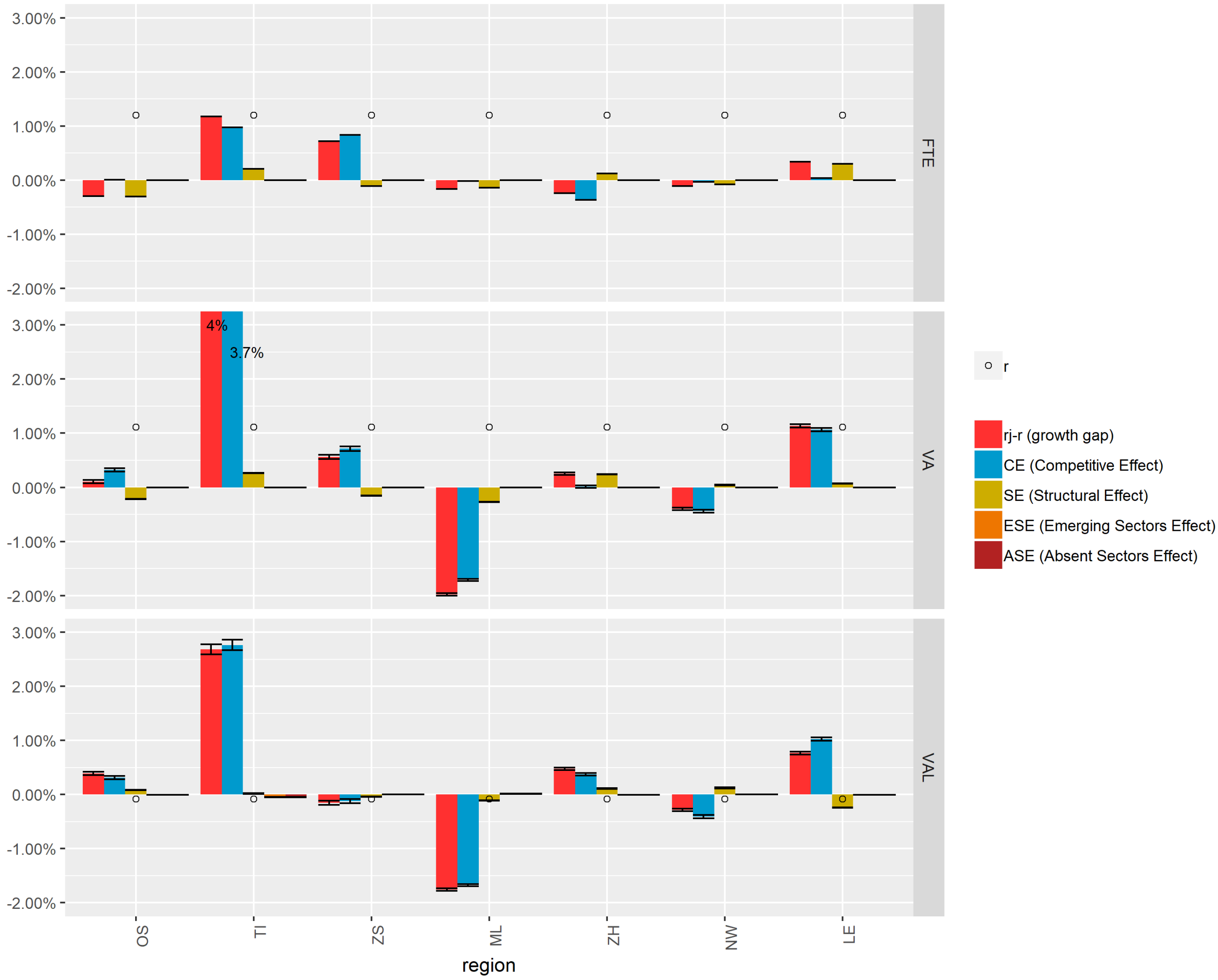
Figure 7 – Structural+competitive effects, productivity, regions 2011-2015, NACE+



Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

three differences however. First, the national productivity growth (r) is slightly negative. Second, the growth differential is now similar for Zurich and Région lémanique, due to differences in employment growth (negative for the former, positive for the later). Third, Zentralschweiz exhibit a negative differential, because employment growth has been larger than value-added growth. Here again, figure A3 in the Appendix confirms strong year-to-year variations.

Figure 8 – Detailed decomposition for employment, value-added and productivity, major regions 2011-2015, NACE+ sectors



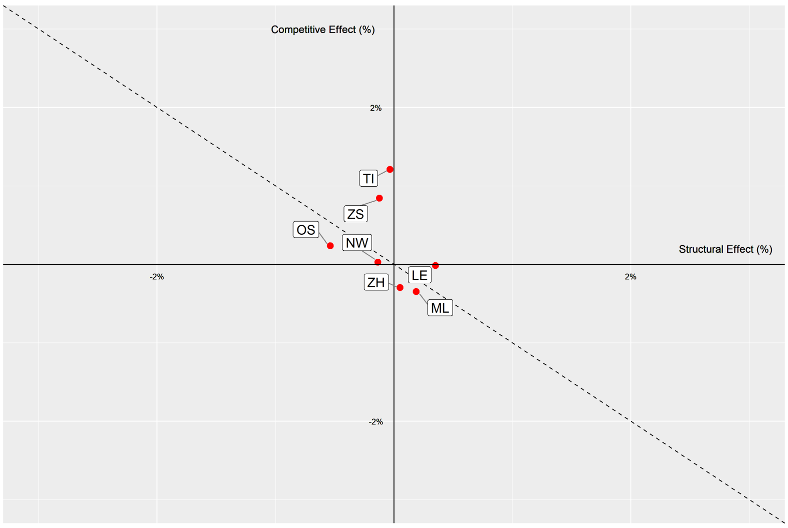
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

5.2 Results for major regions and NOGA4 sectors

The weak structural effects identified so far are probably due to the fact the thirteen NACE+ sectors are too few to reveal important structural differences between regions. What constitutes "machine manufacturing" firms in the Mittelland may be different to what they are in, say Ticino or Région lémanique. Thus, "zooming in" i.e. going further down the industrial classification may unveil differences across regions, which is why we report below results obtained by replacing the NACE+ by the NOGA4 industrial classification (460 sectors, see figure A7 in the Appendix).

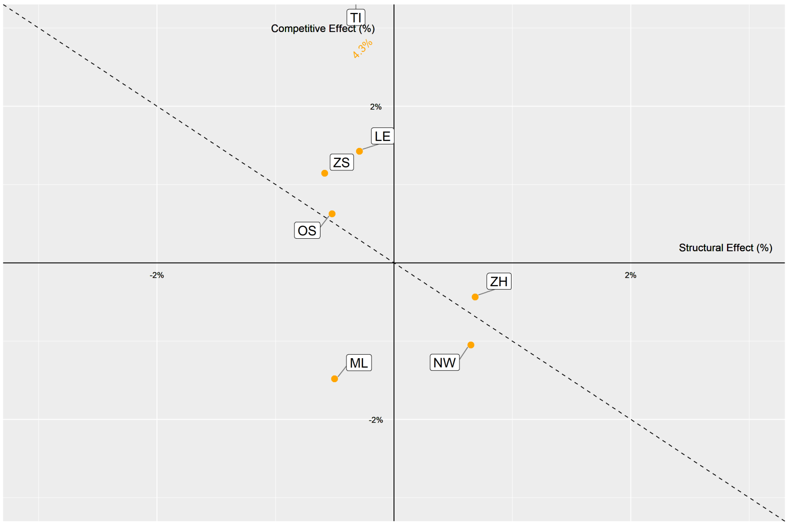
At first sight, the impact of that change is negligible, at least regarding employment. Most dots in figure 9 (NOGA4) are at the same location as in figure 5 (NACE+). However, this is not true for value-added. In figure 10, apart from Ticino which remains an outlier, most dots are now more evenly spread horizontally in comparison to figure 6. Structural effects are now non-negligible, either positive as in Région lémanique, Zurich or Nordwestschweiz, or negative as in Zentralschweiz, Ostschweiz and Mittelland. For the same reasons as previously discussed, the pattern for productivity growth is very similar (see figure 11).

Figure 9 – Structural+competitive effects, employment, regions 2011-2015, NOGA4



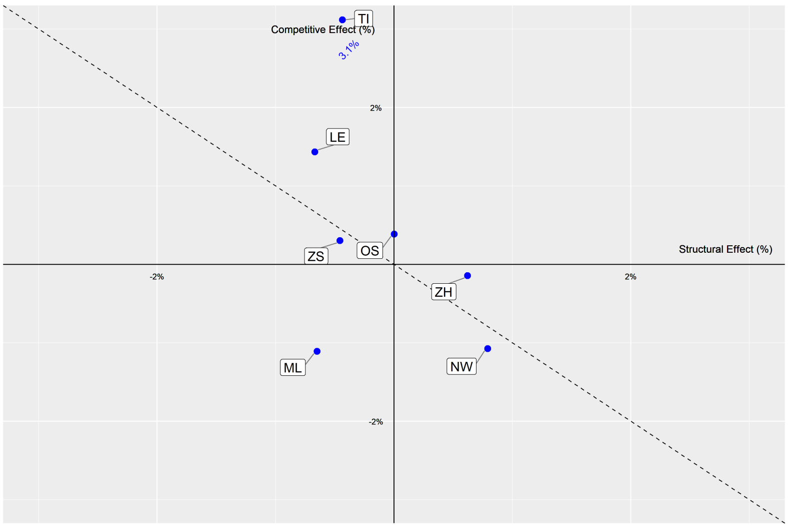
Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

Figure 10 – Structural+competitive effects, value-added, regions 2011-2015, NOGA4



Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

Figure 11 – Structural+competitive effects, productivity, regions 2011-2015, NOGA4



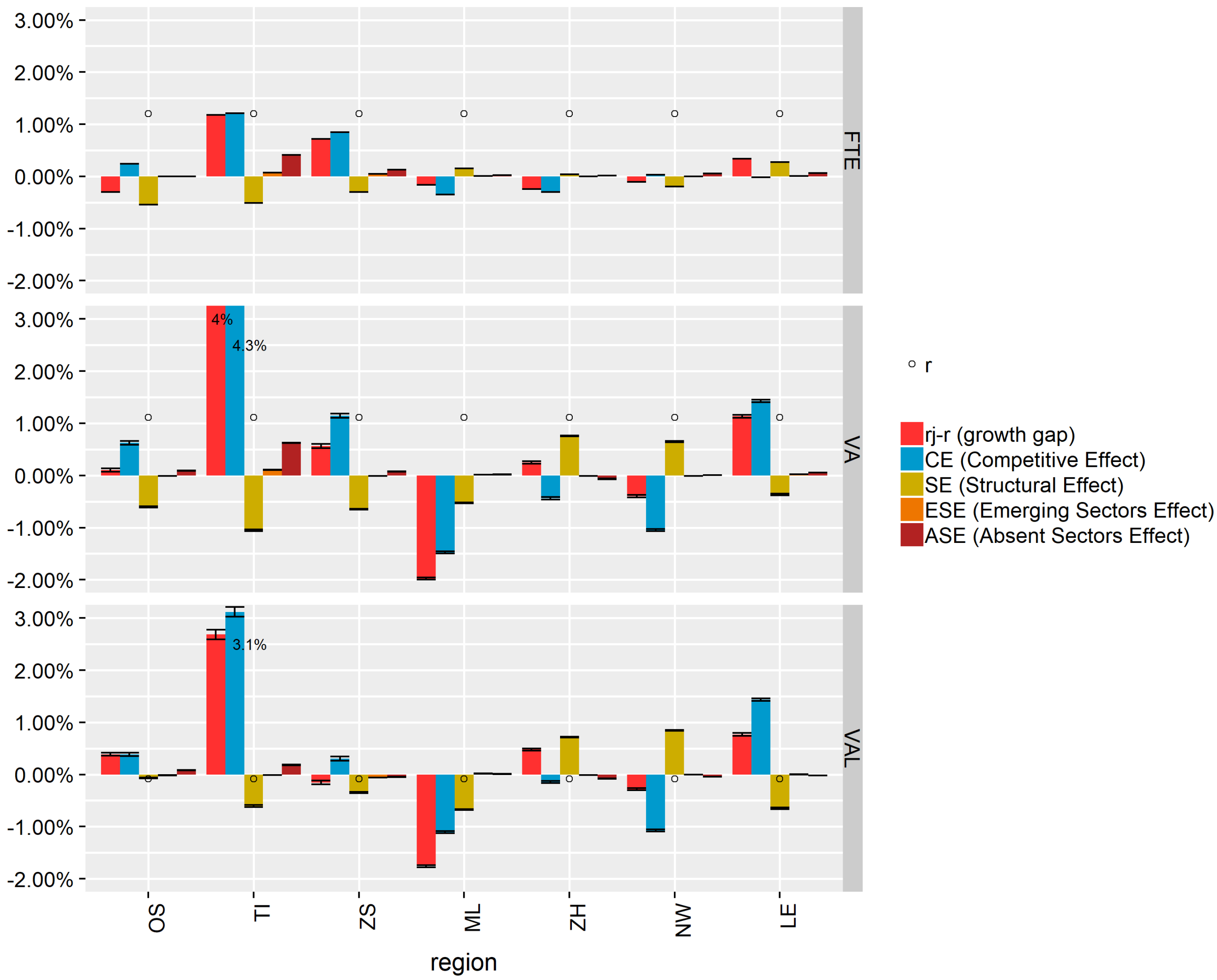
Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

Overall, the productivity growth pattern that emerges looks different now. While most of it was attributed to the competitive effect while working at the NACE+ level (dots aligned along the vertical axis in figure 11), both types of effects seem to matter when using NOGA4 sectors (dots more evenly spread in figure 7). Of course the orthogonal distance to the downward-sloping diagonal, i.e. the net total effect, remains identical between the two diagrams, but the contributions of the two effects to that distance are now more varied. In short, it seems that zooming in the industrial structure has allowed to explain out part of the competitive effects identified at the aggregate level.

Figure 12 presents the decomposition of the three elements constituting the gross structural effect discussed above (see equation (2)). As it turns out, apart from Ticino where they play a relatively minor role, the impact of the emerging sectors (ESE) absent sectors (ASE) effects on productivity growth appears negligible. Most of the variation can thus be attributed to the "pure" structural effects affecting the incumbent sectors. [10] However, this may be due to the fact that regions are so large that even when working at the NOGA4 level, all sectors are present in all regions and all years. This may not be the case anymore when working with smaller geographical areas like cantons, which is what the next subsection analyses.

10. Apart from a few exceptions, this remains true when working on year-to-year variations, see figures A4, A5 and A6 in the Appendix

Figure 12 – Detailed decomposition for employment, value-added and productivity, major regions 2011-2015, NOGA4 sectors

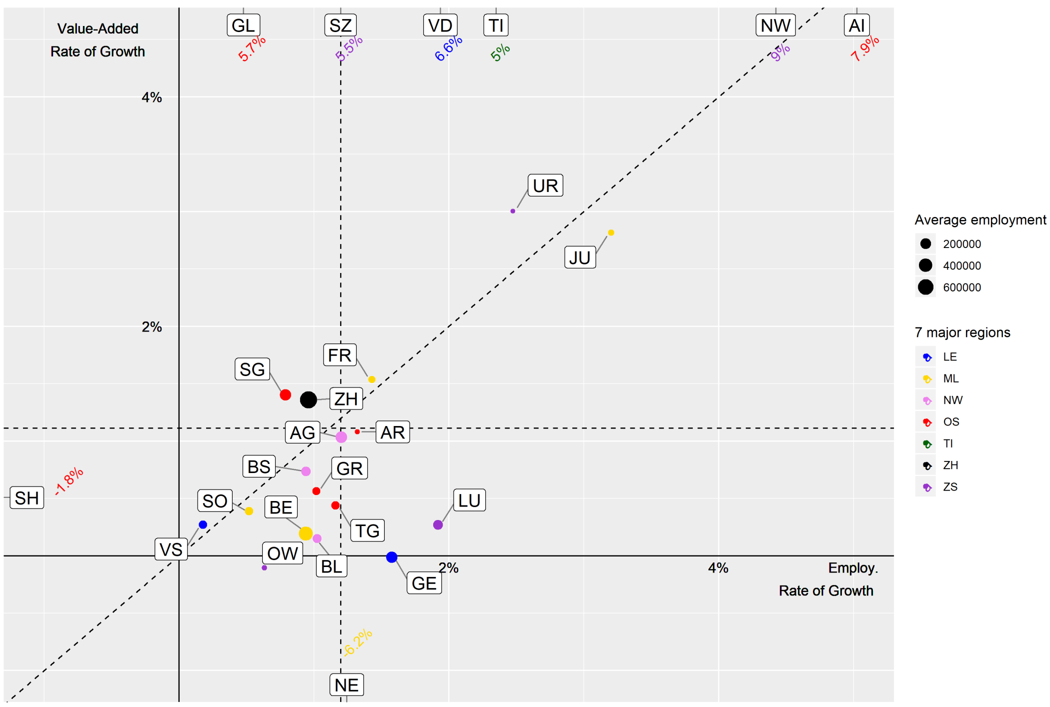


Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

5.3 Results for cantons and NOGA4 sectors

Figure 13 provides the scatter plot for employment and value-added growth at the level of cantons over the 2011-2015 period. The general picture is similar to what is obtained at the level of major regions (see figure 2) i.e. most dots seem vertically aligned along the sample mean. Apart from the specific cases of Ticino and Zurich, the only major region which seems homogeneous is Région lémanique, with Geneva, Vaud and Valais locating close to one another. All other major regions present sharp contrasts between the highest growing canton (Fribourg, Baselstadt, Appenzell Innerrhoden and Schwyz) and the lowest growing canton in terms of value-added (Neuchâtel, Baselland, Schaffhausen and Luzern).

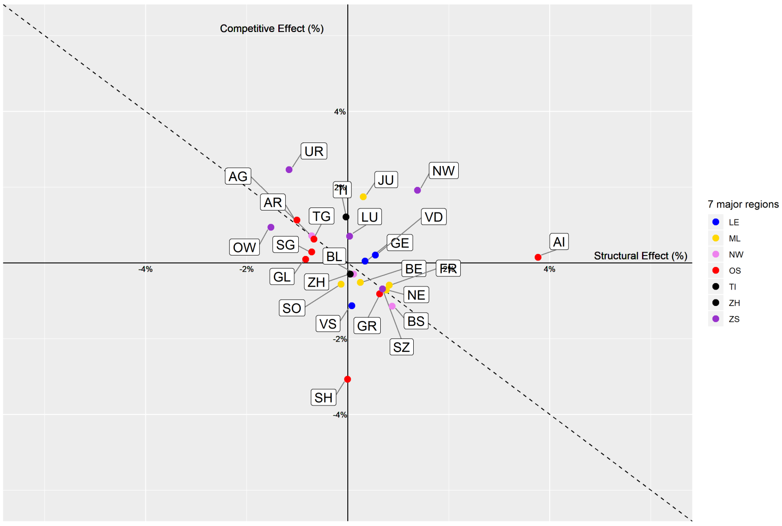
Figure 13 – Average growth of employment and value-added by cantons 2011-2015



Note: Annual growth over the 2011-2015 period; employment measured in full time equivalents; the size of dots is proportional to the average cantonal employment.

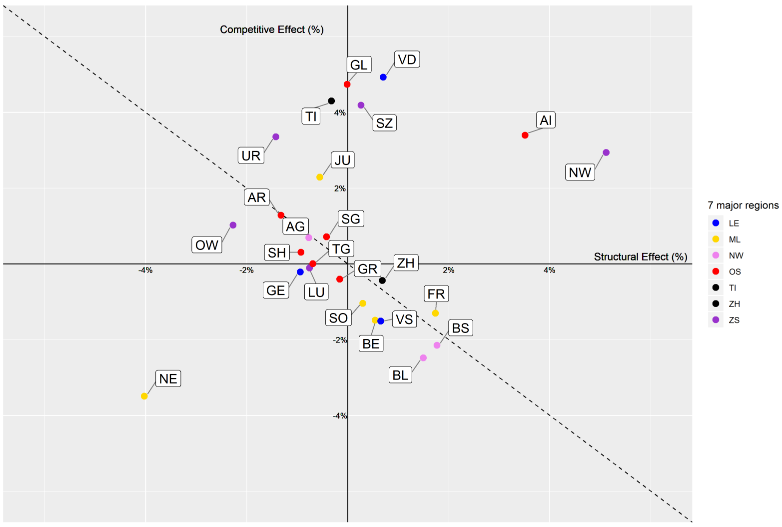
The SE-CE decomposition applied to employment, value-added and productivity leads to overall figures (see figures 14, 15 and 16) which are similar in shape to those obtained above that is, rather low SE effects for employment, but larger ones for value-added and productivity. The order of magnitude is larger, as could be expected given the observed heterogeneity within major regions. In particular, regarding productivity, two new outliers emerge namely Schwyz (around +4%) and Neuchâtel (around -7%).

Figure 14 – Structural+competitive effects, employment, cantons 2011-2015, NOGA4



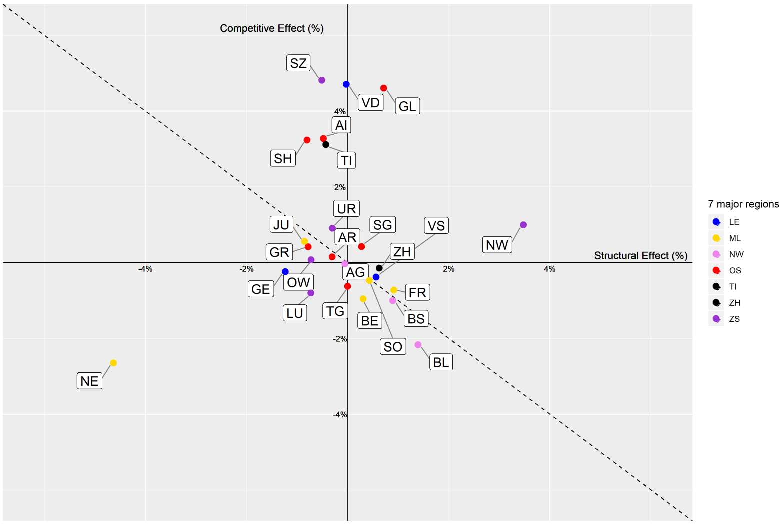
Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

Figure 15 – Structural+competitive effects, value-added, cantons 2011-2015, NOGA4



Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

Figure 16 – Structural+competitive effects, productivity, cantons 2011-2015, NOGA4



Note: The horizontal axis regroups the SE, ESE and ASE terms of equation (2) in the main text, the vertical axis represents only the CE term.

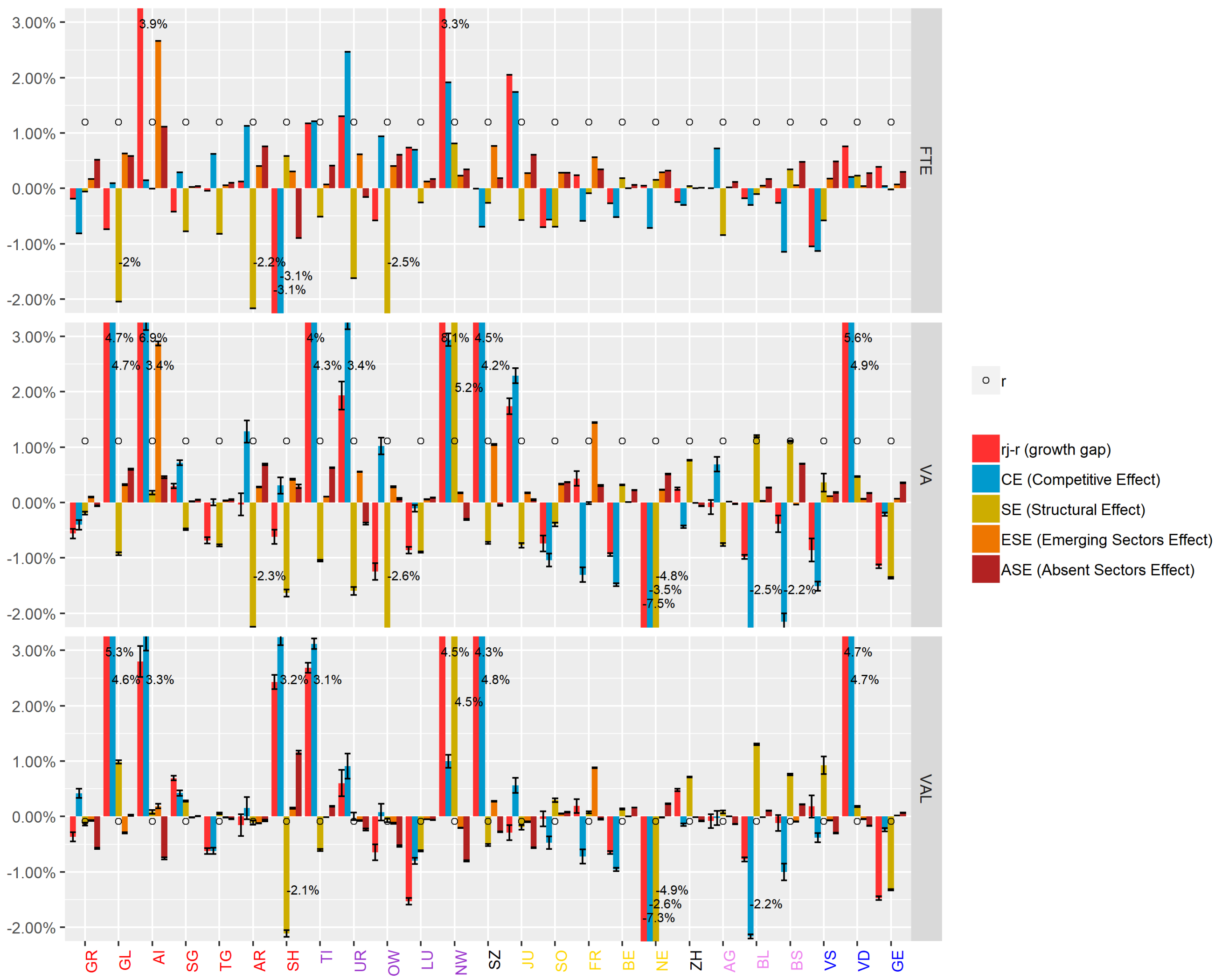
The structural effects that appear in the plot diagrams are underestimates of the true structural forces at work, given that they collapse the three effects described in equation (2) into a single term. Figure 17 provides the decomposition into the three components. In several instances, there are strong compensations between the three effects.

For example, for employment growth and in both Glarus and Appenzell Ausserrhoden, the "pure" structural on incumbent sectors is strongly negative (less than -1%) but it is almost perfectly matched by the positive impact of emerging and absent sectors (ESE and ASE effects). The opposite occurs for productivity growth in Nidwald, where the positive pure SE effect is almost matched by the negative ESE and ASE effects. In the case of Fribourg, the contribution of incumbent and absent sectors on productivity growth is negative, and compensated by the positive impact of emerging sectors.

Overall, and as expected, the structural effects turn out to matter more when using cantons rather than major regions. [11]. Even if the competitive effect remains the dominant force in certain cases (e.g. the strong productivity increase for Ticino and Schwyz), it becomes less prevalent in other cases (e.g. in Neuchâtel, where structural forces regarding incumbent and emerging sectors combine to generate a strong productivity decline).

11. See also their importance in year-to-year variations in figures A8, A9 and A10 in the Appendix)

Figure 17 – Detailed decomposition for employment, value-added and productivity, cantons 2011-2015, NOGA4 sectors



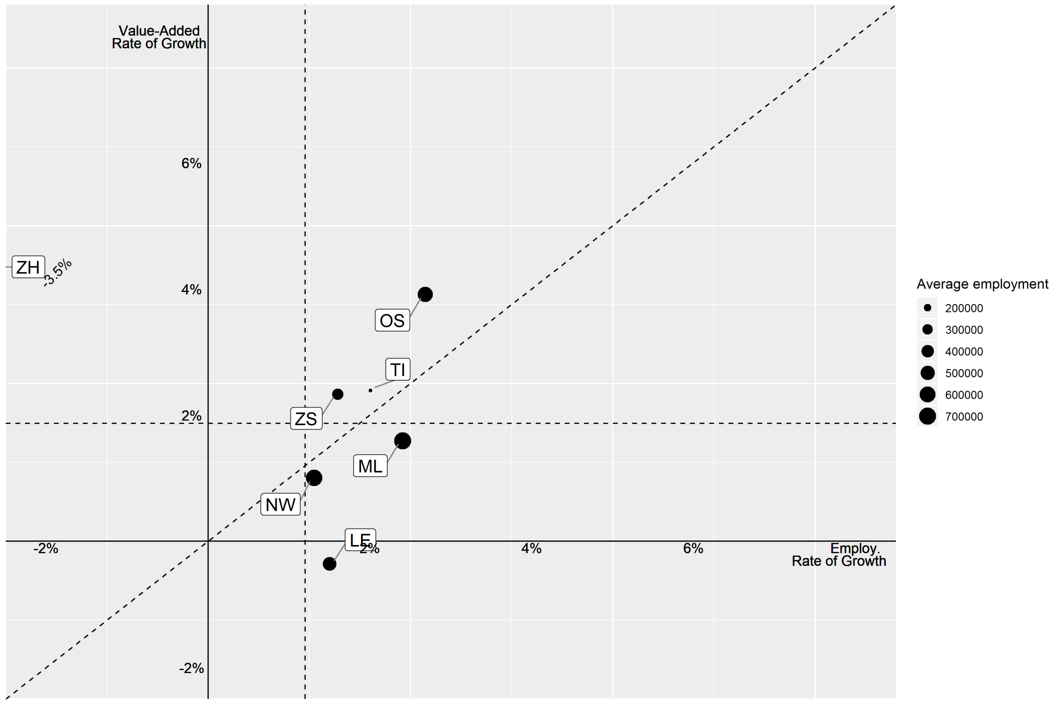
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples. Cantons sorted in ascending average productivity order in each given major region (colored).

6 Alternative data sample

A final set of results is obtained using the alternative *restricted* sample described in section 4. As above mentioned, this sample is less representative of the whole population of Swiss firms, with around six times less observations and a bias towards large single plant firms. It should come as no surprise if results turn out to be different, which they do. As patterns are already different at the most aggregated level (major regions and large sectors) we limit the discussion to that case.

Figures 18 and 19 present growth rates for employment and value-added either for regions or sectors, and should thus be compared to figures 2 and 3. The overall pattern of dots rather aligned vertically for regions and along the diagonal for sectors remains broadly unchanged, so for that sample also we should expect that region-specific competitive effects dominate over structural effects, as can be verified looking at figure 20.

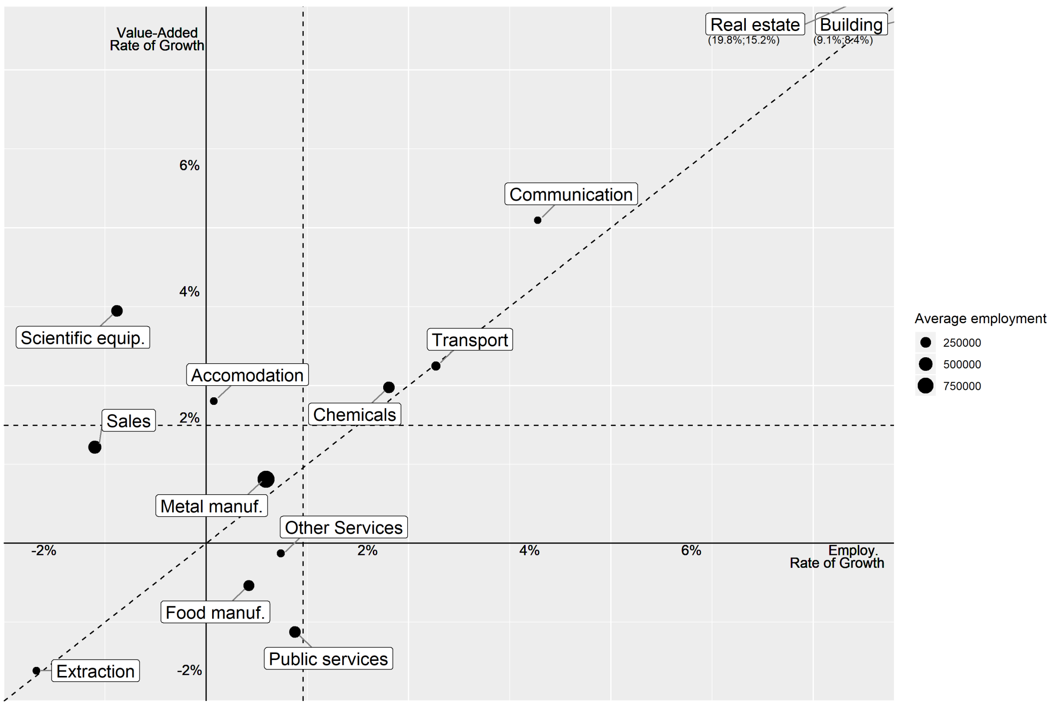
Figure 18 – Average growth of employment and value-added by major regions 2011-2015 (restricted sample)



Note: Annual growth over the 2011-2015 period; employment measured in full time equivalents; the size of dots is proportional to the average regional employment; see Table 1 for names of major regions.

However, apart from theses general characteristics, there a many differences. First,

Figure 19 – Average growth of employment and value-added by major sectors 2011-2015 (restricted sample)



Note: Annual growth over the 2011-2015 period; employment measured in full time equivalents; the size of dots is proportional to the average industrial employment; see Table 1 for names of major sectors.

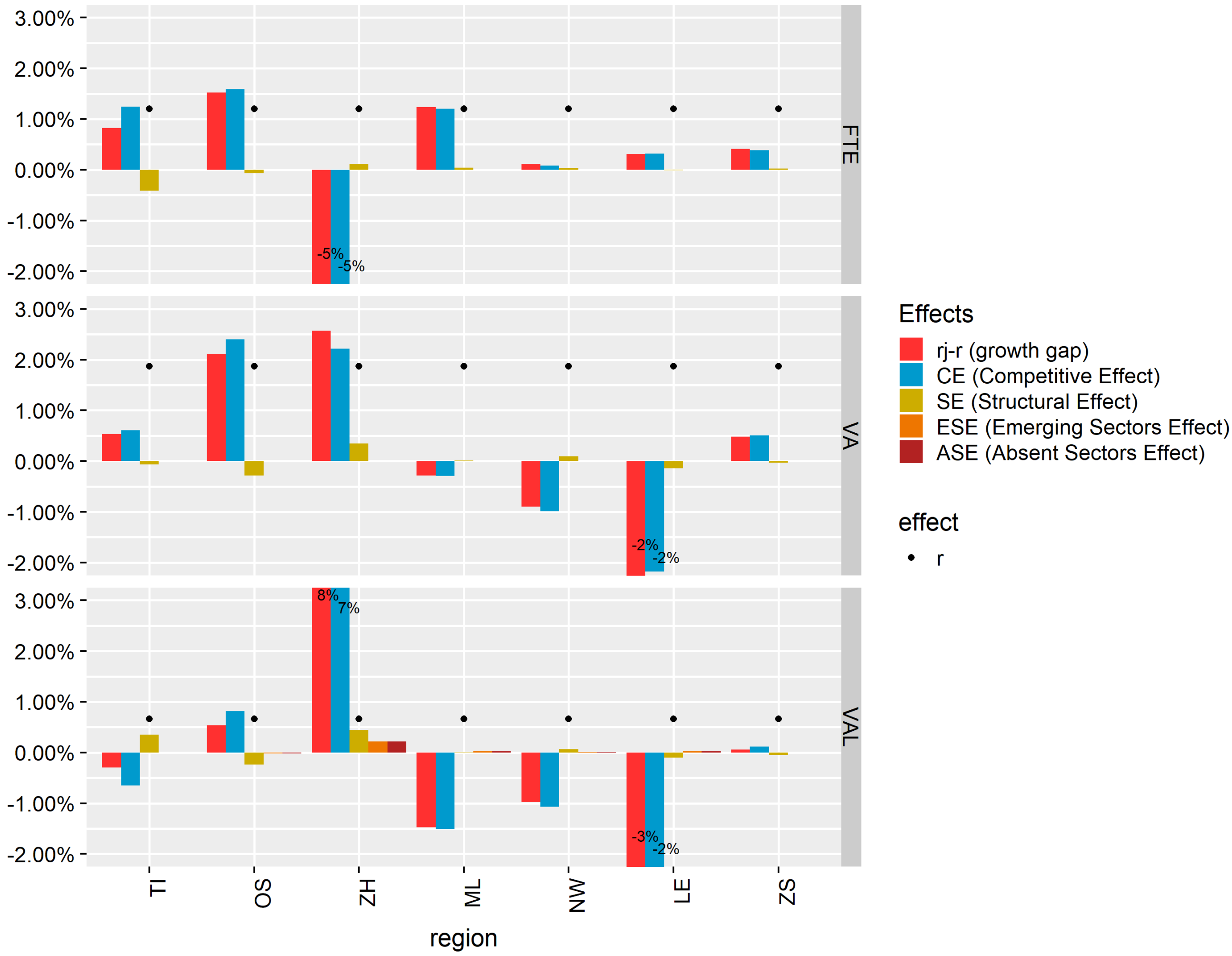
the overall growth rate for value-added is almost twice as large, while the growth rate for employment is similar, Therefore, based on the restricted sample, on average there is an increase (slightly less than 1%) in productivity in Switzerland, contrasting with the small decrease (around -0.2%) discussed for the imputed sample.

Second, important differences appear between regions. Ticino and Zentralschweiz loose their outlier status. The outlier is now Zurich, with a strong productivity increase due to both an increase in value added and a decrease in employment. In total contrast with the imputed sample, Région lémanique now exhibits a productivity decrease while productivity increases in Zentral, Ost and Nordwestschweiz. Year-to-year differences are also important (see figures A11, A12 and A13 in the Appendix).

Third, there are also some differences for sectors. In general, the sign of the productivity growth rate remains unchanged (apart from Accommodation and food services and Extraction industries where productivity increases). However, there are important differences in the magnitude of employment growth, which becomes very large for the

Building and Real estate sectors, and negative for the Whole and retail sales sector.

Figure 20 – Detailed decomposition for employment, value-added and productivity, major regions 2011-2015 (restricted sample)



Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r).

7 Conclusion

On the basis of a shift-share analysis of labour productivity growth applied to a novel database for Switzerland across the 2011-2015 period, we identify a number of interesting results at the level of geographical entities or industrial sectors. Apart from the Région lémanique, most major regions in Switzerland are characterized by strong differences between cantons. In terms of average productivity growth, Ticino and Schwytz exhibit the largest increase (around +4%) while Neuchâtel suffers the largest loss (-7%). Productivity heterogeneity between large sectors is more limited. The highest performing sectors are communication and scientific equipement (+1%), the lowest public administration and Food, textiles and wood products (-2%). Detailed results are provided in the figures presented in the text and the Appendix.

Moreover, four basic patterns emerge that may have a more general relevance. First, productivity growth differences tend to be larger across geographical units than across sectors. Second, structural effects tend to be weaker for employment growth than for value-added or productivity growth. Third, when the aggregation level if high (major regions or NACE+ sectors), competitive effects are dominant, but incrementing the number of geographical units (cantons) and/or the number of industrial categories (NOGA4 sectors) increases the importance and the variance of structural effects (related to incumbent, emerging or absent sectors). Fourth, year-to-year variations are stronger and do not necessarily replicate the observed pattern of productivity growth sources across the whole period.

In sum, two general lessons should be kept in mind when addressing the puzzle of low productivity growth at the aggregate level. On the one hand, it may hide strong variations in performance between sub-components, across both industrial sectors and geographical regions. On the other hand, the share of structural effects (or rationalization effects) in the total depends crucially on the level of disaggregation. This may be important when discussing industrial and regional policy proposals to enhance productivity.

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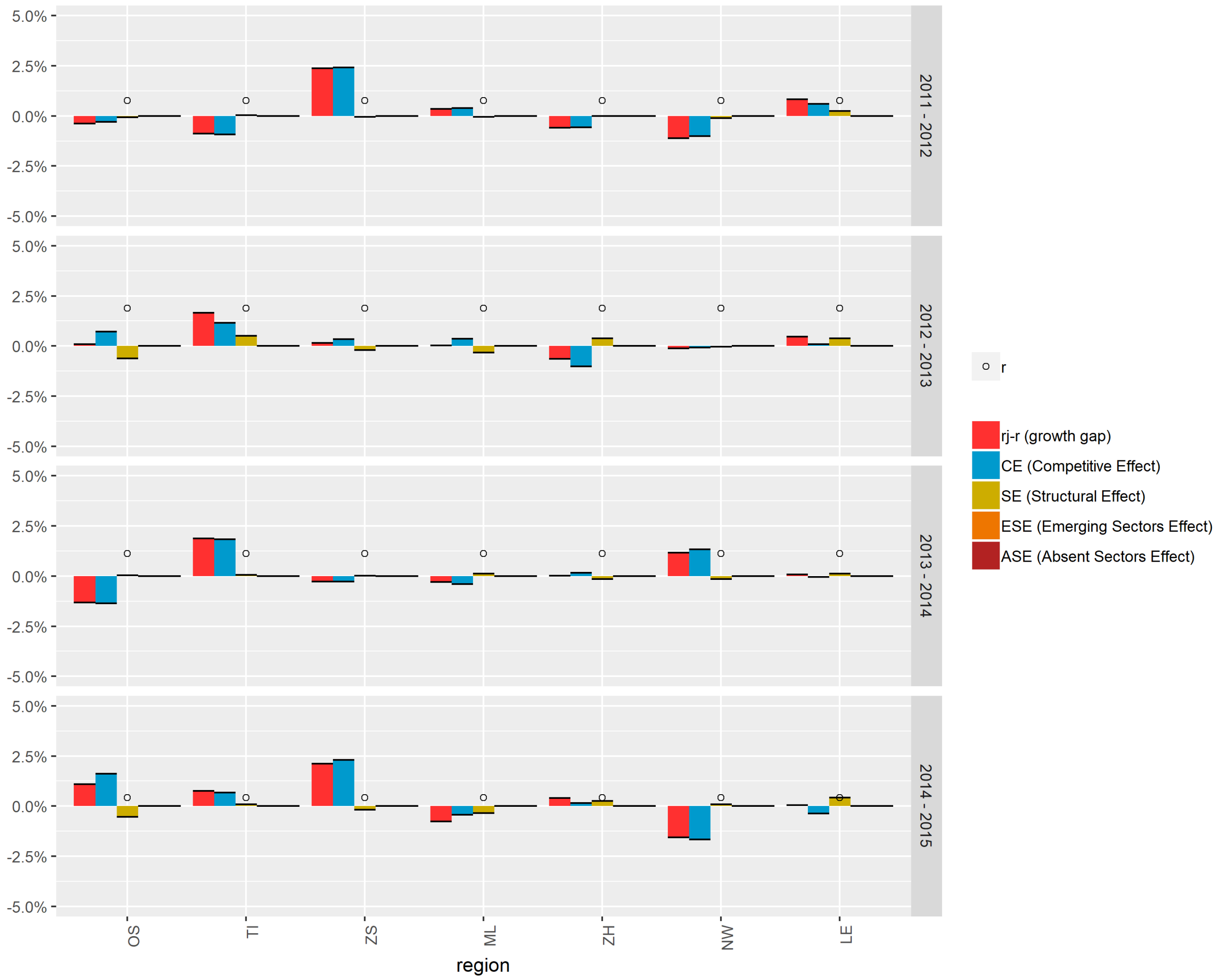
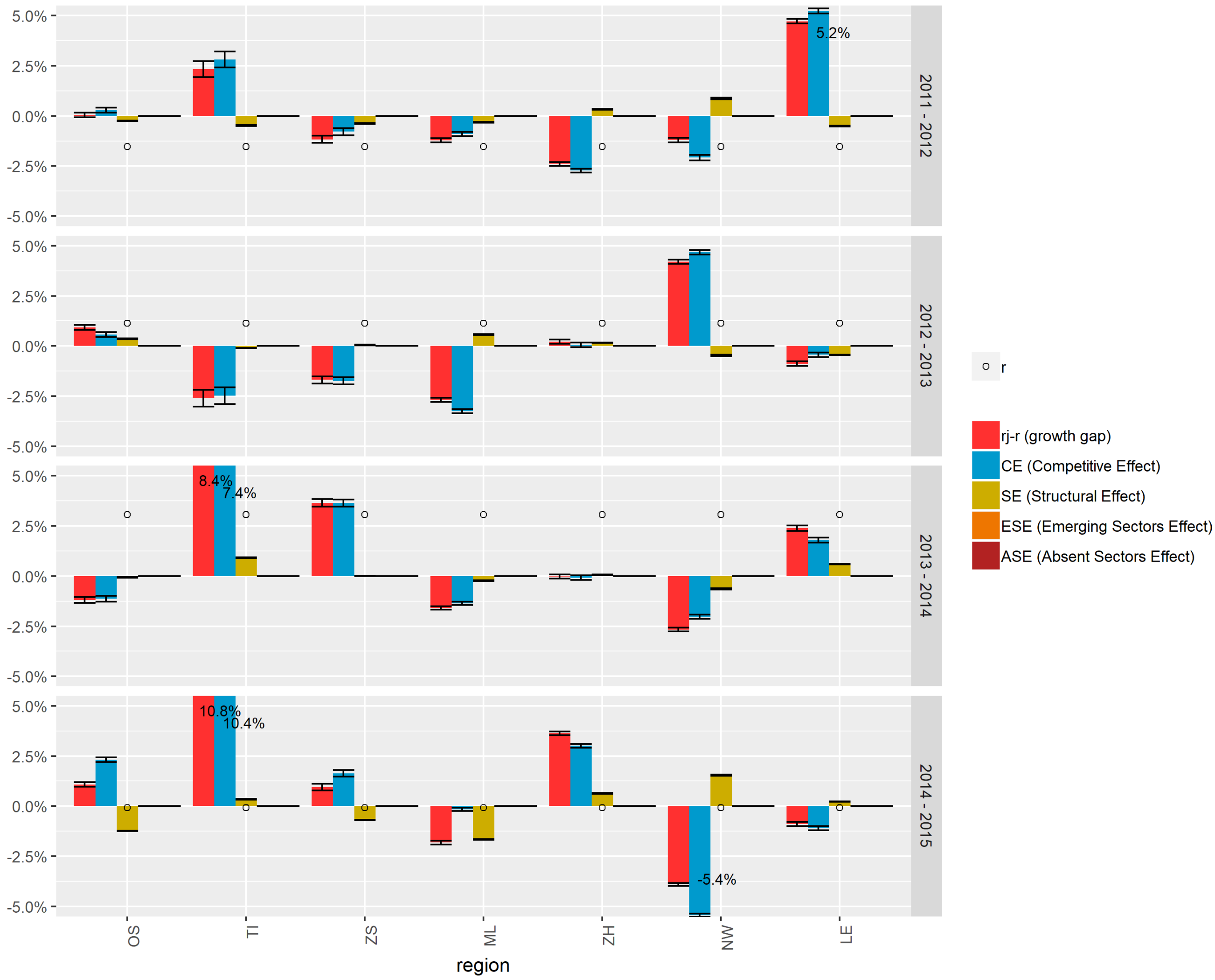
A Appendix

Figure A1 – Detailed employment decomposition for major regions 2011-2015, NACE+ sectors



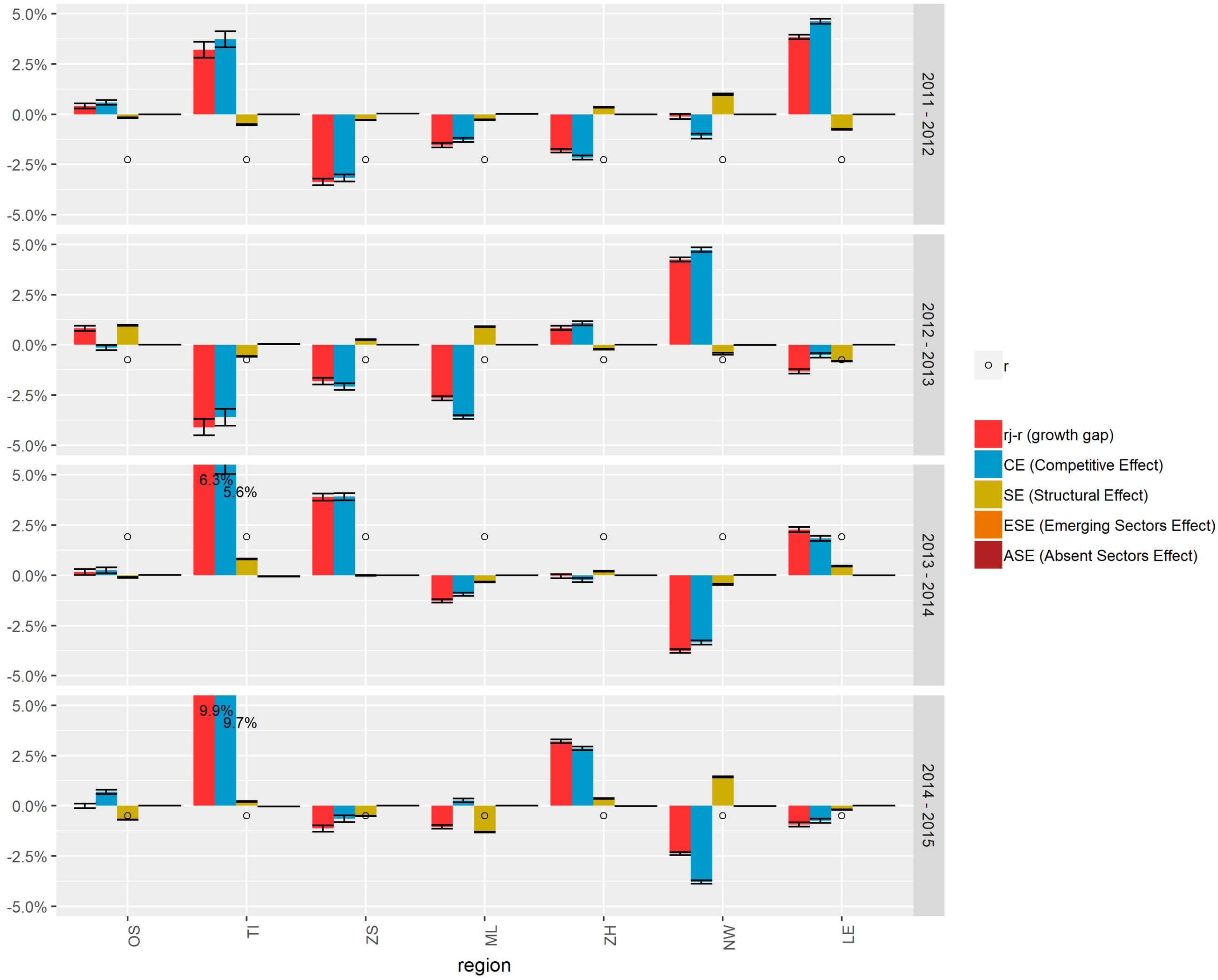
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

Figure A2 – Detailed value-added decomposition for major regions 2011-2015, NACE+ sectors



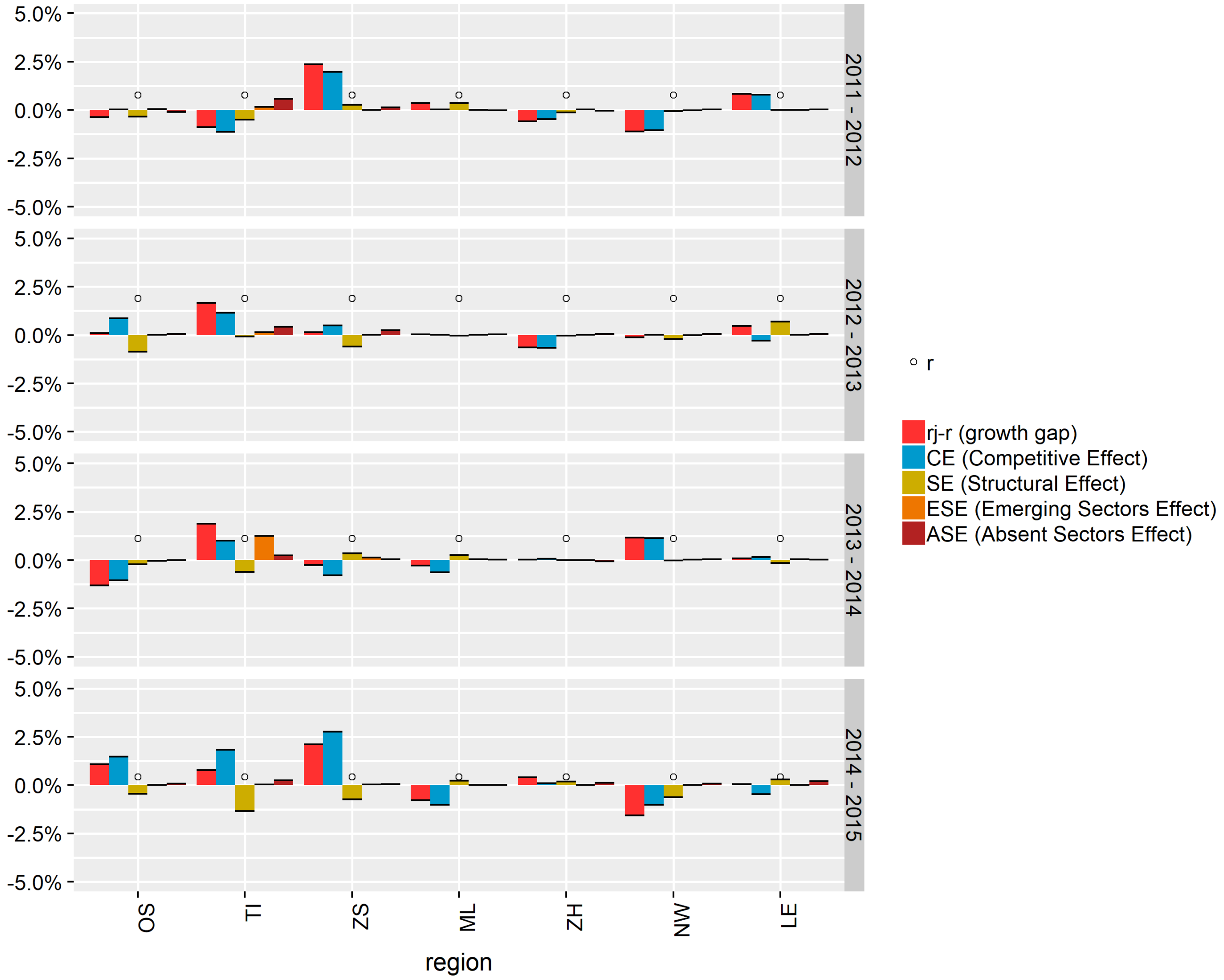
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

Figure A3 – Detailed productivity decomposition for major regions 2011-2015, NACE+ sectors



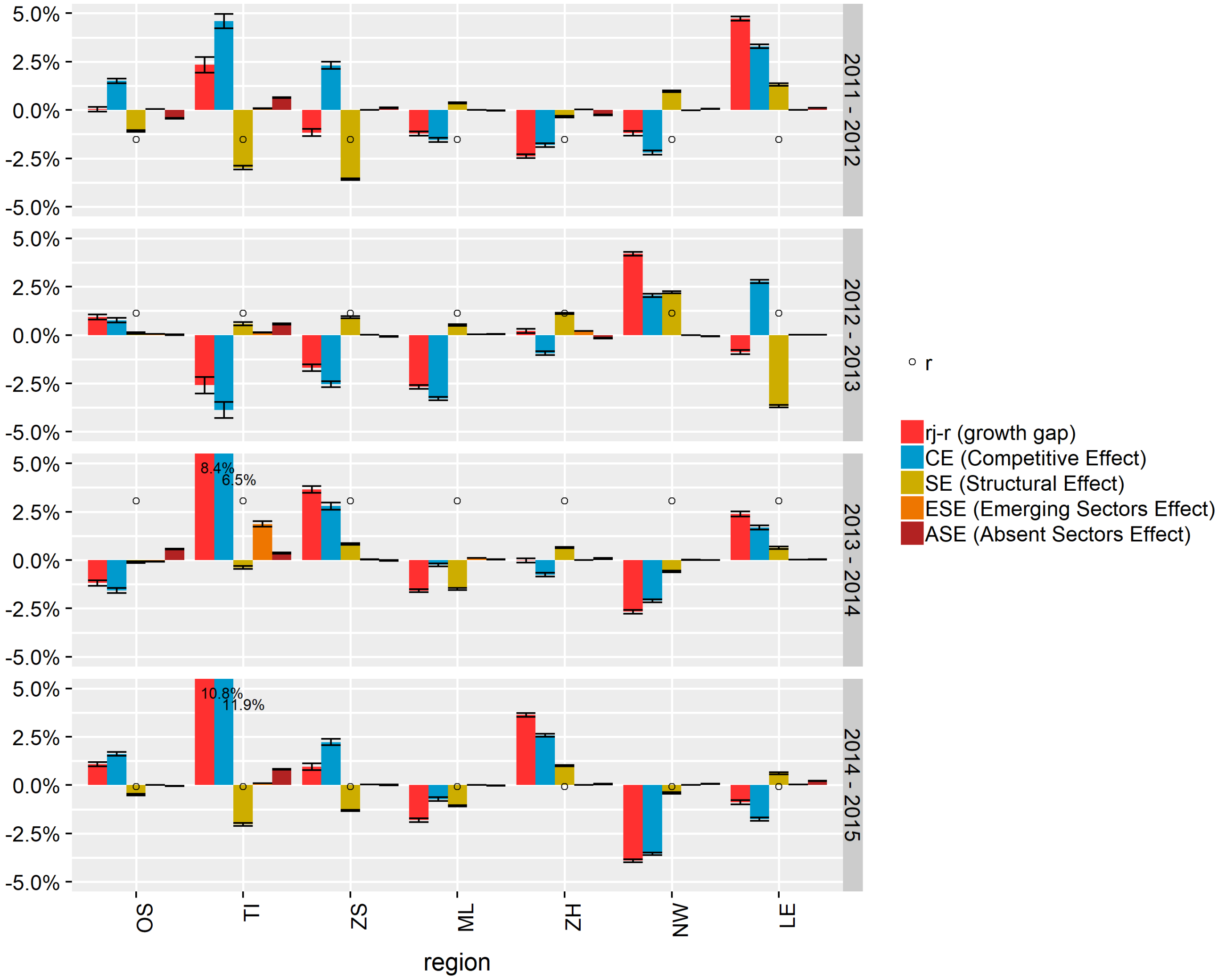
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

Figure A4 – Detailed employment decomposition for major regions 2011-2015, NOGA4 sectors



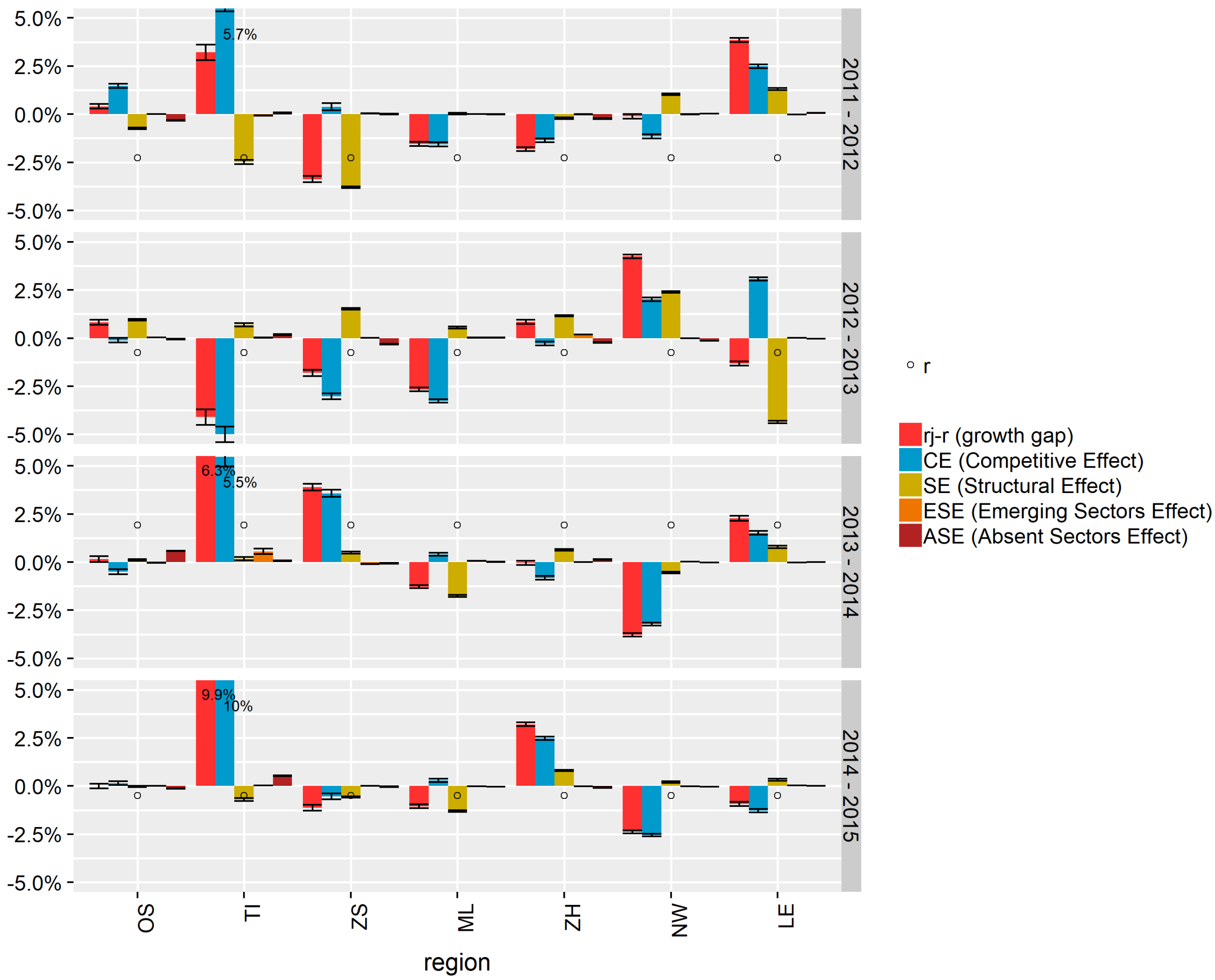
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

Figure A5 – Detailed value-added decomposition for major regions 2011-2015, NOGA4 sectors



Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

Figure A6 – Detailed productivity decomposition for major regions 2011-2015, NOGA4 sectors

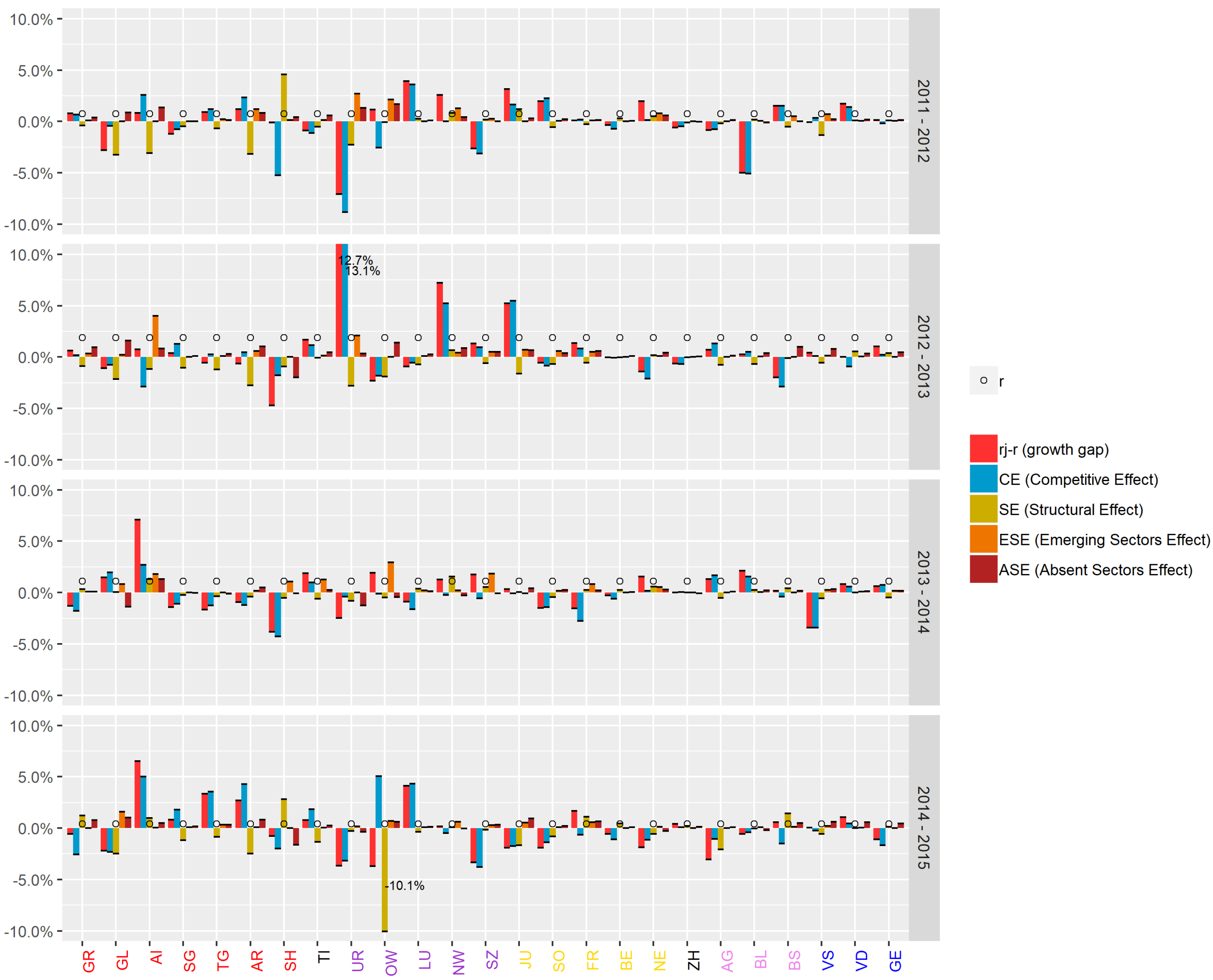


Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples.

Figure A7 – Average growth of employment and value-added by NOGA4 sector 2011-2015

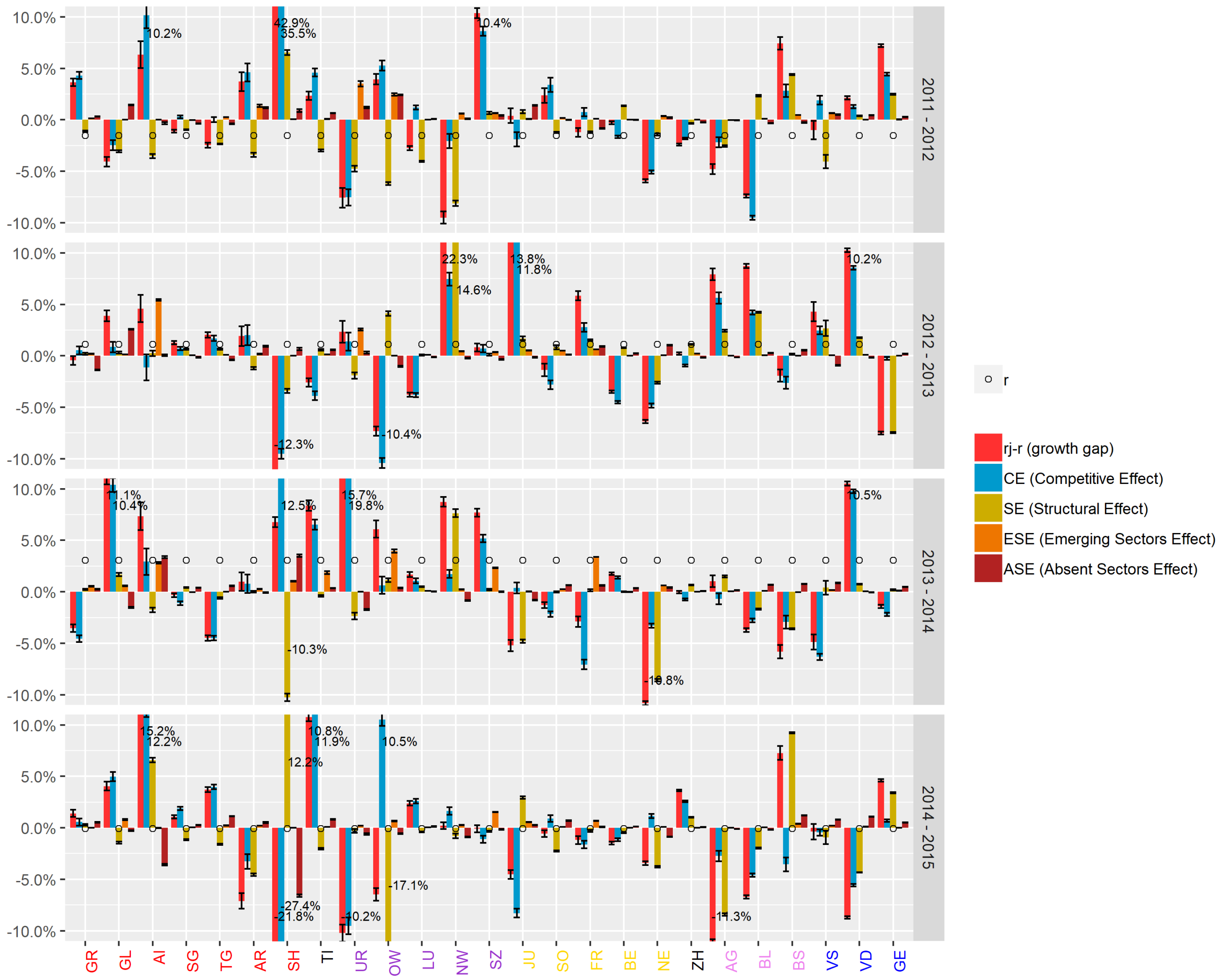
Note: Annual growth over the 2011-2015 period; employment measured in full time equivalents; the size of dots is proportional to the average industrial employment; see Table 1 for names of major sectors.

Figure A8 – Detailed employment decomposition for cantons 2011-2015, NOGA4 sectors



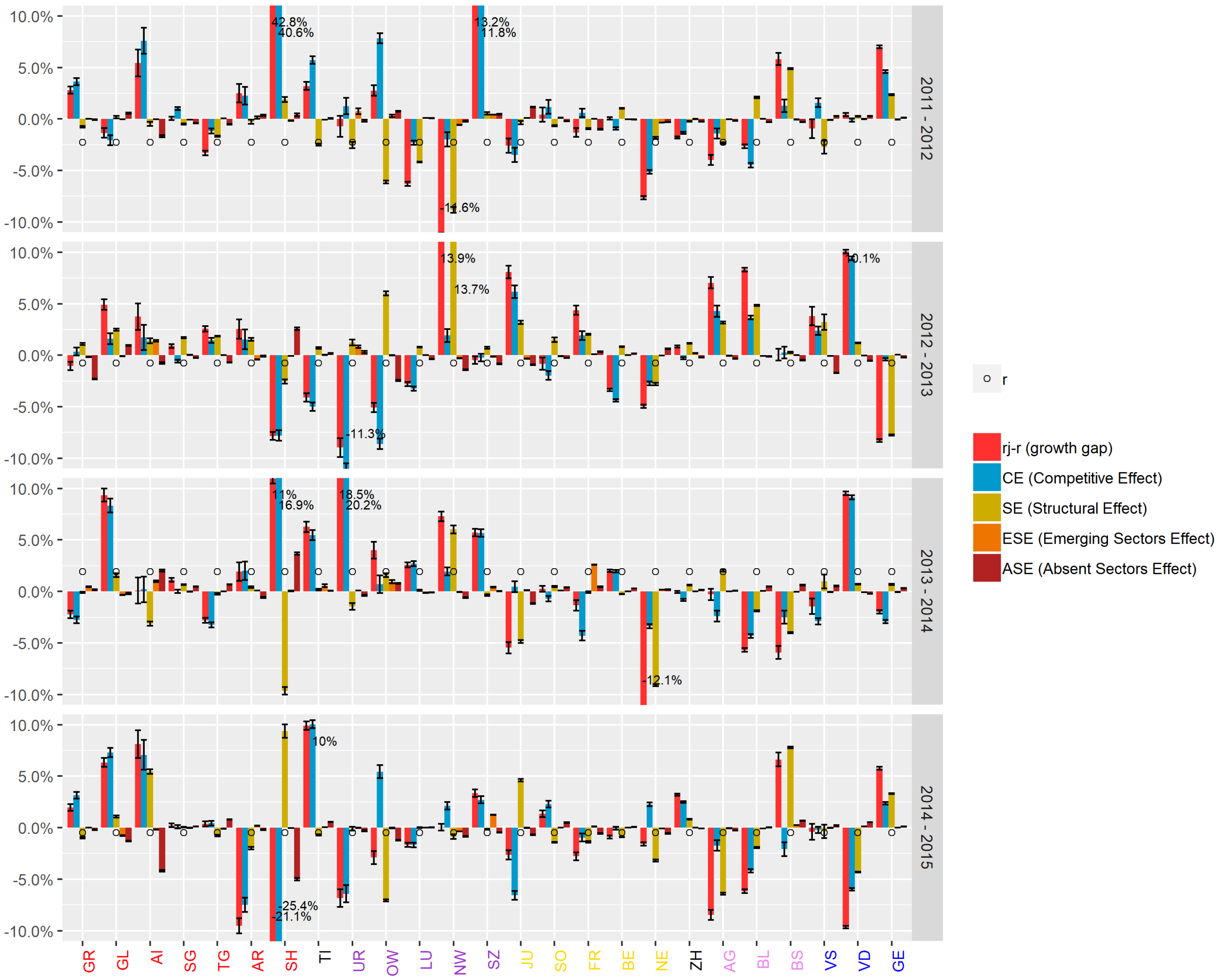
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r). Cantons sorted in ascending average productivity order in each given major region (colored).

Figure A9 – Detailed value-added decomposition for cantons 2011-2015, NOGA4 sectors



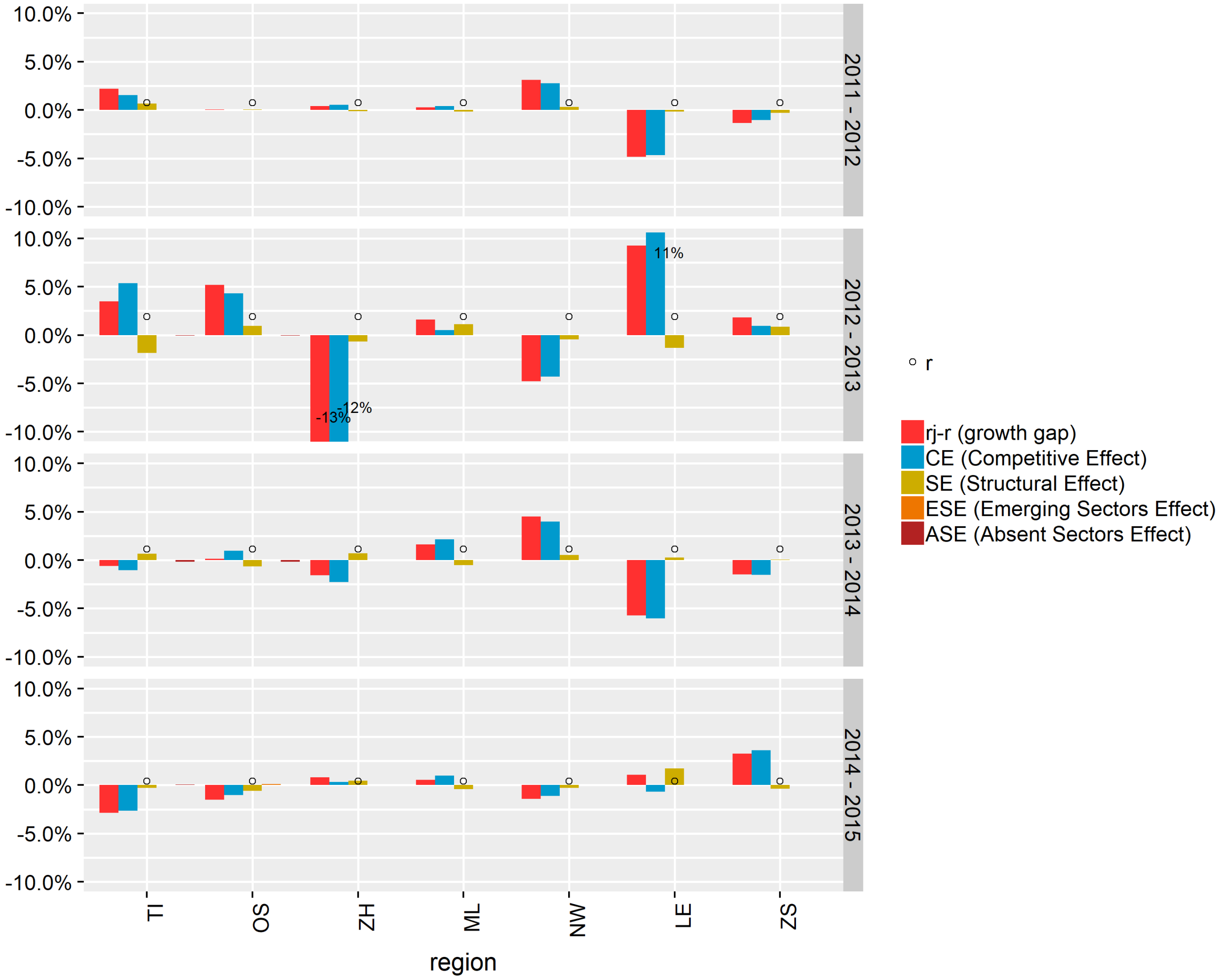
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples. Cantons sorted in ascending average productivity order in each given major region (colored).

Figure A10 – Detailed productivity decomposition for cantons 2011-2015, NOGA4 sectors



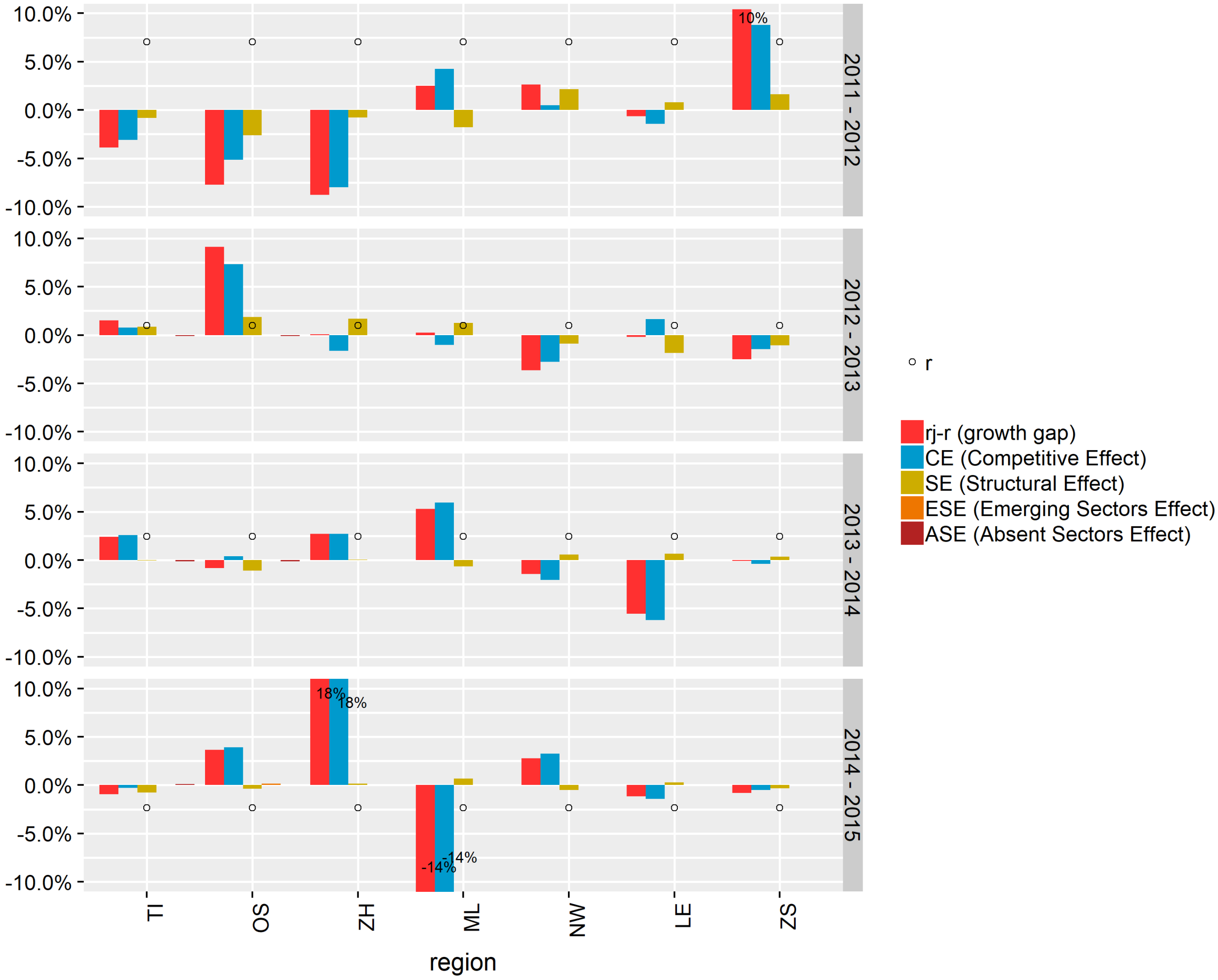
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r) and the top or bottom "T" the mean 95%-confidence interval from the 400 imputed samples. Cantons sorted in ascending average productivity order in each given major region (colored).

Figure A11 – Detailed employment decomposition for major regions 2011-2015 (restricted sample)



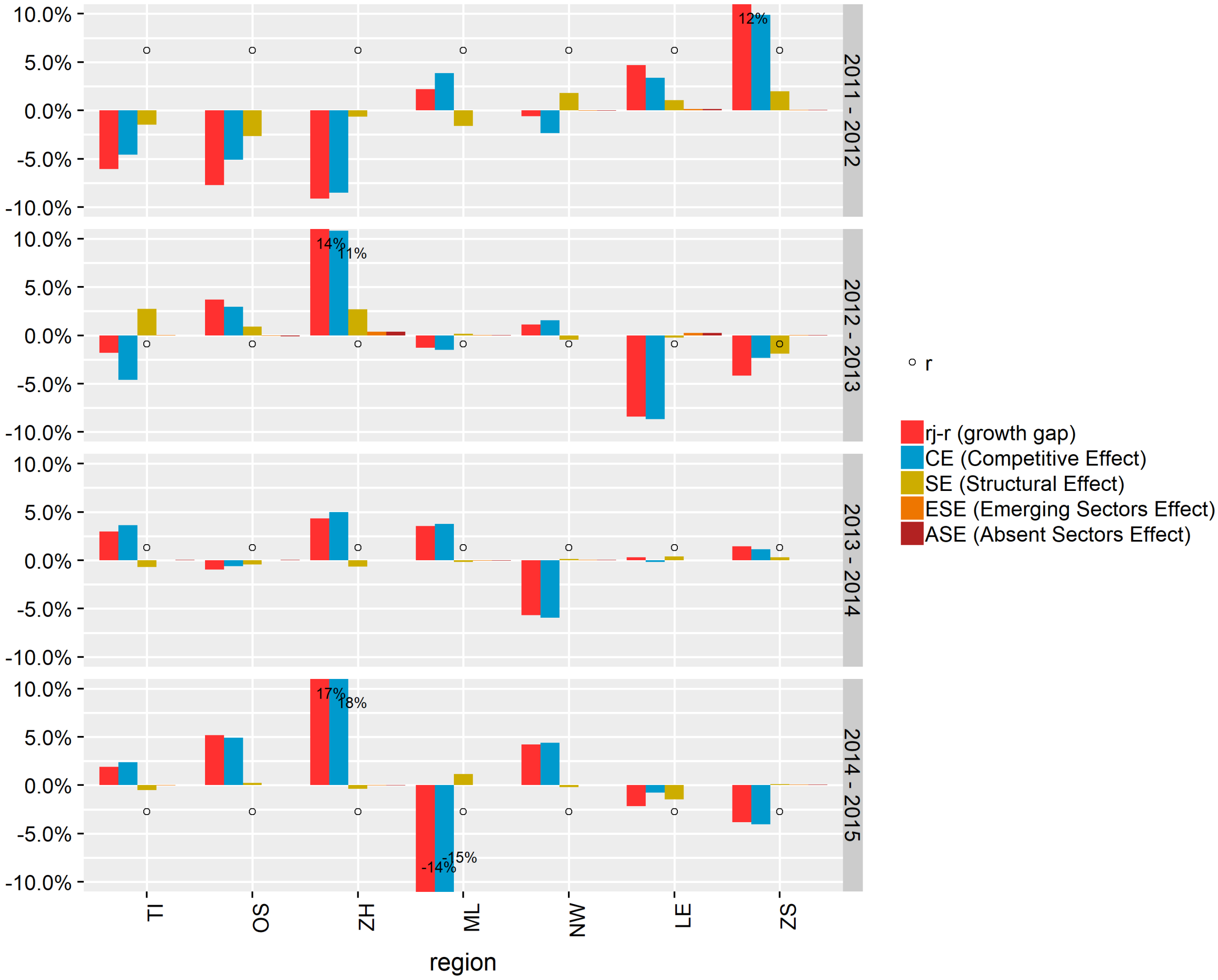
Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r).

Figure A12 – Detailed value-added decomposition for major regions 2011-2015 (restricted sample)



Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r).

Figure A13 – Detailed productivity decomposition for major regions 2011-2015 (restricted sample)



Note: See equation (2), in the main text, for a definition of the different effects and Table 1 for a definition of the major regions and "NACE+" sectors. The "°" character represents the national average (r).