Successful Economic Diversifications: Implications for Refining Smart Specialisation Strategies in Less Developed Regions

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Related and unrelated diversification take ample space in scientific and political debates. Against the backdrop of refining smart specialisations strategies, this paper identifies diversification patterns towards the highest income growth in less developed areas in 1931–2000. It is argued that both related and unrelated (in longer-term) diversifications are fundamental for evolutionary growth of less developed regions, however, only the former process has been confirmed in the analyses. Both related variety of industries and expertise in 1931 also point to successful diversification. The implications for theories of Evolutionary Economic Geography and regional policy actions in less developed regions are discussed.

Keywords: diversification, diversity, related variety, path-dependency, smart specialisation strategies, less developed regions

JEL codes: N14, N34, O11, R11

Introduction

Scholars have been investigating the specialisation and diversification of human economic activity for centuries. In this context, and for a long time, there has been an ongoing localization versus urbanization debate over "Who's right, Marshall or Jacobs?" (BEAUDRY and SCHIFFAUEROVA, 2009). Essentially, based on mixed evidence it wasn't clear whether regions should generate a competitive advantage mainly via increasing local specialisation or by means of diversifying into various sectors, which in turn might facilitate the cross-fertilization of ideas. Only recently such a strict categorical classification of the these two, apparently opposing, theories has been abandoned. Now increasingly there seems to be the understanding that it is the combination of the two phenomena, i.e. economic specialisation as well as the diversification of regional economies in the shape of related variety, which potentially leads to economic growth and prosperity. BOSCHMA and IAMMARINO (2009) claim that industries are related when they use shared or complementary competencies, going beyond existing business networks. It is precisely the possibility of knowledge exchange in cognitive and spatial proximity (KOGLER and WHITTLE, 2018), and first of all building on a coherent competence base of related industries, that is a key element of developing an advantage over other regions and thus boosting economic growth. Interestingly, researchers have so far only confirmed the positive impact of related variety on economic growth (BOSCHMA and IAMMARINO, 2009; BOSCHMA et al., 2012; FRENKEN et al., 2007; SAVIOTTI and FRENKEN, 2008). Building on the apparent positive impact of related variety on economic growth in regions, FORAY et al. (2009) proposed the concept of "smart specialisation". The smart specialisation thesis, which in its core is concerned with domains (sectors) and connectedness (relatedness), and in an extension with the technological affinity of industries, in turn became the foundation for establishing Research and Innovation Strategies for Smart Specialisation (RIS3). RIS3 are currently a key element of European Union cohesion policy instruments, and guide the management of European Structural and Investment Funds for the 2014–2020 programming period (BENNER, 2014). RIS3 are intended to contribute to the growth of regions by building a competitive advantage over other regions through revealing one or several science and technology areas that lay the foundations for new patterns of specialized economic activities (FORAY, 2014), and thus new growth paths (BOSCHMA, 2017).

However, regional diversification has proven to be a limited and complex phenomenon. Regions create new branches of economic activity mainly through the mobilisation and reconfiguration of capabilities that are already present. This means, if a given place is characterized by a limited number of specialized economic activities, sectors that are not closely aligned in terms of their knowledge base and factors of production, and where input-output linkages are restricted, as it is frequently the

case with less developed regions, opportunities to generate further patters of specialization via diversification through related industries are few and far between (BOSCHMA et al., 2015). Following this lead, and although there is a growing literature on both related and unrelated diversification (BOSCHMA, 2017), still little is known about the diversification mechanisms operating in less developed regions as these regions are usually omitted from this type of analysis (ROSÉS and WOLF, 2018). Further, most work in the field of Evolutionary Economic Geography, one of the most relevant lines of inquiry to the study of regional technological and structural economic changes, only considers most recent decades with maximum of four decades (SAVIOTTI and FRENKEN, 2008), despite insights that demonstrate that regionally embedded entrepreneurial patterns persist even over an entire century (FRITSCH and WYRWICH, 2019). Therefore, research curiosity on diversification processes is eagerly expecting longer-spectrum studies in different economic settings, all of which should further our understanding of the basic mechanics of economic development processes.

In pursuing these research gap, the present contribution aims to identify the role of both economic diversity and diversification processes in generating income growth in Polish less developed counties over seven decades i.e. over the time period 1931 to 2000. The novelty of this paper therefore lies in three aspects: 1) exploring mechanisms of economic diversification in less developed regions; 2) extending the time period covered by the analysis beyond the current standard; and 3) distinguishing between not only the related diversity of industries at a particular point in time, but also the process of diversification over a longer period of time. It is anticipated that the greater the related diversity found in a region in 1931, followed by processes of diversification up to 2000 that might have amplified place-based specific knowledge, the more income growth over the observed timeframe has taken place. Nevertheless, it is also expected that income growth was also impacted by unrelated diversification processes, strengthened by general knowledge pools, over the same seven decades. While the results of the analysis partially confirm some of the theories concerning the positive impact of related variety on future economic growth, they also call in question the general believe that the process always follows the predetermined evolutionary path from related to unrelated diversification. Interestingly, the growth of income does not depend on the initial wealth of a county, what in turn hints at opportunities for less developed regions to eventually break out of path dependency and negative lock-in. However, such regions seem to require a sufficient level of initial specific knowledge and expertise in order to succeed. These are important findings and given that studies in Evolutionary Economic Geography rarely focus on less developed regions nor apply an extended timeframe, these results provide unique insights into the evolution of the space economy and offer ample opportunities to refine smart specialisation strategies for places that are not at the centre of the

global economy and thus add to the mission for finding a more optimal RIS3 for less developed regions (KOGLER and WHITTLE, 2018). The paper is structured as follows. The next section gives a brief overview on the impact of diversification processes based on related and unrelated industries on growth. The third section presents the empirical strategy and data. The fourth section discusses the results, while the final section provides some concluding remarks.

The impact of related and unrelated diversification on growth regarding less developed regions

Related diversification and growth

Existing evolutionary literature on diversification processes points to different ways of measuring industry relatedness (BOSCHMA, 2017). BRESCHI et al. (2003) elaborate about the technology-related diversification of patenting activities of companies, while HIDALGO et al. (2007) introduce product relatedness of country export profiles. NEFFKE and HENNING (2013) propose measuring relatedness based on common skills shared by employees changing their jobs. A common ground for all three concepts of relatedness is shared knowledge, however, in different cause and effect contexts. Since knowledge production is a cumulative and path-dependent process (ATKINSON and STIGLITZ, 1969), diversification would also be a path-dependent process (ARTHUR, 1994) as it is based on sharing or complementing competences, i.e. knowledge, skills, attitudes (BOSCHMA and IAMMARINO, 2009) and technologies (KOGLER et al., 2013). Thus, the evolution of the regional diversification process can be predicted to some extent through understanding the relatedness of the technological knowledge base (BOSCHMA and FRENKEN, 2011; KOGLER, 2015). The path dependency of learning process derives from the fact that an increase in technological knowledge can be attained by learning by doing and/or research activities (ATKINSON and STIGLITZ, 1969). In turn, usually progress is being made alongside the overall technological trend which further maintains its continuity (DOSI, 1982). Also, behaviour evolves through evolutionary processes in view of behaviour predictability driven by uncertainty (HEINER, 1983). All acquired capabilities are usually also embedded in historical institutional and cultural settings, providing the grounds and preconditions for advancing learning processes impelling the processes of related diversification (LUNDVALL, 2016; MALMBERG and MASKELL, 1997).

The emergence of related diversification has been confirmed in many regional settings, typically in developed regions. Among others, NEFFKE et al. (2011) confirmed that regions in Sweden diversified mostly in related industries, while technologically peripheral industries retreated. By analysing knowledge spaces in US cities, KOGLER et al. (2013) found that patents cluster in related

technology classes. Similarly, BOSCHMA et al. (2015) found that the density of related technologies is a primary force behind technological change in U.S. cities between 1981 and 2010. Also, the impact of technological relatedness on technological change was found for Ireland (KOGLER and WHITTLE, 2018). NEFFKE and HENNING (2013) discovered that new companies established, or arriving, at a given location are more likely to be skill-related to the existing ones than not.

The contribution of related diversification to economic growth in the broad sense is invaluable and indisputable. FRENKEN et al. (2007) confirmed that related variety increased the number of new jobs in the Netherlands from 1996 to 2002. Further, SAVIOTTI and FRENKEN (2008) found that related variety boosted economic growth in twenty OECD countries over the 1964–2003 timeframe, while BOSCHMA and IAMMARINO (2009) found related variety positively affecting employment growth, value-added growth and labour-productivity growth in Italy, 1995–2003. Finally, BOSCHMA et al. (2012) found a positive impact of related variety on regional value-added growth and regional employment growth in Spain over 1995–2007. Based on this evidence, we have no reason to suspect that in the less developed regions that have also experienced significant growth the role of related variety is different. However, what remains unknown yet is whether static or dynamic related variety applies to growth. Therefore, we may hypothesise that:

H.1. The more the less developed region was diversified in related industries in 1931 and experienced related diversification in the period 1931–2000, the greater the increase in income it now generates.

The lower levels of growth of less developed regions may therefore be combined with a low level of industry affinity and a limited potential for related diversification. Less developed regions are characterised by low industrial affinity and are specialised in more narrow niches (ARCHIBUGI and PIANTA, 1992). Lack of the appropriate conditions and institutions to facilitate the dissemination of knowledge and the setting-up of mechanisms for adaptation, learning and innovation in the local environment, entails the underdevelopment of related variety (MALMBERG and MASKELL, 2002). Indeed, BOSCHMA et al. (2015) found the probability of a new technology to emerge in a place is highly correlated with the diversity found in the technology portfolio of U.S. cities, and an uplift in the relatedness of existing technologies by 10%, raises the chances of the rise of a new technology by 30%. What is more, narrow related variety paired with limited related diversification options are probable reasons why in less developed regions neither European cohesion policy nor regional innovation policies embodied in RIS3 brought the desired effects in the context of effective convergence processes. Such regions are usually also struggling with a whole set of other structural problems, including the lack of good governance, weak institutions, and limited learning abilities.

Such problems negatively affect effective regional policy making, and even worse, mistakes made in the past are frequently replicated by successive authorities. The outcome is that development policies implemented in less developed regions are often not suited to prepare regions' institutions and resources for structural changes subsequently resulting in strong path-dependencies and negative lock-in (PYLAK, 2015).

On the other hand, there are rare examples of less developed regions that have managed to change their development paths due to the presence of strong knowledge pools and processes related to technological change, even without considering RIS3 guidelines (PYLAK and WOJNICKA-SYCZ, 2017). The literature on diversification clearly shows that the access to sector-specific knowledge and the subsequent growth of the local knowledge space (KOGLER and WHITTLE, 2018) could provide an antidote to path-dependent and slower diversification through building sufficient absorptive capacity of a region (FRITSCH & KUBLINA, 2017). Therefore, if less developed regions have both potential and capacity to absorb specific knowledge deriving from higher education and universities or related industries, i.e. knowledge that can be easily adapted via exchange of employees or equipment, related diversification can be facilitated even in less developed regions. In line with the above claim, XIAO et al. (2018) found that the greater the region's potential for innovation, the less important relatedness is for diversification. Sufficiently well assimilated industry-specific knowledge can therefore be in itself a driver of diversification and thus growth. Assuming that this statement refers not only to more developed regions, we can put forward the following hypothesis:

H.1A. Greater access to industry-specific knowledge pools in less developed regions results in greater opportunities for related diversification and thus growth of income compared to less developed regions with poorer access to industry-specific knowledge pools.

Unrelated diversification and growth

Unrelated diversification occurs when new capabilities are acquired and subsequently share new branches of industrial activities in a region (FRENKEN et al., 2007; SAVIOTTI and FRENKEN, 2008). Unrelated diversification can have three main origins. First, unrelated diversification can occur incidentally deriving from the outside of the region. For example, new arrivals to the regions, such as multi-national firms, may decide to invest in a new technology that generates a new knowledge base and links to global value chains, which in turn results in a new development path. Second, endogenous diversification is a response to multifaceted needs within a local community of producers and users.

As clients' needs are not necessarily linked by knowledge-based requirements, in turn the potential market may not attract related entrepreneurs. The larger and more prosperous the local market, the higher the potential that suppliers of products and services are drawn in and inevitability a concentration of economic activities in certain areas and sectors will occur (see for example MYRDAL, 1957). Thus, unrelated diversification in denser and richer regions is expected (PETRALIA et al., 2017).

However, such diversification may also have a completely different origin and overlap with market-based diversification. A long-lasting and evolutionary process of diversification may lead to bringing unrelated industries closer together as it is sometimes difficult to draw a clear line between related and unrelated industries in general. Spatially speaking, industries operating closer to each other seem to be more related than others and their relatedness persists in dynamic socio-economic settings (KOGLER, 2017; TOBLER, 1970). Studies pertaining to knowledge, technology and product spaces clearly demonstrate relatedness in networked representations that usually show dense concentrations of certain nodes that exhibit frequent linkages versus those that are not related to each other (BOSCHMA et al., 2015; HIDALGO et al., 2007; KOGLER et al., 2013; KOGLER et al., 2017). Thus, researchers often set a threshold from which industries are considered to be related. This means that all industries are somehow related to one another. This is confirmed by the different ways of measuring relatedness and the various degrees of relatedness obtained in each measure (NEFFKE and HENNING, 2013).

The ambiguity of industry affinity facilitates unrelated diversification as wider related industries benefit from broader and denser links to non-related industries. In such an environment, it is more likely for existing products or technologies to be utilized in other, more distant, industry sectors for the first time. This in turn entails the introduction of novel product or process innovations, respectively. Because of high costs and risks associated with the necessity for distant jump in the product space and consequently also in the knowledge space potentially, in such an environment costs and risks can be dramatically mitigated (SAVIOTTI and FRENKEN, 2008). Therefore, it is reasonable to expect that regions with abundant related variety, which have already depleted the possibilities of related diversification, will easily move towards unrelated diversification as they fill the gaps that remain in their respective knowledge space (KOGLER and WHITTLE, 2018). This is indeed the case, and PETRALIA et al. (2017) confirm that more developed regions with a wide variety of industries are more likely to diversify in an unrelated way. In the same way, NOSELEIT (2013) indicates initial sectoral structure as critical to adapting to structural change.

Following this lead, SAVIOTTI and FRENKEN (2008) emphasise the evolutionary nature of diversification, moving from related diversification in the short term to unrelated diversification in the long term. This statement is in line with findings of HIDALGO et al. (2007) and PETRALIA et al. (2017). Following this line of argument, we propose that an observation over seven decades is enough time for unrelated diversification to be employed in the development of less developed regions. Assuming that hypothesis 1, above, is confirmed and related diversification in less developed regions leads to income growth, regions with an abundance of related industries could more easily move toward unrelated diversification that continues to derive more income from the local economy:

H.2. In the long term, less developed regions witnessing increased income growth, are increasingly driven by development processes based on unrelated diversification.

Actually, there is no evidence that seven decades is enough time for unrelated diversification to show up as a drive of growth in less developed regions considering that such regions also experience related diversification processes relatively slower than more developed regions. At the other hand, the longest period that has been analysed in the present context in the relevant literature is only three decades (KOGLER and WHITTLE, 2018; BOSCHMA et al., 2015; KOGLER et al., 2013; NEFFKE et al., 2011) or four (SAVIOTTI and FRENKEN, 2008). Nevertheless, even in these studies the positive impact of unrelated diversification on growth in different regions was confirmed. Thus, it is reasonable to expect that seven decades should be enough time for less developed regions to reveal the same dependency.

In general, less developed regions encounter extreme obstacles to diversification beyond related industries (see for example BOSCHMA, 2017; HIDALGO et al., 2007; BOSCHMA et al., 2013) as they are usually faced with weak learning abilities considering that learning dynamics are low in rare industrial affinities (DOSI, 1982). However, less developed regions are not condemned to sluggish growth altogether. If regions overcome barriers by employing appropriate institutions and policies, they might be able to discover completely new prospects for a transition into new and renewed development paths. There are quite a few examples of less developed regions that have been able to converge by embracing the diversity of industries (SAVIOTTI and FRENKEN, 2008), and subsequently changed their development paths thanks to general knowledge pools (PYLAK and WOJNICKA-SYCZ, 2017). XIAO et al. (2018) confirmed that European regions with high innovative capacity easily diversify in unrelated industries and that this capacity refers to general and specific knowledge pools. Subsequently, and translated to the context of the present study, it is assumed that over the 70 years less developed regions with both suitable access to general knowledge

pools and absorptive capacity did diversify in unrelated industries, and that currently these regions are witnessing higher growth rates compared to their less developed counterparts that have lacked such access to general knowledge pools. Thus, we may hypothesise that:

H.2A. Greater access to general knowledge pools in less developed areas results in greater opportunities for unrelated diversification, and thus in higher levels of growth than in less developed regions with poorer access to knowledge pools.

Data and methods

Measuring successful diversifications

Diversifications based on related and unrelated variety have been a subject of numerous studies in the past. However, the case study of Poland can provide many interesting observations and further important insights. Essentially, the Polish economy experienced state interventionism during 1930s, was then devastated during WWII, while following four decades of communism, and eventually experienced one decade of democracy by the year 2000. In the present investigation only regions that were part of Poland before and WWII are considered in order to capture the impact of the indisputable shocks equally across the regions of interest. One could argue, the economy was exposed to many disruptive shocks and was hardly steered by market forces. Therefore, if the inquiry finds reliable evidence of path-dependency in diversification processes leading to income growth, this in turn would indicate that these processes are very strong, resilient and independent of commands issued by authorities. On the other hand, the end point of the study in year 2000 is justified due to two reasons: 1) it is the year just before European support in the form of external investment funds arrived in Poland; and 2) the year 2000 marks just the time before the dot-com crash.

The essential claim put forward is that successful diversification takes place when it leads to significant growth of income. In previous studies income was proxied by GDP per capita (SAVIOTTI and FRENKEN, 2008). Although much of the relevant literature deals with the diversification of countries and regions, the rationale is that there's a need to go to a lower level of spatial aggregation in order to grasp the institutional aspects and spatial and knowledge spill-over effects; something that is also discussed in detail and encouraged by MALMBERG and MASKELL (2002). Following this, in the present investigation NUTS4 *(Nomenclature des unités territoriales statistiques)* level regions, i.e. counties, are analysed. However, this also means that usual GDP measures are not available. To circumvent this, the incomes of self-governments operating at this level, i.e. municipalities, cities, and counties, are utilized as a sufficient proxy of GDP. General income of self-government per capita

captures many aspects other than just the condition and quality of enterprises operating in this area. In addition, the differences in the way income was calculated in the past and now in the present make it difficult to compare measures over time. In order to address this, only income generated by citizens, including entrepreneurs and business entities, is chosen as a proxy of tax incomes of self-governments. The nominal changes of income and thus growth level of counties is measured in the following way:

$$INC\_TAX\_GRWT_r = INC\_TAX\_00_{\mathrm{r}} - INC\_TAX\_31_{\mathrm{r}} \quad (1)$$

where $INC\_TAX\_00_r$ is the tax income per capita of a county or a city *r* in 2000, while $INC\_TAX\_31_r$ is a tax income per capita of the same county or a city in 1931. Therefore, $INC\_TAX\_GRWT_r$ captures the overall growth of income per capita regardless the level of initial income. The initial income in 1931 can then be a control variable capturing the initial level of county development.

We rely on two data sources for constructing the main variables. For the historical variable *(INC_TAX_31)* we use municipal finance statistics, including expenses and income of county-level self-governments (GUS 1930a) as well as annual statistics of Polish cities (GUS 1930b). We use the data from 1927/28 since these years do not capture the Great Depression that started in 1929. For contemporary data *(INC_TAX_00)* the local databank of Statistics Poland serves as the source. For the year 2000 we take tax incomes of communities operating within the area of a county[1].

Since the analyses are performed at the county level in different periods, it was necessary to assure the comparability of the spatial configuration (maps) of 1931 with those in the year 2000. This required adjusting the historical map from 1931 to the current one. In order to do so, each historical variable needed to be recalculated as the sum of products deriving from the historical areas of the counties that are subsequently included in the contemporary county in question to generate corresponding historical values.

[1] In Poland municipalities and counties receive only part of personal income tax (PIT) and corporation income tax (CIT) and the level of shares changed over time. However, because we analyse only one year and in every community and county in Poland the tax ratio is the same, the partial amount of taxes self-governments receive, does not affect the analysis.

Explanatory and control variables

Two groups of explanatory variables concerning both dynamic changes of the economic structure of counties over 1931–2000, and the economic situation and knowledge base before the diversification processes begun are considered. In addition, control variables referring to local settings and the attractiveness of the counties before and after diversification process started are employed. The results are prepared in tables that feature six models, and in each of these we control for income per capita level in 1931 to ensure that results do not depend on the initial level of development. Model (1) covers the related and unrelated diversification processes; model (2) takes additionally the structure of unrelated and related industries in 1931; model (3) covers additionally knowledge pool variables; model (4) refers to local settings; model (5) includes potential and attractiveness of the region, while model (6) covers all of the previous.

We argue that related and unrelated diversifications may influence the growth of regions. Therefore, as explanatory variables we utilize related and unrelated diversification measures between 1931 and 2000. To do so, we built two artificial economies based on NACE codes to emulate a homogenous structure over seven decades (see Appendix A.1 for further details). To measure related and unrelated diversifications, we took only industries that where present in both periods in order to ensure that both economies are comparable, and to avoid impact of completely new industries on the changes in the relevant measures. Unrelated industries refer to sectors with one-digit NACE codes (such as mining, manufacturing, transport etc.), while related industries refer to individual three-digit NACE codes industries within sectors (such as for instance manufacture of paper products, machineries, motor vehicles, electrotechnical industry etc.). We measure the process of **diversification** ($\boldsymbol{DIV}$) **of the unrelated industries** ($\boldsymbol{UV}$) in the following way:

$$DIV\_UV\_NOA\_00 = \sum_{s=1}^{S} p_{s00} \ln\left(\frac{p_{s00}}{p_{s31}}\right) \quad (2)$$

where p_{s00} is the proportion of employment in sector s ($s \in 1, \dots, S$) in total employment except agriculture (NOA) in year 2000 and p_{s31} is analogical proportion in 1931. Thus, the change in proportions between 1931 and 2000 is given by $\left(\frac{p_{s00}}{p_{s31}}\right)$, weighted by the proportion of the sector in 2000 – see equation 2. For alternative measures see appendix A.5.

In the same way, we define the process of **diversification** ($\boldsymbol{DIV}$) **of the related industries** ($\boldsymbol{RV}$) as a weighted sum of the proportion change at the three-digit industries within each one-digit sections:

$$DIV\_RV\_NOA\_00 = \sum_{s=1}^{S} p_{s00} \left(\sum_{i=1}^{I_s} p_{i00} ln \left(\frac{p_{i00}}{p_{i31}} \right) \right) \quad (3)$$

where p_{i00} is the proportion of employment in industry i ($i \in 1, \dots, I_s$) in total employment in sector s, I_s is the number of industries in sector s. Taking into account the structure of both indicators, diversification measures take mostly positive values and increases as the changes in industry proportions increases.

The structure of the economy will be reflected by entropy measures of related and unrelated variety in 1931. Following the research of JACQUEMIN and BERRY (1979) and ATTARAN (1986), and most recent of FRENKEN et al. (2007) and SAVIOTTI and FRENKEN (2008), we implement entropy measures at two levels of aggregation according to NACE codes i.e. sections and groups. All levels of aggregation can be inputted in regression analysis as a decomposable nature of entropy does not cause problems with collinearity as it might be the case with a Herfindahl index (JACQUEMIN and BERRY, 1979). First, we define **unrelated variety** (UV) as a between-section entropy:

$$UV\_31\_NOA = \sum_{s=1}^{S} p_s \ log_2 \left(\frac{1}{p_s} \right) \quad (4)$$

where $p_s = \frac{E_s}{E_{tot}}$ is a proportion of employment in section s in total employment (excluding agriculture), E_s is the employment in section s, E_{tot} is total employment (excluding agriculture), S is a number of sections in the economy (excluding agriculture), and $s = 1, \dots, S$.

Second, we define **related variety** (RV) as a weighted sum of the entropy at the three-digit groups within each one-digit sector:

$$RV\_31\_NOA = \sum_{s=1}^{S} p_s \left(\sum_{g=1}^{G_s} \frac{p_g}{p_s} log_2 \left(\frac{1}{\frac{p_g}{p_s}} \right) \right) \quad (5)$$

where $p_g = \frac{E_g}{E_{tot}}$ is a proportion of employment in group g in total employment (excluding agriculture), E_g is the employment in group g, G_s is a number of groups in sector s, and $s = 1, \dots, G_s$.

The next group of control variables refer to knowledge and knowledge flows in regions and between industries. General knowledge that was present in a region *r* in 1931 can be captured by the share of the population with literacy skills in the total population (*LS_31*). We reflect the level of specific

knowledge by skilled workforce, which can be measured by the share of the population with higher education in total population (*HS_21*) **(data only for 1921)* and the distance to the nearest university (*DU*) perceived as the shortest distance to the region with people employed in universities.

We control local settings of region *r* by the key variables reflecting urbanisation and attractiveness of a region. First, we include population density in 1931 (*POP_31*) as a catch-up variable for controlling market-based unrelated diversification. Urbanisation is also measured by the share of people employed in agriculture (*AGR_31*) as the majority of the population was engaged in this activity in that time. The attractiveness of a region is reflected by the population density change during 1921–1931 (*POPCH_21_31*) and between 1931–2000 (*POPCH_31_00*), and unemployment level in 1931 (*UNEMP_31*).

The historical Polish data is based on two sources: (1) the second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938) concerning the structure of the economy in 1931 and all the other control variables except *HS_21*; the census provides information on the numbers of employees by 11 sectors and 197 industries (2) the first dwellings, population and occupation census conducted on September 30, 1921 (GUS 1927) concerning data on *HS_21*. The contemporary indicators referring to the structure of economy are based on Statistics Poland's data on employment in companies over 9 employees.

Results

County incomes and growth in 1931 and 2000

The distribution of tax income per capita in 1931 *(INC_TAX_31)* was highly diversified (see Fig. 1). Clearly, the area of former German partition (north west of Poland around Poznan and Upper Silesia at the West of Cracow) covered the richest counties of Poland at this time. This is a direct result of political and economic conditions since the beginning of the 19th century. At that time, Germans were already the most educated people with the three-tier educational system, including technical universities, and over the course of the 19th century became leaders in industrialisation and innovativeness due to a highly skilled workforce, good standards of work, convenient living conditions paired with a good educational system, and a protectionists strategy (GEISS, 2013). Although the eastern territory of Germany before WW I was the worst its part characterised by with cheap labour, the lowest living standards, low level of investments in the manufacturing industries and thus huge out-migration (KOKOT, 1959), it was still ahead in comparison with other Polish lands recovered in 1918.

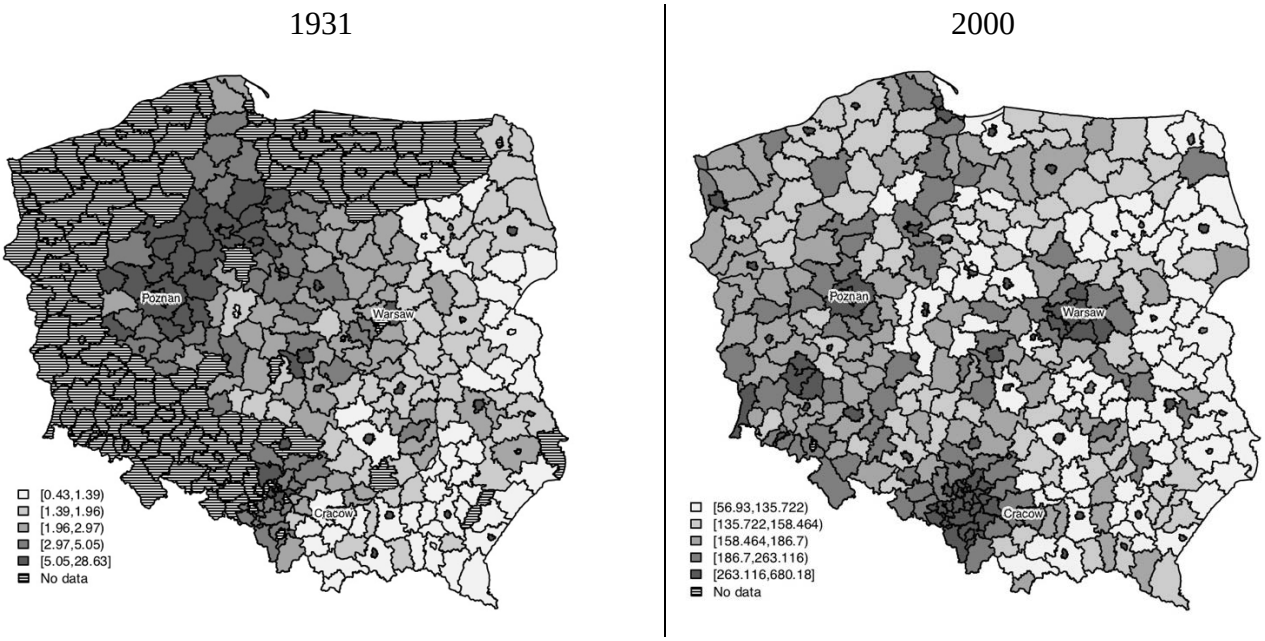


Figure 1. Tax incomes per capita of counites and municipalities in Poland in 1931 (INC_TAX_31) and 2000 (INC_TAX_00).

Central Poland, which is the heir of Congress Poland subordinated to Russia, has also developed at a fairly rapid pace due to numerous investments in the heavy metallurgical and textile industries. However, eastern Poland was characterised by low tax income levels in both 1931 and 2000 *(INC_TAX_00).* In the latter year we clearly see two the richest metropolitan areas around Warsaw and Upper Silesia. Also, western and northern Poland seem to have higher income levels than the rest of Poland, however, because it was regained from Germany after WWII, it is not subject to our investigations.

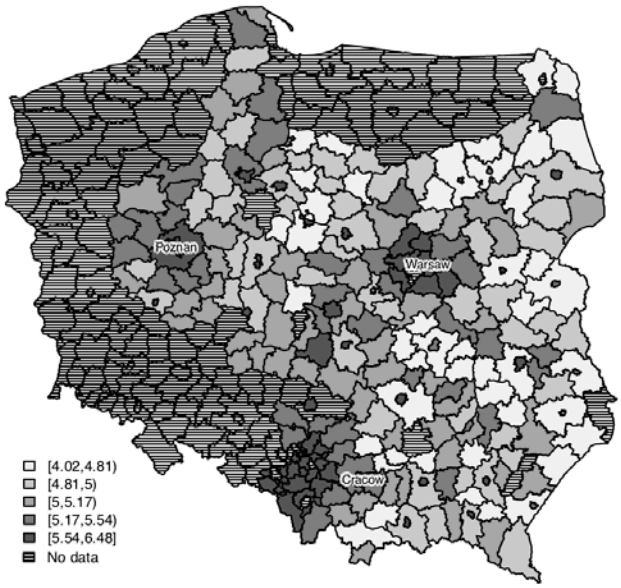


Figure 2. Growth of the nominal tax incomes per capita (log) of counites and municipalities in Poland over 1931–2000.

We observe the highest income growth in metropolitan areas of Upper Silesia and Poznan that were already rich in 1931 (see Fig. 2). However, there are numerous examples of successful counties, which have pulled themselves out of sluggish economic performance, mainly around Cracow, Warsaw and smaller cities. There are also many successful counties in central and even eastern Poland. Thus, this lays the grounds for identifying successful regions defined as those with the lowest rate of *INC_TAX_31* and the highest value of *INC_TAX_GRWT*.

Drivers of the growth in the most successful regions

Growth of the tax income per capita in counties of Poland over seventy years is driven by a few key drivers (see Table 1). The initial observation is that income per capita in 1931 *(INC_TAX_31)* is not a fundamental prerequisite for growth. This means that not only rich counties in 1931 can gain the highest growth levels and convergence is conceivable for the less-developed regions. Clearly, generous related variety in 1931 *(RV_31_NOA)* concerning many related industries with reasonable equal distributions and diversification of these industries in the long run *(DIV_RV_NOA_00)* is one of the key drivers of income growth. Surprisingly, unrelated variety *(UV_31_NOA)* and unrelated diversification *(DIV_UV_NOA_00)* has shown an ambiguous impact on income growth with the latter negatively influencing the growth. However, results are not robust. These findings are confirmed by the robustness check provided in Annex A.6.

Table 1. Regression results for the nominal growth of tax income per capita (log) over 1931–2000

	Dependent variable:							
	The nominal growth of tax income per capita (log)							
	(1)	(2)	(3)	(3a)	(4)	(5)	(6)	(6a)
log(INC_TAX_31)	0.214***	0.213***	0.050	0.093***	0.014	0.139***	–0.005	0.003
	(0.025)	(0.026)	(0.030)	(0.029)	(0.031)	(0.021)	(0.033)	(0.033)
DIV_UV_NOA_00	–0.137***		–0.106**	–0.079*	–0.160***	0.0001	–0.039	–0.039
	(0.051)		(0.047)	(0.043)	(0.045)	(0.041)	(0.037)	(0.037)
DIV_RV_NOA_00	0.254***		0.167***	0.197***	0.187***	0.249***	0.173***	0.188***
	(0.067)		(0.058)	(0.054)	(0.057)	(0.051)	(0.046)	(0.046)
UV_31_NOA		0.510***	–0.045	–0.084	0.289***	0.237**	–0.005	–0.033
		(0.125)	(0.134)	(0.125)	(0.106)	(0.108)	(0.113)	(0.111)
RV_31_NOA		0.170*	0.287***	0.191**	0.209***	0.151*	0.278***	0.227***
		(0.094)	(0.084)	(0.079)	(0.079)	(0.085)	(0.077)	(0.077)
log(LS_31)			0.115	0.036			0.199**	0.163*
			(0.112)	(0.104)			(0.094)	(0.093)
log(HS_21)			0.282***	0.239***			0.083**	0.076**
			(0.034)	(0.032)			(0.039)	(0.038)
log(DU)				–0.103***				–0.051***
				(0.016)				(0.015)
log(POP_31)					0.110**		0.141***	0.111**
					(0.054)		(0.050)	(0.049)
log(AGR_31)					–0.134**		–0.019	–0.059
					(0.057)		(0.065)	(0.065)
log(POPCH_21_31)						1.856***	0.376	0.308
						(0.428)	(0.467)	(0.457)
log(POPCH_31_00)						0.638***	0.555***	0.458***
						(0.065)	(0.059)	(0.064)
Constant	4.936***	3.881***	4.707***	5.514***	4.435***	4.138***	3.362***	4.118***
	(0.055)	(0.279)	(0.531)	(0.508)	(0.524)	(0.249)	(0.715)	(0.735)
Observations	246	246	238	238	246	231	231	231
R^2	0.344	0.330	0.537	0.605	0.553	0.616	0.710	0.724
Adjusted R^2	0.336	0.322	0.523	0.592	0.540	0.604	0.696	0.709

Notes: Robust standard errors are shown in parentheses. ***Statistically significant at the 1% level; **statistically significant at the 5% level, *statistically significant at the 10% level.

The knowledge base is also important for income growth, but only in regards of specific and essential knowledge, *HS_21* (model 3 and 6). The growth is less prolific the further the county is from universities (model 3a and 6a). We extracted distance to the university *(DU)* from model 3 and 6 because naturally this variable also reflects the distance to the metropoles. It appears that the distance variable does not interfere with the impact of the tertiary education, thus both drivers are relevant.

Contrary to the lack of a robust impact of the initial wealth of the county, population density *(POP_31)* shows a positive and robust impact on the increase in income per capita (model 4 and 6). Thus, urbanization economies including more extensive local demand and a more diverse workforce are crucial for growth. This finding is confirmed by increasing attractiveness and inflow of people to the county *(POPCH_31_00)* positively influencing the growth (see model 5 and 6).

The identified growth drivers in Table 1 apply to all regions in Poland covered by the survey. Therefore, it is now worth considering whether and how successful less developed regions differ from

other regions achieving above-average growth. This will be the subject of inquiry in the following sections.

Identifying successful less developed regions

As reported above, identification of successful less developed regions can be derived from the interaction of the lowest level of income in 1931 (*INC_TAX_31)* and the highest growth of tax income per capita *(INC_TAX_GRWT).* Therefore, we applied hierarchical clustering (using Ward's agglomeration method with Euclidean metric) which resulted into five clusters (see Fig. 3). Five clusters are indispensable in order to separate cluster 1 from cluster 3 and to obtain the cluster we are interested in.

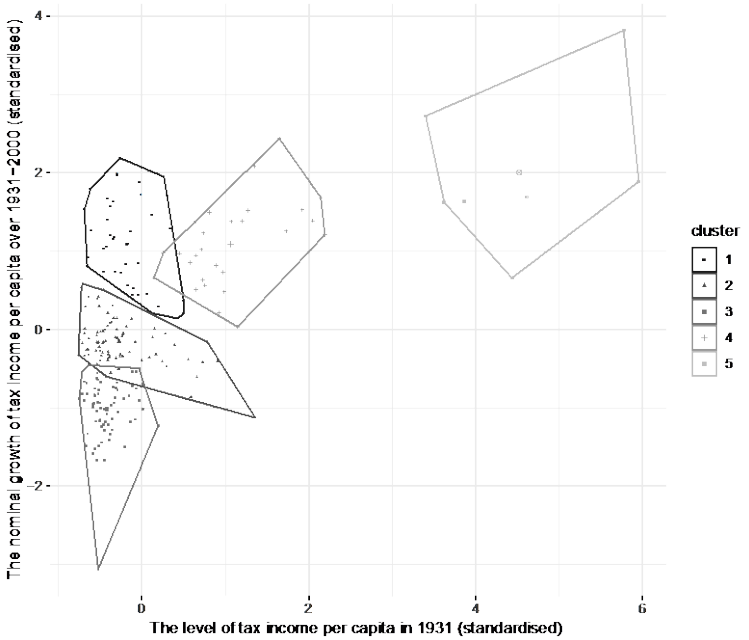


Figure 3. Five clusters based on the level of income in 1931 and income growth in 1931–2000 with applied hierarchical clustering method

Source: own illustration using R (KASSAMBARA and MUNDT, 2017)

Cluster 1 (Poor-Rich) is in the cluster of 40 "diversification winners" and the subject of our interest. Cluster 2 (Poor-Catching-up) covers the counties that were disadvantaged in 1931 and achieved an increase in income at an above-average level. This cluster is also interesting in terms of the overall objectives of the present study. Cluster 3 (Stagnation) concerns the poorest counties in 1931 which experienced very low growth of income. Cluster 4 (Stable growth) is composed of remarkably richer counties in 1931 experiencing high growth, while cluster 5 (Rich-Rich) refer to the richest cities in both, past and today.

Table 2. Descriptive statistics of five clusters of counties by median

Cluster	1	2	3	4	5
	Poor-Rich	Poor-Catching-up	Stagnation	Stable growth	Rich-Rich
Size (counties)	40	84	73	27	7
INC_TAX_GRWT	5.509	5.055	4.774	5.479	5.718
INC_TAX_31	2.712	1.955	1.591	7.512	22.227
INC_TAX_00	249.004	158.515	119.648	246.207	327.399
DIV_UV_NOA_00	0.652	0.611	0.760	0.644	0.421
DIV_RV_NOA_00	0.474	0.301	0.276	0.409	0.454
UV_31_NOA	1.723	1.676	1.650	1.801	2.065
RV_31_NOA	1.300	1.151	1.138	1.199	1.228
LS_31	73.797	69.685	67.038	80.967	96.174
HS_21	0.299	0.220	0.166	0.836	1.703
DU	35.744	71.022	81.816	106.049	108.024
POP_31	105.116	78.580	76.181	450.373	920.615
AGR_31	52.873	72.422	77.736	12.029	4.221
POPCH_21_31	0.076	0.042	0.056	0.066	0.120
POPCH_31_00	0.191	0.040	–0.059	0.208	0.351
UNEMP_31	14.658	9.523	7.444	15.267	14.936

Table 2 presents the descriptive statistics of the clusters. It is easy to spot the differences not only between cluster 1 and clusters 2&3, but also between cluster 1 and the most developed clusters 4&5. The 40 winners of the diversification process are characterised by the highest level of related variety in 1931 (1.300) and the highest related diversification taking place during seven decades (0.474) out of all clusters. The growth of income is nearly as high as for the ‘Rich-Rich’ cluster and higher than in ‘Stable growth’ cluster. The rest of descriptive statistics locate the ‘Poor-Rich’ cluster on the third place, after both ‘Rich-Rich’ and ‘Stable growth’ clusters. Interestingly, table 2 confirms the ambiguous impact of unrelated diversification, which is the highest for ‘Stagnation’ cluster and lowest for the ‘Rich-Rich’ cluster. However, in ‘Poor-Catching-up’ cluster this diversification is also low, while in both ‘Stable growth’ and ‘Poor-Rich’ clusters these values are high.

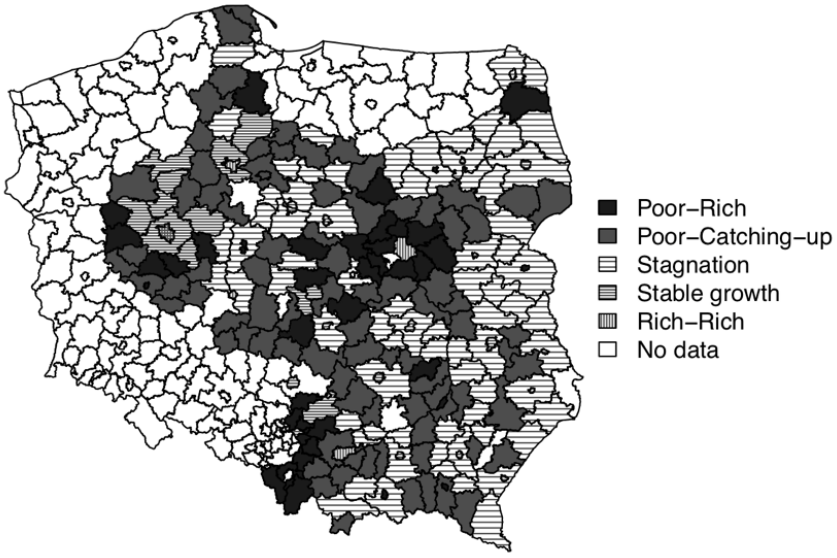


Figure 4. Spatial distribution of five clusters of counties in Poland

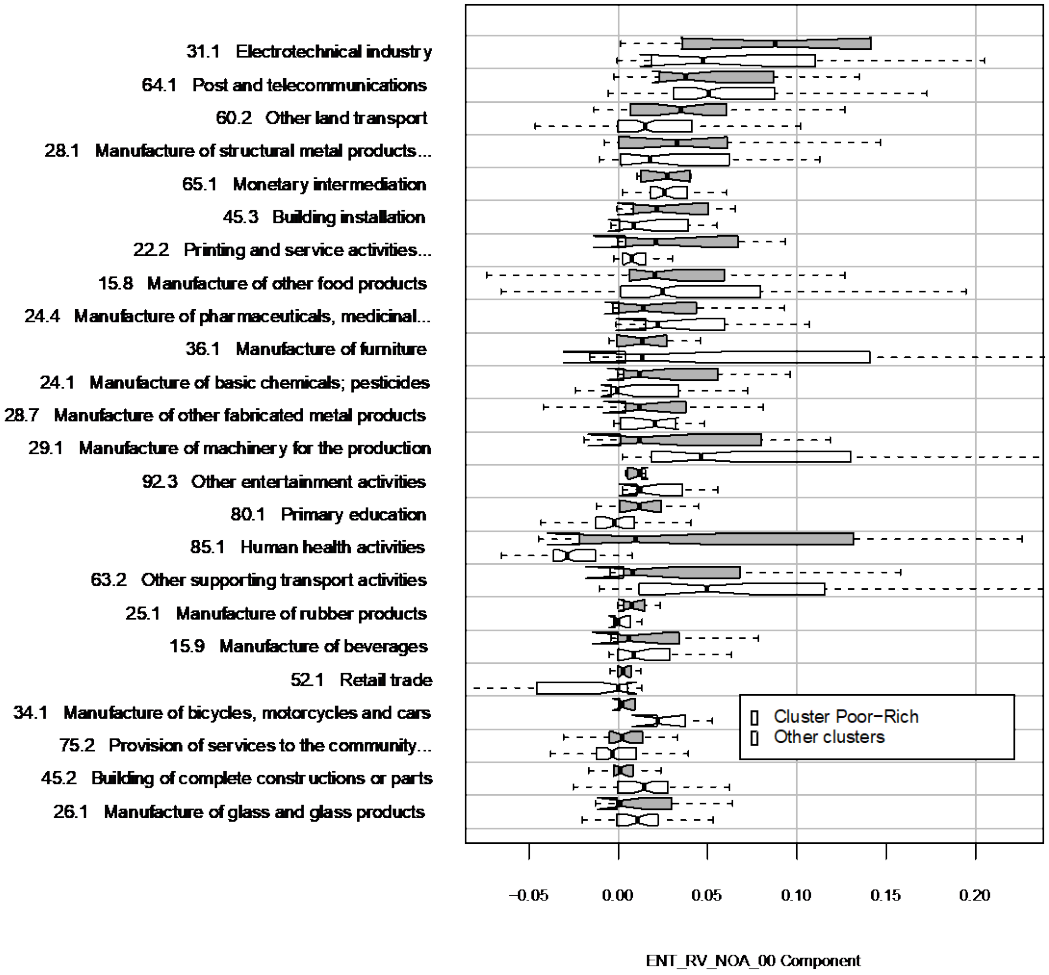
As we expected, the spatial distribution of clusters (see Fig. 4) is in line with the key growth factors. 'Poor-Rich' counties are located mostly in urban areas near metropolitan areas of Upper-Silesia, Warsaw and Poznan. 'Poor-Catching-up' counties are located further from the metropolitan areas, but it is possible to identify the transport corridors along which these regions are arranged.

Industrial drivers of growth in less developed regions

Given the fact that less developed regions gathered in cluster 'Poor-Rich' are growing significantly through tremendous changes in the proportions of related industries (reflected by *DIV_RV_NOA_00* variable), it is interesting to trace particularly which industry proportions increased to the greatest extent indicating indirectly the specialisation processes taking place throughout seven decades. Figure 5 shows that majority of winning counties increased the proportions of numerous knowledge-intensive industries in both manufacturing and service sectors. Among knowledge-intensive manufacturing industries, the electrotechnical industry appears to have the highest increase out of all the industries and what is more, the increase is much higher than in the rest of counties. Apart from the electrotechnical industry, we can also spot the manufacture of machinery for the production; and the manufacture of bicycles, motorcycles and cars. In addition to the engineering and technical industries, also chemistry-related industries like manufacture of pharmaceuticals, medicinal chemicals and botanical products; and manufacture of basic chemicals; pesticides are relevant. Knowledge-intensive services that grew to the greatest extent and that have their origins in 1931 are related to different kinds of communication (post and telecommunications; other land transport; and

supporting transport activities, including logistics), monetary intermediation, education, health, entertainment and other services to the community.

Figure 5. The most influential industries on growth in less developed counties gaining the highest growth rates (cluster 'Poor-Rich') against other counties



Notes: the graph contains industries which appeared in over-median number of counties with over-median value of *DIV_RV_NOA_00* component equal to: $p_{s00} \times p_{i00} ln\left(\frac{p_{i00}}{p_{i31}}\right)$ – for explanation see equation 3b. Outliers are discarded for clarity.

Concluding Remarks

Main findings

The aim of the present investigation was to find examples of successful economic diversification leading to significant growth of income, and to identify settings enabling such diversifications that could be used in refining smart specialisations strategies in less-developed regions. The creation of two artificial economies in 1931 and 2000 comprised of the same industries allowed to study how

both the initial related and unrelated variety and subsequently the change in related and unrelated industry structures over seven decades influenced the growth of tax income in counties of Poland.

First, it was confirmed that the greater related diversification taking place from 1931 till 2000, the higher the growth of income in less-developed regions. Interestingly, related variety in 1931 is also one of the key drivers of growth, thus hypothesis H.1 put forward above is fully confirmed. These two findings suggest that successful regions are those with abundant and evenly distributed related industries in the past paired with a tendency to easily adjust to structural changes over time, which also confirms findings of NOSELEIT (2013). Most likely changes in the structure entail minimising activities in least productive industries while at the same time maximising efforts in the most productive ones resulting in growing efficiency of regional economies (FRITSCH & SLAVTCHEV, 2010) and thus income growth. Such changes were made possible in the relevant regions due to extensive specific knowledge pools residing in related industries paired with a highly educated workforce, which in turn confirms hypothesis H.1A. This is also in line with previous findings on a survey of both developed regions (FRITSCH & KUBLINA, 2017) and the breaking out of path dependency by less developed regions (PYLAK, 2015), but then in a much shorter time period. Extensive diversity of related industries and accessible knowledge with high absorptive potential creates numerous opportunities for entrepreneurs to develop new but related activities (which in present analysis may be reflected by the change in the proportion of the industry). This confirms finings of DOSI (1982) that learning abilities grow in dense industrial affinities. Access to knowledge may also facilitate an increase in the productivity or switching to more productive activities (that at the same time could be more knowledge-intensive). Indeed, the cases of successful less developed regions show that they are developing knowledge-intensive industries in the similar way and intensity as the most developed regions.

Interestingly, the growth of income does not depend on the initial wealth of the county, what gives direct opportunities for less developed regions to break out of path dependency, and perhaps hope for processes of convergence to take place over the long run, in general. On the other hand, a successful less developed region if located close to a large city or along essential transport corridors appears to have a better chance than those that are more remote. Furthermore, a considerably dense workforce and local demand, all what indicates urbanisation economies, seems to generate a more favourable setting in this context.

Surprisingly, both unrelated variety in 1931 and changes in unrelated sectors are not relevant to income growth and thus hypothesis H.2 is not confirmed, i.e. rejected. Furthermore, the results may

vaguely indicate that changes in the proportions of sectors could potentially be even harmful for growth. This finding may contradict findings of SAVIOTTI and FRENKEN (2008), HIDALGO et al. (2007) and PETRALIA et al. (2017) stating that regions move from related diversification in the short term to unrelated diversification in a long term. In contrast, the present inquiry shows that changes, i.e. intensification, in industries within sectors lead to increased levels of productivity and value added, and thus might be crucial for long term economic success. It is reasonable to expect that Polish regions have not managed to exploit all the opportunities that can be derived from related diversification processes, and thus unrelated diversification might not have become a significant driver as of yet. Another explanation might be that regions diversified into unrelated sectors already before 1931 as the more developed the region, the more evenly distributed sectors it has. This would indicate that the process of evolution functions the other way around as generally believed, i.e. from unrelated to related diversification pending on initial conditions, the spatial proximity to other, perhaps more developed, economic spaces, among possible other factors. One should keep in mind that changes in the proportion of related industries are always cause perturbances in the proportion of sectors, and that a higher observed related diversification may be the result of the exit of unrelated activities in a region. Thus, we cannot unambiguously separate these two concepts. No doubt, this certainly calls for further inquiries and analysis.

It was not possible to confirm directly the role of general knowledge in the process of successful diversification (hypothesis H.2A). The impact of knowledge on income growth is positive, but not robust. Nevertheless, clusters ranked from the most to the least successful ones are characterised by a descending level of literacy. General knowledge can then be a sine qua non condition for growth overall with no direct measurable impact on income levels. Perhaps, therefore, one should be more inclined to believe that unrelated diversification also requires specific knowledge, as stated by FRITSCH & KUBLINA (2017).

Implications for theory

The present study contributes to the ongoing debate surrounding smart specialisation strategies for less developed regions in several ways. The investigation shows the mechanism of related diversification as a spatial, historical and path-dependent process. It confirms that related diversification processes are long term, i.e. seven decades in this case. Furthermore, local settings, including the related variety of industries in the past, significantly shape the observed level of income growth. This implies a profound dependence on the development path of Polish regions, especially as they have experienced a number of devastating shocks during these seven decades. However, at the same time, the related diversification taking place during these seven decades points to the

evolutionary development of the regions. Evolutionary changes within industries are most likely concerned with moving from less productive to more productive activities if, of course, the region also manages to increase its wealth overall.

The lack of the role of unrelated diversity in income growth is puzzling and warrants further investigation and theory building or possible adjustments based on empirical evidence along the lines that is presented here.

Policy implications

The article outlines a number of key recommendations for the regional policy making in less developed regions. The seven-decade-long investigation of the path-dependency of related diversification in the Polish economy, despite a number of significant disruptive shocks, allows us to conclude that diversification processes that lead to income growth might be more persistent than perhaps expected. Thus, relevant and potentially successful policy initiatives need to consider the following.

First, the process of creating and strengthening related diversification, and thus specialisation, in a region with a weak affinity of industries will not succeed. Each specialisation strategy in less-developed regions should first focus on creating and widening a specific knowledge base and highly educated workforce to build both appropriate knowledge pools and absorptive capacity (FRITSCH & KUBLINA, 2017). If the strategy focuses on supporting the creation of new activities in a region with a weak affinity of industries and/or a weak knowledge base, it will most likely fail.

Second, policy should focus on the creation and support of as many related industries as possible, and subsequently aim to put measures in place that aim to increase productivity among them. This recommendation is in line with ATKINSON and STIGLITZ (1969) stating that government in less developed regions should encourage infant technologies offering a wide range of applications rather than infant industries. However, if these technologies are already invented in more developed regions, efforts should be put on capabilities geared towards assimilating and implementing such technologies.

Acknowledgements: Dieter F. Kogler would like to acknowledge funding from the same funding source, as well as from the European Research Council under the European Union's Horizon 2020 research and innovation programme (grant agreement No 715631, ERC TechEvo). The authors would like to thank two anonymous referees for comments on an earlier draft.

Disclosure statement: No potential conflict of interest was reported by the authors.

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APPENDIX (online)

A.1. Artificial economies of 1931 and 2000 based on NACE Rev. 1.1

ARTIFICIAL CODES BASED ON NACE		NACE REV 1.1 (2000)		INDUSTRY CODES (1931)	
A	Agriculture, hunting and forestry				
01	Agriculture and related service activities				
01.1	Agriculture, gardening and beekeeping	01.1	Growing of crops; market gardening; horticulture		Division A. Agriculture
		01.2	Farming of animals	08	I. Gardening and beekeeping
		01.3	Growing of crops combined with farming of animals (mixed farming)		
		01.4	Agricultural and animal husbandry service activities, except veterinary activities; landscape gardening		
01.5	Forestry and hunting, including related service activities	01.5	Hunting, trapping and game propagation, including related service activities	00	III. Forestry and hunting
		02.0	Forestry, logging and related service activities		
B	Fishing				
05	Fishing, fish farming and related service activities				
		05.0	Fishing, fish farming and related service activities	09	II. Fishing
C	Mining and quarrying				
10	Mining of coal				
10.1	Mining and agglomeration of hard coal	10.1	Mining and agglomeration of hard coal	102	Hard coal mines
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying				
11.1	Extraction of crude petroleum and natural gas and related service activities	11.1	Extraction of crude petroleum and natural gas	106	Petroleum and natural gas mines
		11.2	Service activities incidental to oil and gas extraction, excluding surveying		
13	Mining of metal ores				
13.1	Mining of iron ores	13.1	Mining of iron ores	103	Iron ore mines
13.2	Mining of non-ferrous metal ores, except uranium and thorium ores	13.2	Mining of non-ferrous metal ores, except uranium and thorium ores	104	Zinc and lead ore mines
14	Other mining and quarrying				
14.1	Quarries	14.1	Quarrying of stone	162	Quarries
		14.2	Quarrying of sand and clay		
		14.3	Mining of chemical and fertilizer minerals		
14.4	Production of salt	14.4	Production of salt	105	Rock salt mines and salt brewing plants
14.5	Other mining and quarrying n.e.c.	10.2	Mining and agglomeration of lignite	101	Mining not separated
		10.3	Extraction and agglomeration of peat	293	Mining and quarrying - persons without a specified occupation industry
		14.5	Other mining and quarrying n.e.c.		
D	Manufacturing				
15	Manufacture of food products and beverages				
15.1	Production, processing and preserving of meat and meat products	15.1	Production, processing and preserving of meat and meat products	254	Butchery
15.4	Manufacture of vegetable and animal oils and fats	15.4	Manufacture of vegetable and animal oils and fats	152	Production of fat preparations
				154	Oil mills
15.5	Manufacture of dairy products	15.5	Manufacture of dairy products	253	Manufacture of dairy products
15.6	Manufacture of grain mill products, starches and starch products	15.6	Manufacture of grain mill products, starches and starch products	242	Mills
15.7	Manufacture of prepared animal feeds	15.7	Manufacture of prepared animal feeds		

15.8	Manufacture of other food products	15.8	Manufacture of other food products	241	Food industry not separated
		15.2	Processing and preserving of fish and fish products	243	Bakeries
		15.3	Processing and preserving of fruit and vegetables	244	Manufacture of sugar products
				245	Sugar factories
15.9	Manufacture of beverages	15.9	Manufacture of beverages	246	Distilleries
				247	Breweries and malting plants
				248	Manufacture of vodkas, wine, honey and juice
				249	Manufacture of mineral and gas waters
				252	Starchy
16	Manufacture of tobacco products				
16.0	Manufacture of tobacco products	16.0	Manufacture of tobacco products	255	Manufacture of tobacco products
17	Manufacture of textiles				
17.1	Preparation and spinning of textile fibres	17.1	Preparation and spinning of textile fibres	202	Linseed mills
				203	Non-separated spinning plants
				204	Cotton spinning plants
				205	Woollen spinning plants
17.2	Textile weaving	17.2	Textile weaving	206	Non-separated weaving plants
				207	Cotton weaving plants
				208	Woollen weaving plants
				209	Spinning plants in combination with weaving plants - not separated
				212	Spinning plants in combination with cotton weaving plants
				213	Spinning plants in combination with woollen weaving plants
17.3	Finishing of textiles	17.3	Finishing of textiles	214	Finishing works
17.4	Manufacture of made-up textile articles, except apparel	17.4	Manufacture of made-up textile articles, except apparel	201	Undivided textile industry
		17.6	Manufacture of knitted and crocheted fabrics		
		17.7	Manufacture of knitted and crocheted articles		
17.5	Manufacture of other textiles	17.5	Manufacture of other textiles	215	Manufacture of carpets
				216	Rope working
18	Manufacture of wearing apparel; dressing and dyeing of fur				
18.2	Manufacture of wearing apparel and accessories	18.1	Manufacture of leather clothes	231	Clothing industry not separated
		18.2	Manufacture of other wearing apparel and accessories	232	Tailoring
				233	Lingerie
				217	Manufacture of stockings and knitted and crocheted articles
				236	Hat making and modinery
18.3	Dressing and dyeing of fur; manufacture of articles of fur	18.3	Dressing and dyeing of fur; manufacture of articles of fur	234	Furriership
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear				
19.1	Tanning and dressing of leather	19.1	Tanning and dressing of leather	222	Tanneries
19.2	Manufacture of luggage, handbags and the like, saddlery and harness	19.2	Manufacture of luggage, handbags and the like, saddlery and harness	221	Leather industry not separated
				223	Rhyming, saddlery and production of leather goods

19.3	Manufacture of footwear	19.3	Manufacture of footwear	235	Shoemaking and manufacture of mechanical footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials				
20.1	Sawmilling and planing of wood; impregnation of wood; manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards	20.1	Sawmilling and planing of wood; impregnation of wood	172	Exploitation of forests
		20.2	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards	173	Exploitation of forests in combination with sawmills
				174	Sawmills
20.3	Manufacture of builders' carpentry and joinery	20.3	Manufacture of builders' carpentry and joinery	175	Woodworking and manufacture of ordinary furniture
20.4	Manufacture of wooden containers	20.4	Manufacture of wooden containers	177	Bedding
20.5	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	20.5	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	171	Wood industry not separated
				178	Wheel wrighting
				179	Basketry and wickerwork
21	Manufacture of pulp, paper and paper products				
21.1	Manufacture of pulp, paper and paperboard	21.1	Manufacture of pulp, paper and paperboard	192	Paper and paperboard plants
21.2	Manufacture of articles of paper and paperboard	21.2	Manufacture of articles of paper and paperboard	193	Manufacture of paper products
				19x	Unspecified occupations in branches 19x
22	Publishing, printing and reproduction of recorded media				
22.1	Publishing	22.1	Publishing	731	Newspapers other than daily press and other publications
				732	Daily press
22.2	Printing and service activities related to printing; reproduction of recorded media	22.2	Printing and service activities related to printing	261	Printing industry not separated
		22.3	Reproduction of recorded media	262	Printing works and lithographs
				263	Bookbinding
23	Manufacture of coke, refined petroleum products and nuclear fuel				
23.1	Manufacture of coke oven products	23.1	Manufacture of coke oven products	143	Coking plants
23.2	Manufacture of refined petroleum products	23.2	Manufacture of refined petroleum products	144	Oil and gas refineries
24	Manufacture of chemicals and chemical products				
24.1	Manufacture of basic chemicals; pesticides and other agro-chemical products; paints, varnishes and similar coatings, printing ink and mastics	24.1	Manufacture of basic chemicals	141	Chemical industry not separated
		24.2	Manufacture of pesticides and other agro-chemical products	142	Tar and turpentine plants
		24.3	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	146	Manufacture of matches
		24.6	Manufacture of other chemical products	149	Large inorganic industry
24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	155	Manufacture of cosmetic and pharmaceutical products
24.5	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	24.5	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	153	Production of soap
24.7	Manufacture of man-made fibres	24.7	Manufacture of man-made fibres	147	Manufacture of artificial silk

25	Manufacture of rubber and plastic products				
25.1	Manufacture of rubber products	25.1	Manufacture of rubber products	148	Manufacture of rubber products
25.2	Manufacture of plastic products	25.2	Manufacture of plastic products		
26	Manufacture of other non-metallic mineral products				
26.1	Manufacture of glass and glass products	26.1	Manufacture of glass and glass products	168	Glassworks
26.2	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products, ceramic tiles and flags	26.2	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	167	Ceramic and pottery industry
		26.3	Manufacture of ceramic tiles and flags		
26.4	Manufacture of bricks, tiles and construction products, in baked clay	26.4	Manufacture of bricks, tiles and construction products, in baked clay	166	Brick factories
26.5	Manufacture of cement, lime and plaster and articles of concrete, plaster and cement	26.5	Manufacture of cement, lime and plaster	163	Lime kilns and gypsum mines
		26.6	Manufacture of articles of concrete, plaster and cement	164	Cement plants
				165	Concrete plants
26.7	Cutting, shaping and finishing of ornamental and building stone	26.7	Cutting, shaping and finishing of ornamental and building stone	169	Stonemasonry
26.8	Manufacture of other non-metallic mineral products	26.8	Manufacture of other non-metallic mineral products	161	Mineral industry not separated
27	Manufacture of basic metals				
27.1	Manufacture of basic iron and steel and of ferro-alloys	27.1	Manufacture of basic iron and steel and of ferro-alloys	112	Ironworks
27.3	First processing of iron and steel; manufacture of tubes	27.2	Manufacture of tubes	113	Ironworks combined with further processing departments
		27.3	Other first processing of iron and steel	111	Metallurgy and metal industry not separated - without production of machines
				125	Sheet metalworking
				122	Manufacture of wire, nails, screws and chains
27.4	Manufacture of basic precious and non-ferrous metals	27.4	Manufacture of basic precious and non-ferrous metals	114	Zinc and lead smelters
27.5	Casting of metals	27.5	Casting of metals	115	Foundries
28	Manufacture of fabricated metal products, except machinery and equipment				
28.1	Manufacture of structural metal products; manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers; manufacture of steam generators, except central heating hot water boilers	28.1	Manufacture of structural metal products	116	Manufacture of boilers and armatures and structures
		28.2	Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers	278	Dullness
		28.3	Manufacture of steam generators, except central heating hot water boilers		
28.4	Forging, pressing, stamping and roll forming of metal; powder metallurgy	28.4	Forging, pressing, stamping and roll forming of metal; powder metallurgy	123	Smithery
28.5	Treatment and coating of metals; general mechanical engineering; manufacture of cutlery, tools and general hardware	28.5	Treatment and coating of metals; general mechanical engineering	124	Locksmithery
		28.6	Manufacture of cutlery, tools and general hardware		
28.7	Manufacture of other fabricated metal products	28.7	Manufacture of other fabricated metal products	118	Manufacture of sheet metal dishes and other sheet metal products
				119	Manufacture of articles of copper and copper alloys
29	Manufacture of machinery and equipment n.e.c.				

29.1	Manufacture of machinery for the production and use of mechanical power; manufacture of other general and special purpose machinery; manufacture of machine tools and domestic appliances n.e.c.	29.1	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	121	Metalworking industry not separated combined with machine manufacturing
		29.2	Manufacture of other general purpose machinery	127	Manufacture of industrial machinery
		29.5	Manufacture of other special purpose machinery	129	Manufacture of engines
		29.4	Manufacture of machine tools		
		29.7	Manufacture of domestic appliances n.e.c.		
29.3	Manufacture of agricultural and forestry machinery	29.3	Manufacture of agricultural and forestry machinery	128	Manufacture of agricultural machinery
30	Manufacture of office machinery and computers				
30.0	Manufacture of office machinery and computers	30.0	Manufacture of office machinery and computers		
31	Electrotechnical industry				
31.1	Electrotechnical industry	31.1	Manufacture of electric motors, generators and transformers	134	Electrotechnical industry
		31.2	Manufacture of electricity distribution and control apparatus		
		31.3	Manufacture of insulated wire and cable		
		31.4	Manufacture of accumulators, primary cells and primary batteries		
		31.5	Manufacture of lighting equipment and electric lamps		
		31.6	Manufacture of electrical equipment n.e.c.		
		32.1	Manufacture of electronic valves and tubes and other electronic components		
		32.2	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy		
		32.3	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods		
33	Manufacture of medical, precision and optical instruments, watches and clocks				
33.1	Manufacture of medical, precision and optical instruments, watches and clocks	29.6	Manufacture of weapons and ammunition	135	Manufacture of scales, instruments and precision instruments
		33.1	Manufacture of medical and surgical equipment and orthopaedic appliances		
		33.2	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment		
		33.3	Manufacture of industrial process control equipment		
		33.4	Manufacture of optical instruments and photographic equipment		
33.2	Watchmaking and jewellery	33.5	Manufacture of watches and clocks	137	Watchmaking and jewellery
		36.2	Manufacture of jewellery and related articles		
34	Manufacture of motor vehicles, trailers and semi-trailers				
34.1	Manufacture of bicycles, motorcycles and cars	34.1	Manufacture of motor vehicles	133	Manufacture of bicycles, motorcycles and cars
		34.2	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers		
		34.3	Manufacture of parts and accessories for motor vehicles and their engines		
		35.4	Manufacture of motorcycles and bicycles		
35	Manufacture of other transport equipment				
35.1	Building and repairing of ships and boats	35.1	Building and repairing of ships and boats		

35.2	Manufacture of railway and tramway locomotives and rolling stock	35.2	Manufacture of railway and tramway locomotives and rolling stock	132	Production of wagons (carriages)
35.3	Manufacture of aircraft and spacecraft	35.3	Manufacture of aircraft and spacecraft		
35.5	Manufacture of other transport equipment n.e.c.	35.5	Manufacture of other transport equipment n.e.c.		
36	Manufacture of furniture; manufacturing n.e.c.				
36.1	Manufacture of furniture	36.1	Manufacture of furniture	176	Manufacture of bentwood furniture
				182	Upholstery
				117	Manufacture of furniture and metal equipment and hardware, locks and padlocks
36.3	Manufacture of musical instruments	36.3	Manufacture of musical instruments	136	Manufacture of musical instruments
36.4	Manufacture of sports goods	36.4	Manufacture of sports goods		
36.5	Manufacture of games and toys	36.5	Manufacture of games and toys		
36.6	Miscellaneous manufacturing n.e.c.	36.6	Miscellaneous manufacturing n.e.c.	292	Unknown industry
				224	Brush making
				2x	XV. Workers not defined in detail
37	Recycling				
37.1	Recycling of metal waste and scrap	37.1	Recycling of metal waste and scrap		
37.2	Recycling of non-metal waste and scrap	37.2	Recycling of non-metal waste and scrap		
E	Electricity, gas and water supply				
40	Electricity, gas, steam and hot water supply				
40.1	Production and distribution of electricity	40.1	Production and distribution of electricity	281	Power plants, gasworks and water supply systems not separated
				282	Power plants
40.2	Manufacture of gas; distribution of gaseous fuels through mains	40.2	Manufacture of gas; distribution of gaseous fuels through mains	283	Gasworks
40.3	Steam and hot water supply	40.3	Steam and hot water supply		
41	Collection, purification and distribution of water				
41.0	Collection, purification and distribution of water	41.0	Collection, purification and distribution of water	284	Water supply and sewerage systems
F	Construction				
45	Construction				
45.1	Site preparation	45.1	Site preparation	273	Ground construction
				279	Measuring and carrying out melioration works
45.2	Building of complete constructions or parts thereof; civil engineering	45.2	Building of complete constructions or parts thereof; civil engineering	271	Building industry not separated
				272	Land construction in combination with house building
				274	Construction of houses
45.3	Building installation	45.3	Building installation	275	Carrying out building installations
45.4	Building completion	45.4	Building completion	276	Glass-making
				277	Painting and wallpaper-making
45.5	Renting of construction or demolition equipment with operator	45.5	Renting of construction or demolition equipment with operator		
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods				
51	Wholesale trade and commission trade				
51.1	Wholesale trade and commission trade	51.1	Wholesale on a fee or contract basis	312	Wholesale trade
		51.2	Wholesale of agricultural raw materials and live animals		
		51.3	Wholesale of food, beverages and tobacco		

		51.4	Wholesale of household goods		
		51.5	Wholesale of non-agricultural intermediate products, waste and scrap		
		51.8	Wholesale of machinery, equipment and supplies		
		51.9	Other wholesale		
52	Retail trade				
52.1	Retail trade	50.1	Sale of motor vehicles	30	I. Non-separate trade
		50.2	Maintenance and repair of motor vehicles	31	II. Trade of goods
		50.3	Sale of motor vehicle parts and accessories	311	Trade of goods not separated
		50.4	Sale, maintenance and repair of motorcycles and related parts and accessories	314	Trade cooperatives
		50.5	Retail sale of automotive fuel		
		52.1	Retail sale in non-specialized stores		
		52.2	Retail sale of food, beverages and tobacco in specialized stores		
		52.4	Other retail sale of new goods in specialized stores		
		52.5	Retail sale of second-hand goods in stores		
52.3	Retail sale of pharmaceutical and medical goods, cosmetic and toilet articles	52.3	Retail sale of pharmaceutical and medical goods, cosmetic and toilet articles	803	Pharmacies and medical analysis laboratories
52.6	Retail sale not in stores	52.6	Retail sale not in stores	313	Travelling and door-to-door trade
52.7	Repair of personal and household goods	52.7	Repair of personal and household goods		
H	Hotels and restaurants				
55	Hotels and restaurants				
55.1	Hotels	55.1	Hotels	321	Rental of premises not separated
		55.2	Camping sites and other provision of short-stay accommodation	323	Hotels and guesthouses
55.3	Catering establishments	55.3	Restaurants	325	Catering establishments
		55.4	Bars		
		55.5	Canteens and catering		
I	Transport, storage and communication				
60	Land transport; transport via pipelines				
60.1	Transport via railways	60.1	Transport via railways	42	III. Railways
60.2	Other land transport	60.2	Other land transport	43	IV. Trams and buses in urban areas
				44	V. Other modes of communication and transport
				441	Communication and transport modes not separated
				442	Taxis
				443	Horse-drawn carriages
				444	Communication and road transport
				445	Communication and horse transport
				446	Messengers and porters
60.3	Transport via pipelines	60.3	Transport via pipelines		
61	Water transport				
61.1	Sea and coastal water transport	61.1	Sea and coastal water transport	412	Maritime transport
61.2	Inland water transport	61.2	Inland water transport	413	Inland waterway transport
62	Air transport				
62.1	Air transport	62.1	Scheduled air transport	414	Civil aviation
		62.2	Non-scheduled air transport		
63	Supporting and auxiliary transport activities; activities of travel agencies				
63.1	Cargo handling and storage	63.1	Cargo handling and storage		
63.2	Other supporting transport activities	63.2	Other supporting transport activities	45	VI. Road and water surveillance

63.3	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.	63.3	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.		
63.4	Activities of other transport agencies	63.4	Activities of other transport agencies	R4	Remaining divisions of section E
64	Post and telecommunications				
64.1	Post and telecommunications	64.1	Post and courier activities	40	I. Post, telephone, telegraph, radiotelegraph
		64.2	Telecommunications		
J	Financial intermediation				
65	Financial intermediation, except insurance and pension funding				
65.1	Monetary intermediation	65.1	Monetary intermediation	33	IV. Cash transactions
65.2	Other financial intermediation	65.2	Other financial intermediation	35	VI. Brokerage
		65.21	Financial leasing	x1	II. Capitalists and pensioners
66	Insurance and pension funding, except compulsory social security				
66.0	Insurance and pension funding, except compulsory social security	66.0	Insurance and pension funding, except compulsory social security	34	V. Private insurance companies
67	Activities auxiliary to financial intermediation				
67.1	Activities auxiliary to financial intermediation	67.1	Activities auxiliary to financial intermediation, except insurance and pension funding	R3	Remaining divisions of section D
		67.2	Activities auxiliary to insurance and pension funding		
K	Real estate, renting and business activities				
70	Real estate activities				
70.1	Real estate activities with own property	70.1	Real estate activities with own property		
70.2	Letting of own property	70.2	Letting of own property	322	Rent houses (landlords and caretakers)
				324	Private room rental and private serving of meals
70.3	Real estate activities on a fee or contract basis	70.3	Real estate activities on a fee or contract basis		
71	Renting of machinery and equipment without operator and of personal and household goods				
71.1	Renting of automobiles	71.1	Renting of automobiles		
71.2	Renting of other transport equipment	71.2	Renting of other transport equipment		
71.3	Renting of other machinery and equipment	71.3	Renting of other machinery and equipment		
71.4	Renting of personal and household goods n.e.c.	71.4	Renting of personal and household goods n.e.c.		
72	Computer and related activities				
72.1	Hardware consultancy	72.1	Hardware consultancy		
72.2	Software consultancy and supply	72.2	Software consultancy and supply		
72.3	Data processing	72.3	Data processing		
72.4	Database activities	72.4	Database activities		
72.5	Maintenance and repair of office, accounting and computing machinery	72.5	Maintenance and repair of office, accounting and computing machinery		
72.6	Other computer related activities	72.6	Other computer related activities		
73	Research and development				
73.1	Research and experimental development	73.1	Research and experimental development on natural sciences and engineering	722	Scientific institutions
		73.2	Research and experimental development on social sciences and humanities		
74	Other business activities				
74.1	Legal, accounting, book-keeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; holdings	74.1	Legal, accounting, book-keeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; holdings	523	Advocacy and notary's office
				524	Court defenders and legal advice and inquiry offices

74.2	Architectural and engineering activities and related technical consultancy	74.2	Architectural and engineering activities and related technical consultancy		
74.3	Technical testing and analysis	74.3	Technical testing and analysis		
74.4	Advertising	74.4	Advertising		
74.5	Labour recruitment and provision of personnel	74.5	Labour recruitment and provision of personnel		
74.6	Investigation and security activities	74.6	Investigation and security activities		
74.7	Industrial cleaning	74.7	Industrial cleaning	815	Keeping squares and streets in order
74.8	Miscellaneous business activities n.e.c.	74.8	Miscellaneous business activities n.e.c.	264	Photographs workshops
L	Public administration and defence; compulsory social security				
75	Public administration and defence; compulsory social security				
75.1	Administration of the State and the economic and social policy of the community	75.1	Administration of the State and the economic and social policy of the community	512	State administration
				513	Self-government administration
				514	Administration of other public-law associations
75.2	Provision of services to the community as a whole	75.2	Provision of services to the community as a whole	522	Judiciary
				531	Public security service not separated
				532	State Police
				533	Border guards
				535	Prisons
				536	Fire brigades
75.3	Compulsory social security activities	75.3	Compulsory social security activities		
M	Education				
80	Education				
80.1	Primary education	80.1	Primary education	702	General education
				705	Cheders
80.2	Secondary education	80.2	Secondary education	703	General secondary education
80.3	Higher education	80.3	Higher education	704	Higher education
80.4	Adult and other education	80.4	Adult and other education	701	Schooling of an unknown nature
				706	Other education
				712	Private teachers
				713	Pre-primary education
				714	Non-school education
				715	Physical education and sport
N	Health and social work				
85	Health and social work				
85.1	Human health activities	85.1	Human health activities	801	Prevention not separated
				802	Healthcare establishments and sanitary services of all institutions
				804	Freelance doctors
				805	Feldshers, nurses and freelance masseurs
				806	Freelance midwifery
				R8	Remaining divisions of section I
85.2	Veterinary activities	85.2	Veterinary activities	807	Veterinary services
85.3	Social work activities	85.3	Social work activities	82	III. Social welfare institutions
O	Other community, social and personal service activities				
90	Sewage and refuse disposal, sanitation and similar activities				
90.0	Sewage and refuse disposal, sanitation and similar activities	90.0	Sewage and refuse disposal, sanitation and similar activities		
91	Activities of membership organizations n.e.c.				

91.1	Activities of business, employers' and professional organizations	91.1	Activities of business, employers' and professional organizations	55	VI. Administration of social organizations and institutions
91.2	Activities of trade unions	91.2	Activities of trade unions		
91.3	Activities of other membership organizations	91.3	Activities of other membership organizations	542	Clergy
				543	Secular persons in church and religious associations
92	Recreational, cultural and sporting activities				
92.1	Motion picture and video activities	92.1	Motion picture and video activities	743	Cinematographers
92.2	Radio and television activities	92.2	Radio and television activities		
92.3	Other entertainment activities	92.3	Other entertainment activities	723	Literature and art
				741	Spectacles not separated
				742	Theatre and music
				744	Circus and travelling artists
92.4	News agency activities	92.4	News agency activities		
92.5	Library, archives, museums and other cultural activities	92.5	Library, archives, museums and other cultural activities	733	Reading facilities
92.6	Sporting activities	92.6	Sporting activities		
92.7	Other recreational activities	92.7	Other recreational activities		
93	Other service activities				
93.0	Other service activities	93.0	Other service activities	811	Personal and household hygiene not separated
				812	Bathing establishments
				813	Hairdressing & cosmetics
				814	Laundry, ironing rooms and mangles
				816	Cemeteries and funeral facilities
				R7	Remaining divisions of section H
P	Activities of households				
95	Activities of households as employers of domestic staff				
95.0	Activities of households as employers of domestic staff	95.0	Activities of households as employers of domestic staff	904	Domestic servants residing with employers
				912	Domestic servants living in their own dwellings
				R9	Remaining divisions of section J
96	Undifferentiated goods producing activities of private households for own use				
96.0	Undifferentiated goods producing activities of private households for own use	96.0	Undifferentiated goods producing activities of private households for own use		
97	Undifferentiated services producing activities of private households for own use				
97.0	Undifferentiated services producing activities of private households for own use	97.0	Undifferentiated services producing activities of private households for own use		
Q	Extra-territorial organizations and bodies				
99	Extra-territorial organizations and bodies				
99.0	Extra-territorial organizations and bodies	99.0	Extra-territorial organizations and bodies	50	I. Diplomatic and consular offices of foreign countries

A.2. Summary of the main variables of interest, the five groups of control variables with definitions and sources

Variable	Definition	Source
Main variable of interest		

INC_TAX_GRWT	The nominal difference in counties' tax income per capita between 1931 and 2000	Municipal finance statistics. Expenses and income of poviat and voivodship self-governments in the years 1927/28 (GUS 1930) ("Statystyka finansów komunalnych. Wydatki i dochody samorządu powiatowego i wojewódzkiego w latach 1927/28") Annual statistics of Polish cities (GUS 1930) ("Rocznik statystyki miast Polski") GUS local data bank (2000)
The group of control variables for the change in the structure of the economies over 1931–2000		
$ENT\_UV\_NOA\_31$	The entropy measure of the change in unrelated industries shares at the one-digit NACE level between 1931–2000 weighted by the structure of the economy in 1931	The second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938) GUS data on employment in companies over 9 employees in 2000
$ENT\_RV\_NOA\_31$	The entropy measure of the change in related industries shares at the three-digit NACE level within each one-digit sections between 1931–2000 weighted by the structure of the economy in 1931	As above
$ENT\_UV\_NOA\_00$	The entropy measure of the change in unrelated industries shares at the one-digit NACE level between 1931–2000 weighted by the structure of the economy in 2000	As above
$ENT\_RV\_NOA\_00$	The entropy measure of the change in related industries shares at the three-digit NACE level within each one-digit sections between 1931–2000 weighted by the structure of the economy in 2000	As above
The group of control variables for the structure of the economy in 1931		
UV_31_NOA	Unrelated variety reflected by the between-section entropy in 1931 at the on-digit NACE level	The second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938)
RV_31_NOA	Related variety reflected by a weighted sum of the entropy at the three-digit NACE groups within each one-digit sector in 1931	As above
The group of control variables for the knowledge pools		
LS_31	The share of the population with literacy skills in the total population in 1931	As above
HS_21	The share of population with higher education in total population in 1921	The first dwellings, population and occupation census conducted on September 30, 1921 (GUS 1927)
DU	Distance measured in km to the nearest county with the state or private university that existed in the 1920s (distance to the same county is equal to zero)	Distances between given county and the nearest county of: Cieszyn, Crakow, Gdansk, Gdynia, Katowice, Lodz, Lublin, Poznan, Warsaw, Lvov and Vilnius
The group of control variables for the local settings		
POP_31	Population density in 1931 (number of people per 1 square kilometer)	The second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938)
AGR_31	The share of people employed in agriculture in total economically active and passive population in 1931	As above
The group of control variables for the attractiveness		

POPCH_21_31_21	The entropy measure of the change in population between 1921 and 1931 weighted by the population in 1921	The first dwellings, population and occupation census conducted on September 30, 1921 (GUS 1927) The second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938)
POPCH_21_31_31	The entropy measure of the change in population between 1921 and 1931 weighted by the population in 1931	As above
POPCH_31_00_31	The entropy measure of the change in population between 1931 and 2000 weighted by the population in 1931	The second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938) GUS local data bank (2000)
POPCH_31_00_00	The entropy measure of the change in population between 1931 and 2000 weighted by the population in 2000	As above
UNEMP_31	The proportion of unemployed people (excluding agriculture) in total labour force in 1931	The second dwellings, households, population and occupation census conducted on December 9th, 1931 (GUS 1938)

A.3. Descriptive statistics of the main and control variables

	n	mean	sd	min	max	skew	kurtosis	se	CV [%]
INC_TAX_GRWT	246	5.150	0.379	4.016	6.481	0.471	–0.113	0.024	7.350
INC_TAX_31	246	3.869	4.503	0.434	28.625	3.259	12.435	0.287	116.379
INC_TAX_00	372	195.819	79.375	56.925	680.181	1.550	3.826	4.115	40.535
DIV_UV_NOA_31	264	–0.586	0.331	–2.344	–0.131	–1.671	3.798	0.020	–56.4
DIV_RV_NOA_31	264	–0.558	0.306	–1.650	–0.017	–0.653	0.335	0.019	–54.8
DIV_UV_NOA_00	264	0.694	0.386	–0.075	3.179	1.756	6.812	0.024	55.7
DIV_RV_NOA_00	264	0.406	0.295	–0.079	2.018	1.643	4.803	0.018	72.6
UV_31_NOA	264	1.702	0.192	1.050	2.209	–0.035	–0.146	0.012	11.3
RV_31_NOA	264	1.163	0.248	0.493	1.905	0.037	0.028	0.015	21.4
LS_31	264	75.969	15.059	44.668	98.509	–0.036	–0.899	0.927	19.8
HS_21	253	0.401	0.527	0.094	4.702	4.145	22.468	0.033	131.5
DU	264	83.686	57.612	0.282	418.335	1.283	3.680	3.546	68.8
POP_31	264	224.004	425.911	37.349	3,548.818	4.348	22.505	26.213	190.1
AGR_31	264	57.338	25.898	0.593	88.224	–1.029	–0.338	1.594	45.2
POPCH_21_31	245	0.058	0.040	–0.008	0.225	1.038	1.608	0.003	67.780
POPCH_31_00	264	0.114	0.262	–0.416	1.592	2.256	8.061	0.016	228.555
UNEMP_31	264	11.214	4.682	0.559	25.065	0.256	–0.695	0.288	41.8

A.4. Correlation matrix of the main and control variables

	INC_TAX_31	INC_TAX_00	DIV_UV_NOA_31	DIV_RV_NOA_31	DIV_UV_NOA_00	DIV_RV_NOA_00	UV_31_NOA	RV_31_NOA	LS_31	HS_21	DU	POP_31	AGR_31	POPCH_21_31	POPCH_31_00	UNEMP_31
INC_TAX_GRWT	0.527***	0.960***	0.082	–0.349***	–0.201***	0.356***	0.304***	0.157**	0.345***	0.547***	–0.137**	0.554***	–0.750***	0.323***	0.590***	0.517***
INC_TAX_31		0.628***	0.004	–0.149**	–0.157**	0.194***	0.352***	0.067	0.467***	0.748***	0.114*	0.726***	–0.733***	0.188***	0.259***	0.431***
INC_TAX_00			0.017	–0.323***	–0.175***	0.336***	0.342***	0.145**	0.329***	0.629***	–0.151**	0.665***	–0.769***	0.364***	0.544***	0.474***
DIV_UV_NOA_31				–0.161**	–0.541***	0.150**	0.085	–0.014	0.365***	–0.108	–0.033	–0.251***	0.092	–0.209***	0.197***	0.160**

DIV_RV_NOA_31	–0.009	–0.639***	0.014	–0.202***	–0.106	–0.133**	–0.138**	–0.142**	0.241***	–0.153**	–0.153**	–0.234***
DIV_UV_NOA_00		–0.102	–0.239***	0.027	–0.365***	–0.094	0.083	–0.013	0.097	0.067	–0.262***	–0.212***
DIV_RV_NOA_00			0.036	0.163**	0.168**	0.160**	0.056	0.172***	–0.229***	0.031	0.125*	0.242***
UV_31_NOA				–0.523***	0.303***	0.544***	0.012	0.283***	–0.334***	0.039	0.342***	0.044
RV_31_NOA					0.055	–0.170***	–0.062	0.003	–0.145**	0.342***	–0.104	0.475***
LS_31						0.207***	0.011	0.147**	–0.440***	–0.106	0.212***	0.643***
HS_21							–0.007	0.692***	–0.707***	0.255***	0.326***	0.161**
DU								0.094	–0.146**	0.018	–0.213***	0.023
POP_31									–0.743***	0.336***	0.190***	0.252***
AGR_31										–0.369***	–0.348***	–0.606***
POPCH_21_31											0.124*	0.090
POPCH_31_00												0.170***

A.5. Alternative measures of the variables

Alternative measures of successful diversifications

Differently to the measure applied in the analysis in the main text (see equation 1) we can measure the changes of income and thus growth level of counties by dynamics. However, the dynamic growth measure calculated as in equation A.1 is multiplying the weak growth in less-developed regions (see Fig. A.1).

$$INC\_TAX\_GRWT = \ln\left(\frac{INC\_TAX\_00}{INC\_TAX\_31}\right) \quad \text{(A.1)}$$

where INC_TAX_00 is a tax income per capita of a county or a city in 2000, while INC_TAX_31 is a tax income per capita of the same county in 1931.

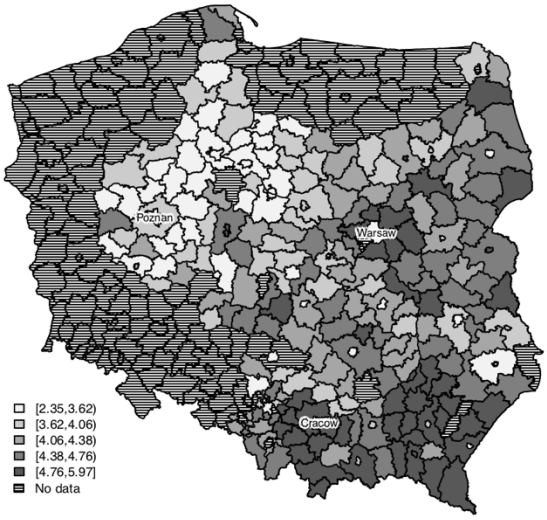


Figure A.1 Dynamics of tax income per capita growth (log) over 1931–2001 in Poland.

Therefore, we can adjust this measure by applying weighting by the initial income in 1931 or final income in 2000 (see equations A.2 and A.3). Weighting these two indicators by tax incomes from 1931 or 2000 is necessary for two reasons. First, tax income growth with no weighting increases remarkably rapidly with small income levels in 1931. Also, major step from low income in 1931 to very high income in 2000 is not correctly reported as the distribution of the variable becomes more stable when income in 2000 increases (Fig. A.2 (a)). Thus, in fact the highest growth levels are assigned mainly to the weakest counties with relatively weak growth and our aim is to decouple less-developed regions that have achieved significant growth.

$$INC\_TAX\_GRWT\_31 = INC\_TAX\_31 \times \ln\left(\frac{INC\_TAX\_00}{INC\_TAX\_31}\right) \qquad \text{(A.2)}$$

$$INC\_TAX\_GRWT\_00 = INC\_TAX\_00 \times \ln\left(\frac{INC\_TAX\_00}{INC\_TAX\_31}\right) \qquad \text{(A.3)}$$

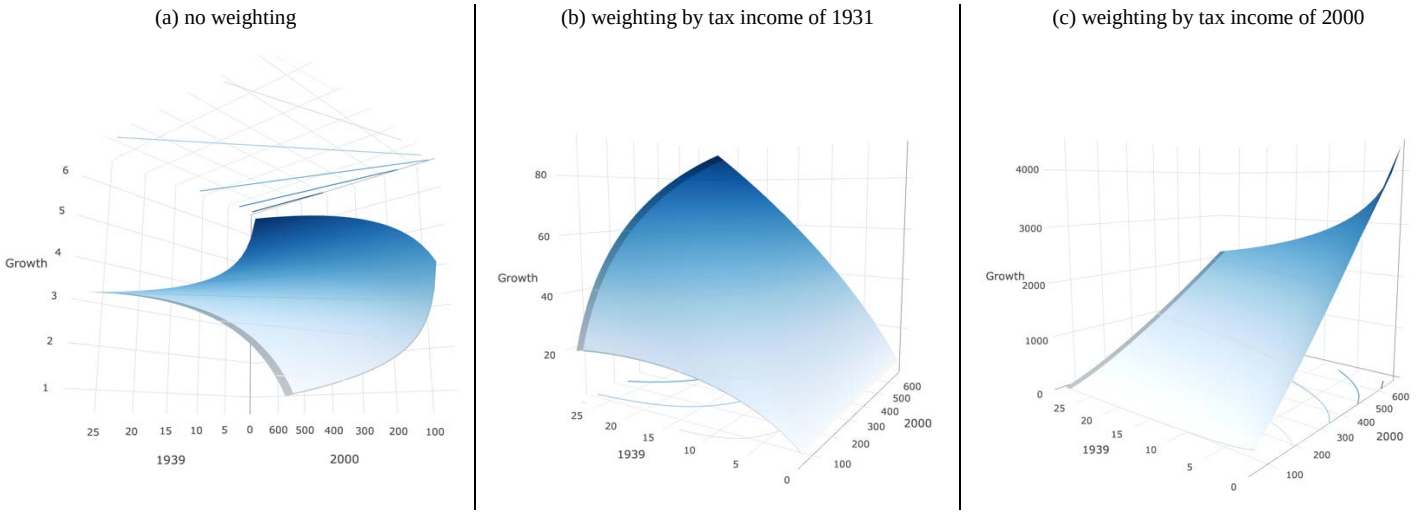


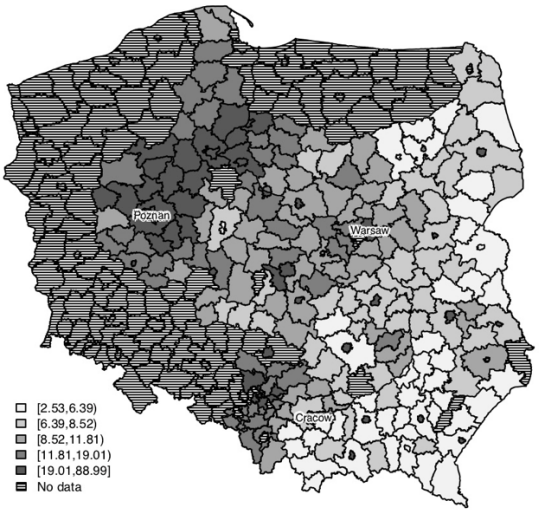
Figure A.2 Simulation of the dynamics of tax income per capita growth (log) over 1931–2001 in Poland.

Weighting the growth with tax income of 1931 makes the distribution more proportional (Fig. A.2 (b)) and thus reflecting general growth tendency with greater sensitivity given to richer counties in 1931. Although this weighting does not reflect the successful stories of historically poor regions, it can be a good reference for the analysis. Successful poor regions are exposed in the income measure as we weight it by tax incomes of 2000 (Fig. A.2 (c)). The highest levels of the growth variable are assigned to counties with the lowest levels of income in 1931 and highest levels of income in 2000. Therefore, with both variables we can measure the successful impoverished counties against the rich regions in 1931.

As expected, both growth indicators (*INC_TAX_GRWT_31* and *INC_TAX_GRWT_00*) are correlated with respective weighting income levels *(INC_TAX_31* and *INC_TAX_00)*, see Fig. 3. At the same time, the latter growth indicator sharpens income growth level to a greater extent than the former. Unfortunately, sharpening of growth levels applies both to the poorest and the richest counties, as confirmed by Fig. A.3. This observation stems from the construction of the indicator and implies that the indicator gives high value if the less developed county in 1931 grows significantly or rich county grows reasonably. For this reason, it is possible to identify the successful regions with the highest

income growth only by comparing both measures. The successful regions will then be those with the lowest rate of *INC_TAX_GRWT_31* and the highest rate of *INC_TAX_GRWT_00*.

Tax income growth dynamics weighted by tax income of 1931



Tax income growth dynamics weighted by tax income of 2000

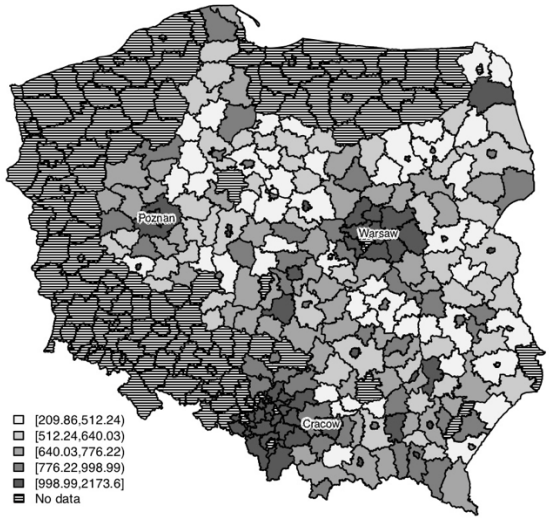


Figure A.3 Tax incomes per capita growth dynamics over 1931–2000 weighted by tax income level in 1931 *(INC_TAX_GRWT_31)* and 2000 *(INC_TAX_GRWT_00).*

Alternative measures of related and unrelated diversifications

According to measures of related and unrelated diversifications presented in equations 2 and 3, we can propose alternative measure based on weighting by proportion of employment in 1931 (see equations A.4 and A.5).

$$DIV\_UV\_NOA\_31 = \sum_{s=1}^{S} p_{s31} \ln\left(\frac{p_{s00}}{p_{s31}}\right) \quad \text{(A.4)}$$

$$DIV\_RV\_NOA\_31 = \sum_{s=1}^{S} p_{s31} \left(\sum_{i=1}^{I_s} p_{i31} ln\left(\frac{p_{i00}}{p_{i31}}\right)\right) \quad \text{(A.5)}$$

Both ways of measuring diversification processes allow to focus on different aspects of evolution. While weighting with the share of the 1931 sectors is more sensitive to a significant decline in the share of key sectors in the past, weighting with the share of the 2000 sector is more sensitive to the significant growth of small sectors in 1931.

A.6. Robustness check

Table A.3. Regression results for the nominal growth of tax income per capita (log) over 1931–2000 with diversification measures weighted by the proportions of sectors and industries in 1931

	Dependent variable:							
	The nominal growth of tax income per capita (log)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(INC_TAX_31)	0.232***	0.213***	0.066**	0.114***	0.022	0.147***	0.005	0.016
	(0.024)	(0.026)	(0.031)	(0.029)	(0.031)	(0.021)	(0.034)	(0.033)
ENT_UV_NOA_31	0.056		0.099	0.080	0.207***	-0.012	0.074	0.083
	(0.061)		(0.061)	(0.056)	(0.054)	(0.054)	(0.052)	(0.051)
ENT_RV_NOA_31	-0.285***		-0.183***	-0.230***	-0.162***	-0.230***	-0.127***	-0.156***
	(0.064)		(0.056)	(0.052)	(0.056)	(0.051)	(0.046)	(0.046)
UV_31_NOA		0.510***	0.013	-0.036	0.313***	0.263**	0.017	-0.011
		(0.125)	(0.132)	(0.121)	(0.104)	(0.106)	(0.113)	(0.110)
RV_31_NOA		0.170*	0.279***	0.168**	0.200**	0.162*	0.290***	0.228***
		(0.094)	(0.084)	(0.079)	(0.080)	(0.086)	(0.078)	(0.078)
log(LS_31)			0.104	0.011			0.171*	0.120
			(0.117)	(0.108)			(0.098)	(0.096)
log(HS_21)			0.272***	0.224***			0.086**	0.077**
			(0.034)	(0.032)			(0.039)	(0.038)
log(DU)				-0.109***				-0.057***
				(0.016)				(0.016)
log(POP_31)					0.105**		0.140***	0.105**
					(0.053)		(0.051)	(0.050)
log(AGR_31)					-0.154***		-0.023	-0.069
					(0.056)		(0.066)	(0.065)
POPCH_21_31						1.592***	0.275	0.198
						(0.445)	(0.473)	(0.461)
POPCH_31_00						0.629***	0.544***	0.432***
						(0.066)	(0.060)	(0.066)
Constant	4.800***	3.881***	4.586***	5.498***	4.490***	4.056***	3.467***	4.360***
	(0.059)	(0.279)	(0.542)	(0.515)	(0.521)	(0.246)	(0.724)	(0.746)
Observations	246	246	238	238	246	231	231	231
R^2	0.343	0.330	0.539	0.616	0.559	0.612	0.705	0.722
Adjusted R^2	0.335	0.322	0.525	0.602	0.546	0.599	0.690	0.707

Notes: Robust standard errors are shown in parentheses. ***Statistically significant at the 1% level; **statistically significant at the 5% level, *statistically significant at the 10% level.

Table A.2. Regression results for the growth dynamics of tax income over 1931–2000 weighted by the tax income in 1931

	Dependent variable:					
	The growth dynamics of tax income over 1931–2000 (entropy) weighted by tax income in 1931					
	(1)	(2)	(3)	(4)	(5)	(6)
ENT_UV_NOA_31	–1.615	–2.899	–7.054***	4.404***	–2.356	0.728
	(2.447)	(2.240)	(2.068)	(1.468)	(1.854)	(1.351)
ENT_RV_NOA_31	–7.030***	–5.186**	–4.562**	0.263	–1.110	0.855
	(2.572)	(2.406)	(2.158)	(1.531)	(1.796)	(1.327)
UV_31_NOA		31.414***	22.440***	13.596***	14.889***	6.360**
		(4.391)	(4.105)	(2.857)	(3.576)	(2.595)
RV_31_NOA		12.020***	8.666***	8.658***	7.618***	5.550***
		(3.407)	(3.081)	(2.127)	(2.651)	(2.121)
log(LS_31)			26.785***			7.912**
			(3.432)			(3.051)
log(DU)			–0.419			1.101***
			(0.653)			(0.417)
log(POP_31)				–1.320		–1.206
				(1.410)		(1.354)
log(AGR_31)				–11.270***		–8.645***
				(1.286)		(1.312)
POPCH_21_31_21					0.0001***	
					(0.00004)	
log(UNEMP_31)						–0.445
						(1.311)
POPCH_31_00_31					0.0001***	0.0001***
					(0.00001)	(0.00001)
Constant	9.214***	–57.807***	–154.362***	32.995**	–25.541***	–2.238
	(2.274)	(10.117)	(16.408)	(13.471)	(8.282)	(20.671)
Observations	246	246	246	246	231	246
R^2	0.030	0.200	0.367	0.698	0.550	0.781

Adjusted R^2	0.022	0.187	0.351	0.690	0.538	0.772	

Notes: Robust standard errors are shown in parentheses. ***Statistically significant at the 1% level; **statistically significant at the 5% level, *statistically significant at the 10% level.

Table A.3. Regression results for the growth dynamics of tax income over 1931–2000 weighted by the tax income in 2000

	Dependent variable:							
	The growth dynamics of tax income over 1931–2000 (entropy) weighted by tax income in 2000							
	(1)	(2)	(3)	(3a)	(4)	(5)	(6)	(6a)
ENT_UV_NOA_00	–140.903***	–88.750*	–102.348**	–58.482	–123.368**	–20.979	–77.579	–64.500
	(53.051)	(53.137)	(49.740)	(43.162)	(49.540)	(46.471)	(47.651)	(41.918)
ENT_RV_NOA_00	248.070***	218.320***	141.980**	183.785***	132.896**	175.800***	143.576**	199.368***
	(68.637)	(67.982)	(61.684)	(53.386)	(62.965)	(60.123)	(59.510)	(52.762)
UV_31_NOA		505.151***	120.403	35.810	291.278**	312.630**	172.685	119.417
		(123.898)	(142.975)	(123.631)	(117.269)	(122.955)	(145.372)	(127.955)
RV_31_NOA		166.289*	274.070***	175.675**	155.069*	202.768**	275.392***	176.047**
		(93.114)	(87.871)	(76.549)	(85.412)	(87.520)	(88.814)	(79.026)
log(LS_31)			–147.581	–133.490			–137.112	–187.013**
			(100.195)	(86.401)			(106.081)	(93.451)
log(HS_21)			203.332***	175.077***			109.350**	91.947**
			(31.729)	(27.537)			(50.751)	(44.663)
log(DU)				–142.089***				–147.210***
				(15.812)				(18.159)
log(POP_31)					172.745***		125.125**	70.536
					(56.832)		(60.495)	(53.601)
log(AGR_31)					17.056		118.334*	–20.828
					(52.791)		(65.895)	(60.413)
POPCH_21_31_31						0.002**	0.001*	0.001
						(0.001)	(0.001)	(0.001)
POPCH_31_00_00						0.001***	0.001***	–0.0002
						(0.0002)	(0.0003)	(0.0003)
Constant	786.607***	–288.377	1,161.403**	1,856.398***	–731.782	–130.672	–218.928	1,595.783*
	(52.021)	(288.163)	(521.925)	(456.597)	(543.746)	(284.683)	(885.817)	(810.195)
Observations	246	246	238	238	246	231	231	231
R^2	0.082	0.141	0.310	0.490	0.295	0.334	0.387	0.528
Adjusted R^2	0.074	0.127	0.292	0.474	0.277	0.316	0.359	0.505

Notes: Robust standard errors are shown in parentheses. ***Statistically significant at the 1% level; **statistically significant at the 5% level, *statistically significant at the 10% level.