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The Impact of EU Funds on the Composite Development Index Across Austrian
Political Districts

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Amila Rahmanović

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Zusammenfassung

Ziel dieser Masterarbeit ist die Konstruktion eines Entwicklungsindex für 91 österreichische politische Bezirke auf Grundlage sozioökonomischer Indikatoren aus den Bereichen Wirtschaft, Demografie, Infrastruktur und Tourismus für den Zeitraum 2016 bis 2022. Darüber hinaus wird der Zusammenhang zwischen EU-Kohäsionsförderungen und der regionalen Entwicklung anhand von Förderdaten der Programmperiode 2014-2020 untersucht.

Zur Konstruktion des multidimensionalen Entwicklungsindex werden die Hauptkomponentenanalyse (Principal Component Analysis, PCA) sowie ein einfacher Durchschnittsansatz herangezogen. Zur Analyse des Zusammenhangs zwischen EU-Fördermitteln und regionaler Entwicklung kommen Paneldaten-Regressionsmodelle mit Two-Way Fixed Effects sowie unterschiedlichen Lag-Spezifikationen zum Einsatz.

Die PCA identifiziert vier zentrale Dimensionen regionaler Entwicklung: Arbeitskräftepotenzial, Einkommen und wirtschaftliches Wohlbefinden, urbane Struktur sowie die tourismusbezogene Dimension. Die Ergebnisse zeigen deutliche regionale Unterschiede. Höher platzierte Bezirke befinden sich überwiegend in urbanen und tourismusorientierten Regionen, während niedriger platzierte Bezirke vor allem in peripheren ländlichen Gebieten liegen. In sämtlichen Spezifikationen der Fixed-Effects-Modelle zeigt sich kein statistisch signifikanter Einfluss der EU-Kohäsionsförderung auf den regionalen Entwicklungsindex im untersuchten Zeitraum.

Die Ergebnisse dieser Studie tragen zu einem vertieften Verständnis regionaler Entwicklungsunterschiede in Österreich bei und können politische Entscheidungsträgerinnen und Entscheidungsträger bei der Gestaltung regionaler Entwicklungsstrategien, insbesondere in den Bereichen Tourismus, Gesundheitswesen und Bildung, unterstützen.

Abstract

The objective of this thesis is to construct a development index for 91 Austrian political districts based on socioeconomic indicators from economic, demographic, infrastructural, and tourism-related dimensions from 2016 to 2022. In addition, the relationship between EU cohesion funding and regional development is analysed using funding data from the 2014-2020 programming period.

Principal Component Analysis and the simple average approach are used to construct a multidimensional development index. Panel data regression models with two-way fixed effects and different lag specifications are used to analyse the relationship between EU funds and regional development.

PCA identified four main dimensions of development: labour force, income and economic well-being, urban structure, and, finally, the tourism-related dimension. Significant regional differences are visible: higher-ranked districts are in urban and tourism-oriented areas, while lower-ranked districts are mostly located in peripheral rural regions. Across all fixed effects model specifications, EU cohesion funding did not show a statistically significant effect on the regional development index during the observed period.

This study contributes to a better understanding of development disparities in Austria and may support policymakers in designing regional development strategies in areas such as tourism, healthcare and education.

Dedication

“*Rabbi zidnī ‘ilmā*”
“My Lord, increase me in knowledge.”

I would like to express my gratitude to my parents and sisters for their love and endless support.

I dedicate this thesis to every girl who was denied the opportunity to pursue her education. While I had the privilege to study, countless minds brighter and more determined than mine were never given the chance for their potential to flourish. This degree is for the scholars you were never allowed to become.

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1. Introduction

It is a fact, proven over time, that regional inequalities exist and persist in any country at any level of development (Williamson, 1965). Regional disparities within a country are among the most complex development concerns for economists and policymakers. Besides structural differences that result from historical development and geographical location, there are also significant socioeconomic gaps in regional development that can be influenced by different policies.

The most widely used development indicator is Gross Domestic Product (GDP), which provides a general overview of economic performance. While GDP is a simple, straightforward and statistically reliable measure, it captures only material well-being. However, it ignores social or environmental inequalities (Widuto, 2016). Instead of relying on one single measure, combining multiple quantitative indicators into a single index is often used to analyse the level of development across countries or regions. European Union funds are among the main instruments for achieving economic, social, and territorial cohesion (European Union, 2008).

Austria has participated in the EU's Cohesion Policy right from the start of its membership in 1995. It has received financial support through the Structural and Investment Funds (ESIF): the European Regional Development Fund (ERDF), the European Social Fund (ESF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF). Together with national co-financing, these funds have contributed around €31 billion to regional development projects in Austria over the past 25 years (ÖROK, 2023).

As a high-income economy categorised by the World Bank and a member of the Organisation for Economic Co-operation and Development (OECD), Austria is considered a highly developed country (World Bank, 2024). In addition, according to Eurostat, Austria's performance exceeds the EU average on key economic parameters. However, despite the high level of development, regional disparities that affect local growth and overall development persist.

The goal of this study is to show different ways of calculating the development index and to examine the impact of European Union funds on economic development across Austrian political districts.

Research Subject and Goals

As a federal country, Austria is politically divided into nine federal states (Bundesländer), which are further subdivided into 94 political districts (Bezirke). Of these, 15 are statutory cities, while the remaining 79 are districts headed by a district governor. As of 1 January 2025, Austria consists of 2,092 municipalities (“Gemeinden”), including 205 cities (Statistics Austria, 2026). The municipal analysis would provide a more detailed perspective; however, not much data is available at this level. The use of data on the level of districts is especially suitable for such an analysis, since districts often represent functional economic units organised around central places where economic activities and public services take place. Such data allows for obtaining a more precise measurement of regional inequality on the local level (Berentsen, 1976).

Although Austria officially consists of 94 political districts, the final sample includes [91 units of analysis](#), as some districts were merged. Eisenstadt (Urban), Rust (Urban) and Eisenstadt (Surrounding area) were treated as a single unit, while Waidhofen an der Ybbs (Urban) was merged with Amstetten. Officially they are separate districts, but some data sources report them jointly.

The **main objective** of the thesis is to construct a composite development index for Austrian districts based on a set of socioeconomic indicators. In addition, it aims to analyse the impact of European Union funds on the constructed development index at the district level.

The **main hypothesis** of this study says: European Union funding has a positive impact on Austrian regional development. It is further expected that this impact may vary across districts and may not be immediate but rather occur with a time lag.



Figure 1. Administrative division of Austria

Source: Statistics Austria (2026)

2. Background and Literature Review

2.1. Regional Disparities

Regional inequality goes beyond simple variations of income and wealth. It is about everyday disparities in society, such as access to public services, education, and infrastructure (European Union, 2019). We can look at this through the lens of “inequality of outcomes,” which means an unequal distribution of income and wealth. Another way of looking is “inequality of opportunity”, where access, for instance, to education and healthcare differs between regions (European Union, 2019).

Unequal development can destabilise a country and has significant effects on social relations. Therefore, reducing regional disparities is a key EU policy concern (McAleavey & De Rynck, 1997). In practice, most studies focus on cross-country analyses or large regions due to lack of reliable data for small regions.

The European Union uses the NUTS (Nomenclature of Territorial Units for Statistics) classification for regional statistics. According to Eurostat, NUTS levels are mainly determined by population size and administrative characteristics. This system distinguishes between three levels: 1.) larger regions (NUTS 1), mainly with a population above 3 million, where it can be the country itself, 2.) basic regions used for policy purposes (NUTS 2), with a population

between 800 000 and 3 million, and 3.) smaller areas used for more detailed analysis (NUTS 3), usually with 150 000 to 800 000 inhabitants (Eurostat, 2026).

From previous research regarding regional disparities, including those done by Ozaslan et al. (2006), Braukša (2011) and Pintilescu (2011), it becomes clear that regional development is complex and cannot be captured by one indicator. Evidence from both high- and less-developed countries confirms that socioeconomic gaps are consistently present regardless of the overall national development. For example, Ozaslan found significant differences between Turkish regions and grouped them from more urban to more rural areas.

The literature often shows that development tends to be higher in regions around the capital city. It can be expected that Vienna, as the capital and the main cultural, economic and political center, stands out as the most developed. We see the same pattern across Europe: Bucharest, Romania (Pintilescu, 2011), Riga, Latvia (Braukša, 2011) and Prague, the Czech Republic (Kvičalova et al., 2014).

2.2. Multidimensionality

Socioeconomic development is a multidimensional process which improves the quality of life. It requires the satisfaction of economic, social, political and cultural rights, as well as equal opportunities and the empowerment of disadvantaged groups (Myrdal, 1972). Previous research uses a wide range of socioeconomic indicators, including income levels, employment, health, education, demographic characteristics and infrastructure. For example, Perišić (2014) combined economic (e.g., average income per capita, average unemployment rate) and social variables (migration, share of educated population) to measure regional development. Similar indicators were used by Goletsis et al. (2011), but they also considered other factors, including health-related and tourism indicators (e.g., number of doctors and hospital beds per 1000 inhabitants). Xiaoxin (2012) also examines development from multiple perspectives by combining variables from different areas: economic, social, demographic and infrastructure.

Soares et al. (2003) conducted their analysis at the NUTS 2 level using 33 socioeconomic variables in 275 municipalities in Portugal. Their classification was much wider and included six groups: demography, economy, health, education, employment and culture. The selected indicators covered a broad range of variables, including age groups, migration, tourism, infrastructure, the number of healthcare centres, schools, firms, and cultural activities. These studies included multiple indicators from different sectors and showed that regional development is about more than just economics.

2.3. Composite Development Index Construction

The human development index (HDI), introduced in 1990, has served as a leading indicator of multidimensional development. It is a simple composite measure of a nation's key dimensions: longevity, education and income. The HDI is calculated as the geometric mean of normalised indices for each of the three dimensions (UNDP, 2022). The Human Development Report Office (HDRO) provides several other composite indices that reflect additional aspects of human development: the inequality-adjusted human development index (IHDI), the gender development index (GDI), the gender inequality index (GII), the planetary pressures-adjusted human development index (PHDI), and the multidimensional poverty index (MPI). MPI combines 10 indicators covering three dimensions: health, education and standard of living (UNDP, 2026).

Due to differences in measurement scales of the variables, it is necessary to standardize the variables. Goletsis et al. (2011) in their research normalized selected variables using the Min-Max method to make them comparable before constructing the index. Schrott et al. (2012) examined the regional development index in Austria and standardized each sub-indicator by a z-transformation and ensured that each variable is equally weighted in the overall index.

Vydrová et al. (2012) selected 12 variables and, using factor analysis, reduced them to 3 main factors: basic characteristics (wage, education, health), risk groups (number of women, seniors, disabled), and environmental. Xiaoxin (2012) also uses principal component analysis (PCA) to reduce a large number of indicators (22 variables) across economic, social, demographic, and infrastructure areas into a smaller set of key components that explain development. This method explores the underlying factors that explain the relationships within a set of interdependent variables (Kim & Mueller, 1978). Palevičienė and Dumčiuvienė (2015) used the same multivariate approach, PCA, on 25 regional indicators for EU NUTS 2 regions to get a smaller number of independent components representing different dimensions of regional development. The extracted factor scores were later used for cluster analysis. This thesis expands on the use of PCA to construct the development index.

2.4. EU Cohesion Policy in Austria

The Cohesion Policy is an important instrument for reducing economic, social and territorial disparities across the European Union. It should support economic growth, competitiveness, employment, sustainable development and quality of life of all cities and regions within the European Union (European Communities, 2006). EU Cohesion Policy started in 1975 when the

European Regional Development Fund (ERDF) was created. The main aim of EU Cohesion Policy is to strengthen economic, social and territorial cohesion in the EU (European Commission, n.d.). During the 2014-2020 programming period, European Structural and Investment Funds (ESIF) also included the Cohesion Fund (CF), the European Social Fund Plus (ESF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF).

In Austria, regional development support was mainly provided through ERDF, ESF, EAFRD and EMFF programmes. Austria received more than €5 billion from EU Cohesion Policy during the mentioned period (ÖROK, 2025). The largest share came through EAFRD (€3,937 million), ERDF (€536 million), ESF (€442 million), and EMFF (just under €7 million). In addition, around €257 million in ERDF funds were allocated to European Territorial Cooperation (ETC) and other interregional programmes (ÖROK, 2025).

The allocation of EU Structural Funds depended on the development level of regions. Less developed regions (those with GDP per capita below 75% of the EU-27 average for 2007-2009) received the highest level of financial support, followed by transition regions (75-90% of the EU-27 average), while more developed regions (>90%) received a lower level of support. During the 2014-2020 period, the whole Austria was eligible for funding, as there were no less developed regions, as the country is overall highly developed (ÖROK, 2025). In Austria, the ERDF mainly concentrated on research and innovation, SME competitiveness and the transition towards a low-carbon economy. The ESF primarily supported employment, social inclusion and education, including lifelong learning. Cohesion Policy programmes also required co-financing from national public institutions, and depending on the programme, private contributions to increase overall investment leverage (ÖROK, 2025).

2.5. Effects of EU Cohesion Policy

Previous research on the impact of EU Cohesion Policy shows mixed results and suggests that its effects are often visible only after several years. The time required for project implementation, institutional absorption and multiplier effects are the causes of this time lag (Esposti & Bussoletti, 2008). Despite substantial financial support from the EU Cohesion Policy, Del Campo et al. (2008) identified significant differences in effects across EU regions. Mantegazza and Longo (2025) found significant disparities in GDP per capita in Portugal during the 2014-2020 period, and these effects were increasing over time. Similar findings were made by Žáček et al. (2019), who showed a positive relationship between European Structural Funds and economic growth in the Czech Republic.

Indeed, the literature does not always demonstrate strong positive effects of the EU Cohesion Policy. According to some studies, regional growth is more influenced by other economic characteristics than by the amount of EU support received. The growth differential between Objective 1 regions and other regions is solely due to differences in the characteristics, not in the coefficients (Falk & Sinabell, 2008). Similarly, Ederveen et al. (2002) found that the impact of EU Cohesion Policy on economic growth is mixed. They said that problems such as inefficient spending, crowding out, and poor governance may reduce the benefits of EU support. Becker et al. (2018) believe that positive effects are often stronger in the short run and may become weaker once EU support is reduced or removed.

EU Cohesion Policy makes a significant contribution to reducing the backwardness of less developed regions, but the reduction in regional development disparities is moderate (Pellegrini et al., 2013). Mohl and Hagen (2008) found a positive, but statistically insignificant, relationship between EU Structural Funds and regional growth. Their findings show that the impact may differ across regions and that greater EU funding does not always lead to stronger economic growth.

2.6. Panel Data Literature

It is mentioned that funding effects may differ across regions and become visible only after a certain period. Therefore, panel data methods are commonly used in the literature. These models are suitable for analyses that examine multiple regions over time (Vukašina et al., 2022). Fixed effects models are often applied in regional development research because they remove the effect of those time-invariant characteristics that can lead to biased parameter estimates. These effects control for all differences specific to each region that do not change over time (e.g., geographical position). The model also includes time fixed effects to account for unexpected events across regions during a certain period that may affect the dependent variable, such as the COVID-19 crisis (Vukašina et al., 2022).

In addition, explanatory variables are often lagged to control for potential endogeneity, which can lead to biased estimates and negatively affect the estimation results (Žáček et al., 2019). Research on the impact of Cohesion Policy during the 2014-2020 programming cycle on economic growth in Portugal covers the period from 2009 to 2023. In their study, the effects of EU funds are examined using a two-way fixed effects Difference-in-Differences (DiD) model. It includes both the pre-treatment and extended absorption period. This temporal framing is consistent with the EU's n+3 rule, which allows projects to be implemented up to 3 years after the official programming period ends (Longo & Mantegazza, 2025).

Banko (2022) analysed the use of European Union funds by local government units in Croatia, including counties, cities and municipalities. The study compared several panel-data approaches (pooled OLS, random effects, and fixed effects models). The authors' aim was to find the most appropriate approach for analysing regional differences in EU fund absorption. There were no major differences among the estimated models, but the fixed effects model showed the best overall performance. This again confirms that controlling for region-specific effects is important when analysing the relationship between EU funding and regional development.

3. Data

3.1. Data Sources and Regional Units

The Republic of Austria uses the European Union's NUTS classification system. Austrian federal provinces (Bundesländer) correspond to the NUTS 2 level, while political and judicial districts form the NUTS 3 regions (Statistics Austria, 2023). This study focuses on 91 political districts (Bezirke), which represent a lower and more detailed territorial level than NUTS 3.

The dataset of socioeconomic indicators for each district were retrieved from Statistics Austria and the Austrian Federal Economic Chamber (WKÖ). The Austrian Conference on Spatial Planning (ÖROK) is an institution supported by all administrative levels in Austria for coordinating spatial planning at the national level. Managing authorities are obligated to provide public lists of projects financed through the European Regional Development Fund (ERDF) and the European Social Fund (ESF) (European Communities, 2013). Information on ERDF-funded projects was retrieved from the official Austrian EFRE project database managed by ÖROK, while data on ESF-funded projects were obtained from the official ESF project list provided by the European Social Fund Austria.

3.2. Socioeconomic Indicators

A literature review shows a large number of different socioeconomic indicators used in empirical studies on regional disparities and composite development indices. The most common variables are income per capita, employment and unemployment rates, sectoral employment structure, population density, education achievement, demographic structure, migration indicators, GDP per capita, number of enterprises, healthcare indicators, tourism capacity and infrastructure-related variables.

Since this study focuses on Austrian political districts, certain variables commonly used in regional development research were not available at this level. Therefore, the selection of indicators was determined by data availability and literature relevance.

Socioeconomic variables cover the period from 2016 to 2022. A total of 16 variables were included in the analysis and grouped into four dimensions: economic, demographic, infrastructural and tourism-related. Understanding each dimension is key to analysing regional development. Therefore, the following subsections provide an overview of the selected variables and their specific values in Austria.

3.2.1. Economic Dimension

GDP is most used as a macroeconomic indicator of economic performance. Policymakers often take GDP growth as the ultimate goal of economic policy. Since regional development is a multidimensional concept, GDP growth alone cannot fully capture a region's level of development and well-being. A higher GDP does not automatically mean a higher level of satisfaction or quality of life. Frey and Stutzer (2010) found that despite the increase in real GDP per capita in the United States during the period 1946-1991, the average level of happiness declined. This suggests that the economic dimension should include a broader set of indicators. Since GDP per capita is not available at the district level, income tax assessed is used as a proxy for this dimension.

The following variables were selected as representative economic indicators:

- unemployment rate,
- income tax assessed,
- average net wage,
- average pension,
- number of workers per retiree,
- number of new start-ups.

Employment has a positive influence on the development, and EU funds should support entrepreneurship and the creation of new employment opportunities (Czudec, Kata, & Wosiek, 2019). Excluding the population below the age of 15 and above the age of 65 results in the working-age population (OECD, 2024). Unemployment can also be voluntary, and some individuals prefer to enjoy the benefits of a social security system. Many people who are officially unemployed may work in the shadow economy, where they are not burdened by taxes and social security contributions (Frey & Stutzer, 2010). Austria's level of undeclared work is low relative to the EU-27 average. In recent years, approximately 7-8% of official GDP comes

from the shadow economy (ELA, 2023). Cohesion Policy has a significant positive impact on both regional economic growth and employment, but the effects are not equal across regions (Crescenzi & Giua, 2019). The unemployment rate is calculated as the ratio of unemployed persons to the total labour force. For the period 2014-2020, the average unemployment rate across Austria's districts was 5.2%.

Income reflects an individual's ability to satisfy basic and additional needs and maintain a living standard (Porter & Purser, 2008). The usual assumption is that higher income produces more utility. However, the marginal utility of income decreases as income rises (Frey & Stutzer, 2010). During the observed period, the highest income tax assessed was recorded in Mödling (€3,406.7), and the lowest in Jennersdorf (€482.2).

According to Statistics Austria, monthly income includes the regular monthly salary from the main employment, as well as holiday and Christmas bonuses, regular overtime payments, shift work compensation, seniority bonuses, travel and per diem allowances, tips, commissions and meal compensation. Net pay is gross pay reduced by taxes and other payments that support public services such as healthcare, pensions and unemployment insurance. Therefore, higher income tax assessed values may reflect the region's broader economic capacity (Finanznavi, n.d.). During the period 2016-2022, the highest yearly gross salary was recorded in Mödling (€50,250), while the lowest was in Landeck (€24,939).

Compared to the other EU countries, Austria has a relatively low average retirement age (for men, 65, for women, 60). Individuals have the opportunity to retire earlier and spend a longer period receiving pensions. In the long run, the pay-as-you-go pension system increases pressure on the Austrian pension system and public finances (OECD, 2019). Mödling had the highest pension in the examined period (€34,868), and the lowest pension was in Südoststeiermark (€17,923).

The low number of workers per retiree may indicate population ageing, which tends to reduce aggregate savings, investment, technological progress and entrepreneurial activity, lowering regional development (Gardó, Klaus, Kurig, & Storz, 2025).

Small and medium-sized enterprises (SMEs) make up 99.8% of all companies in the market-oriented sector. They employ 2.4 million people, which is 66% of total employment, and generate more than half of the total turnover and value added (Eurofound, 2025). One key indicator in the literature explaining regional economic disparities is the number of new start-ups. More developed districts are characterised by significantly higher numbers of SMEs. This suggests that the creation of new firms plays an important role in reducing regional development gaps (Stamenkovic & Savic, 2017).

3.2.2. Demographic Dimension

Population is one of the key factors of regional economic development because it represents the source of the labour force. Demographic indicators are strongly correlated. If vitality index values increase, the potential tertiary student population grows and, consequently, the share of the working-age population increases. As previously mentioned, larger shares of retirees may increase pressure on public finances, but higher shares of the working-age population contribute to economic activity and growth.

Some of the most important demographic variables are:

- vitality index,
- share of working-age population,
- number of tertiary students per 1,000 inhabitants.

Czirák et al. (2006), in their analysis of regional development in Croatian municipalities, included socio-demographic indicators such as population trends, vitality index, education and age structure. They found that the most economically developed municipalities are, among other things, characterised by higher shares of the working population and higher educational levels. Also, in the study by Soares et al. (2003), less developed areas are characterised by an ageing population, with very low birth rates and a very low active population. Innsbruck (Urban area) is a district with the highest working-age share (70.5%).

3.2.3. Infrastructural Dimension

Andrejiova & Kimakova (2020) showed that transport infrastructure significantly affects regional differences in Slovakia. In their analysis, among others, these variables were used: motorisation rate, number of cars, trucks and buses per capita. Motorisation rate is the number of passenger cars per inhabitant. A similar variable will be used in this research: vehicle registrations per 1,000 inhabitants. In their study, a high positive correlation between the number of cars and regional GDP was found.

Strzelczyk & Seroka-Stolka (2018) noted that transport congestion, the growing number of road accidents and environmental pollution from transport affect the development of transport infrastructure. However, the number of vehicles does not necessarily indicate weaker infrastructural development. For example, in Vienna, with highly developed public transport, residents may rely less on private cars than in rural areas. Between 1993 and 2015, the share of car trips in Vienna decreased from 40% to 27% (Knoflacher, 2023). Rodrigue (2020) also argued that the share of cars depends on location, social status, income, quality of public transit

and parking availability. Therefore, vehicle registrations in this study are observed as an indicator of mobility and connectivity between districts. It can be concluded that the transport network contributes to social and economic development. In 2016, Bruck an der Leitha recorded 276 cars per 1,000 inhabitants, the highest value during the observed period.

The infrastructural dimension will be measured using:

- number of vehicles registrations (new and used) per 1,000 inhabitants,
- share of workers with long commuting duration,
- share of high-rise construction,
- share of low-rise construction.

According to Eurostat data, the average commuting time in the EU was 25 minutes in 2019. Longer commuting times are more common in urban areas, where approximately 40% of employed people commute for 30 minutes or more. In this research, the commuting indicator is defined as the share of workers whose commute is longer than 25 minutes. The number of workplace commuters is derived from the labour force subset “persons at work.” Individuals on parental leave are not included, as they are not part of the commuting traffic until they return to work.

Housing and residential construction are often considered relevant indicators of regional development. Goletsis & Chletsos (2011) included the number of new houses per 100 inhabitants in their composite index of regional development. Their results show that regions with more houses tend to achieve higher levels of overall development. Ozaslan et al. (2006) also included the number of housing units variable within the construction dimension of regional development. Therefore, housing development in this study is captured through the share of low-rise residential buildings (one dwelling) and the share of high-rise residential buildings (two or more dwellings).

3.2.4. Tourism-related Dimension

Most previous studies include the number of hotel beds as a primary indicator of the tourism dimension of regional development. Goletsis and Chletsos (2011) included the number of hotel beds per 1000 inhabitants in their composite index of regional development for Greek regions. This variable was used as an indicator of tourism development and the “attractiveness” of a region. Aumayr (2006) also included this indicator in the cluster analysis of European NUTS 3 regions. The author found that in tourist regions (192 hotel beds per 1000 inhabitants), gross regional product is significantly higher than the average for all regions. The results show a positive and statistically significant relationship between the number of hotel beds and regional

development. Similarly, in the study of Soares et al. (2003), tourism was identified as a separate dimension of socio-economic development through factor analysis. This “Tourism” factor was represented by one single variable, the number of hotel beds. This highlights how important tourism capacity is and to what extent it contributes to differentiating more developed from less developed regions. Fast growth in tourism has diversified the region’s economic structure, which is close to the country’s average in terms of all indicators (Ozaslan et al., 2006). In this region, tourism represents one of the leading economic activities. This indicates that tourism can be an important component of regional development even in regions that are not among the most developed.

The tourism-related dimension will be captured through:

- number of accommodation establishments per 1,000 inhabitants,
- overnight stays per 1,000 inhabitants,
- bed places per 1,000 inhabitants.

3.3. EU Cohesion Policy Funding

As discussed in the second chapter, EU Cohesion Policy funding in Austria during the 2014-2020 programming period was primarily implemented through the European Regional Development Fund (ERDF) and the European Social Fund (ESF). During this period, one of the European Regional Development Fund’s main goals was to support investment for growth and jobs (IGJ/ERDF). According to the programme evaluation, ERDF interventions contributed to employment creation, support for SMEs, the development of research capacities, and CO₂ reduction projects. The ESF program focused on investing in people by increasing employment and labour mobility, fighting poverty and discrimination, and supporting education and lifelong learning (ÖROK, n.d.).

Burgenland was the only Austrian province with the status of a transition region in the 2014-2020 period (GDP per capita 75-90% of the EU-27 average for 2007-2009). All other Austrian provinces were classified as more developed regions. This means that districts in Burgenland received more EU funding than those in more developed regions.

Data on ERDF-funded projects were obtained from the ERDF Project Database of the Investment for Growth and Jobs Programme Austria 2014-2020. The database contains project-level information, including the project title, beneficiary, project location, start and end dates, and the amount of EU funding allocated to each project. Data on ESF-funded projects were obtained from the Projects in Austria database provided by ESF Austria. Similar information

was available for each project, including the beneficiary, project location, project duration and the amount of EU funding allocated.

Since the analysis is conducted at the district level, individual projects were assigned to Austrian political districts based on their reported locations. As many projects spanned multiple years, funding amounts were allocated to the year in which each project was completed. This approach was chosen because the effects of funded projects are expected to become visible after project completion, when the planned activities and investments have been fully implemented. Subsequently, ERDF and ESF funding amounts were aggregated at the district-year level. To account for differences in district size, the aggregated funding amounts were divided by the district population, resulting in a per capita measure of EU funding. The final variable represents the amount of EU Cohesion Policy funding per inhabitant received in each district and year.

3.4. Population Density

Previous studies have identified population density as an important characteristic associated with regional development and economic performance. Cziráky et al. (2003) included population density as one indicator of the economic development dimension of municipalities. Furthermore, Soares et al. (2003) found that municipalities with higher levels of development were characterised by higher population density, purchasing power and better access to services. Population density can affect regional development because more densely populated areas usually have larger labour markets, better infrastructure, and more business activity. For this reason, population density is used as a control variable to control for these structural differences among Austrian districts.

4. Methodology

4.1. Development Index Construction

Multidimensionality of regional development is captured through the construction of a development index. This index is based on socioeconomic indicators reflecting different dimensions of regional development. The selection and description of original variables are presented in the Data chapter. Before constructing the development index, the dataset was analysed for missing values. Variables representing overnight stays and tertiary students contained a significant number of missing values. Having missing values throughout the entire

period for specific districts, using any imputation procedure would not be appropriate. Therefore, these indicators were excluded from the final dataset to guarantee reliability and comparability. The variables representing the shares of high-rise and low-rise residential buildings contained missing values only for the year 2022 (the last observed year). Variations in these variables are relatively small across years, so the missing observations were imputed using the Last Observation Carried Forward (LOCF) method. This approach replaces missing values with the previous year's value for that district.

Short descriptions and the data type for the variables included in the final dataset are presented in the table below.

Table 1. Description and the data type of the variables

Variable	Data Type	Description
district	Categorical (Nominal)	Austrian political district (Bezirk); Cross-sectional dimension in the panel dataset
year	Time variable	Longitudinal dimension of the data covering the period 2016-2022
unemp_rate	Numeric	Unemployment rate (%). Considered a negative indicator
income_tax	Numeric	Average annual income tax assessed per taxpayer
avg_wage	Numeric	Average gross annual wage per employee
avg_pension	Numeric	Average annual pension income
workers_retiree	Numeric	Ratio of workers to retirees
startups_1000	Numeric	Number of newly established firms per 1 000 inhabitants
vitality_index	Numeric	Ratio of live births to deaths (%)
workage_share	Numeric	Share of working-age population (15-64 years old) in total population (%)
regvehicles_1000	Numeric	Number of registered (used and new) vehicles per 1000 inhabitants, used as a proxy for transport infrastructure and mobility
long_commute_share	Numeric	Share of employed persons with long commuting duration (>25min). Considered a negative indicator of accessibility and city connectivity
accom_1000	Numeric	Number of accommodation establishments (hotels, private

		accommodations) per 1000 inhabitants
hotelbeds_1000	Numeric	Number of hotel beds per 1000 inhabitants
lowrise_share	Numeric	Share of low-rise residential buildings in housing structure
highrise_share	Numeric	Share of high-rise residential buildings in housing structure

Since the selected indicators use different units of measurement, all variables were standardised before the analysis. This procedure ensures that higher values reflect a higher level of regional development and enables comparability between variables. The unemployment rate and long commuting time variables were treated as negative development indicators. Higher values of these variables reduce the overall level of development. Observations were transformed into standardised values by expressing each value's deviation from the mean in standard deviation units.

This procedure is called Z-score standardisation:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}$$

where:

- z_{ij} is the standardised value of indicator j for district i ,
- x_{ij} is the original value of indicator j for district i ,
- $\bar{x}_j$ is the mean value of indicator j ,
- s_j is the standard deviation of indicator j .

4.1.1. Principal Component Analysis (PCA)

The first version of the regional development index was constructed using Principal Component Analysis (PCA). PCA is a multivariate technique often used for dimensionality reduction and the identification of latent structures within a dataset. The general purpose of factor analysis is to summarise the information contained in a large number of original variables into a smaller set of new variates (factors), with a minimal loss of information (Hair et al., 2010).

The objective of applying PCA in this study is to identify the underlying dimensions of regional development and to reduce the number of socioeconomic indicators into a smaller number of components that explain most of the variability in the data. As discussed in the literature review focused on multidimensionality, PCA is used for regional development analysis because many

socioeconomic indicators are highly correlated and often measure similar aspects of development. Instead of analysing each variable separately, PCA extracts a smaller number of latent dimensions.

Before conducting PCA, the data set must be suitable for factor analysis. This was examined using the correlation matrix in order to check whether correlations between variables are high enough (at least 0.30 in absolute value). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy evaluates whether the observed correlations among variables are sufficiently large for factor analysis. The KMO measure ranges from 0 to 1; values below 0.5 indicate that factor analysis may not be appropriate, while values above 0.6 are considered acceptable for a reliable factor analysis (Hair et al., 2010). Kaiser (1974) gave an interpretation scale for these values, presented in the table below:

Table 2. Interpretation of Kaiser-Meyer-Olkin measure

0.90 and above	marvelous
0.80-0.89	meritorious
0.70-0.79	middling
0.60-0.69	mediocre
0.50-0.59	miserable
below 0.50	unacceptable

Bartlett's test of sphericity tests the null hypothesis that the correlation matrix is an identity matrix, implying that the variables are not significantly correlated. A statistically significant Bartlett's test indicates that the variables are sufficiently correlated and therefore suitable for PCA. After these tests, PCA can be performed, and the number of factors need to be determined.

Hair et al. (2010) summarised several rules of thumb for choosing the number of factors. Eigenvalues represent the amount of total variance explained by each component, while components with higher eigenvalues explain a larger proportion of the variability contained in the original variables. Factors with eigenvalues higher than 1.0 should be retained (Hair et al., 2010). A decision on the factor number can also be supported by examining the cumulative percentage of explained variance (usually 60% or higher). In addition, the scree plot can help to identify the point at which the contribution of additional components becomes relatively small (Hair et al., 2010).

After component extraction, Varimax rotation was applied to simplify the factor structure for easier interpretation. Varimax is the most popular orthogonal factor rotation method, where the axes are maintained at 90 degrees. After rotation, components remain uncorrelated. This method focuses on simplifying the columns in a factor matrix. The purpose of rotation is to achieve clearer factor separation (Hair et al., 2010).

The interpretation of components is based on rotated factor loadings, which represent the correlation between the original variables and the extracted components. Higher loadings make the variable representative of the factor (Hair et al., 2010). All variables with high loadings at the same factor form one dimension of regional development.

The extracted components represent different dimensions of regional development. Following the approach often applied in studies of regional development, the factor scores of the retained components were aggregated into a single development index. Since the retained components explain different proportions of the total variance, scores were weighted by their contributions to the overall explained variance. The PCA-based development index is defined as follows:

$$\text{PCAIndex}_{it} = w_1 F_{1it} + w_2 F_{2it} + w_3 F_{3it} + w_4 F_{4it}$$

where:

- F_{jit} is the factor score of the retained component j for district i in year t ,
- w_j are weights based on the share of explained variance of each component.

As a result, components containing more information from the original indicators received a greater weight in the final index.

4.1.2. Simple Average Index Construction

The second version of the regional development index for each district and year was calculated as the simple arithmetic mean of all standardised indicators used in the construction of the PCA-based index. In this approach, each indicator was assigned equal importance in the overall index construction. Higher values of the index indicate a higher level of regional development than other districts in the sample.

In contrast to PCA, the simple average index does not account for relationships among variables and assigns equal weight to each indicator. However, it provides a simple and easy-to-understand measure of regional development. The average index was calculated mainly for

comparison purposes. By comparing the results of both indices, it is possible to examine whether the overall conclusions depend on the method used to construct the index.

4.2. Panel Data Methodology

To analyse the relationship between European Union funds and regional development across Austrian districts over time, a panel data approach was used. The advantage of panel models is that they combine cross-sectional and time-series dimensions, which allows accounting for unobserved heterogeneity across districts (Wooldridge, 2010).

A two-way fixed effects model was used as the main specification. The fixed effects approach controls for all time-invariant characteristics of districts by removing effects specific to one district through *within* transformation (time demeaning). This transformation is performed by subtracting the average value of each variable over time from its original observation. In this way, only within-district variation over time is used for estimation, while unobserved district-specific effects are eliminated from the model. This means that the model estimates how changes within a district over time are associated with changes in the dependent variable. District-specific characteristics (geographical location, historical background, etc.) are implicitly controlled for because they do not vary over time (Wooldridge, 2010).

There are important assumptions of the fixed effects. First, the independent variables must be strictly exogenous. This means that the random errors (the unexplained parts of the model) cannot be connected to or correlated with our explanatory variables at any point in time. In addition, the variables must actually change over time within each district. If a variable remains exactly the same across districts from year to year, the fixed effects model cannot estimate its impact (Wooldridge, 2010).

The model also includes time-fixed effects to control for common shocks and events that affect all districts simultaneously, such as inflation, economic crises, or the COVID-19 pandemic. By combining both district and time fixed effects, a two-way fixed effects specification was used. Additionally, population density was included as a control variable to account for differences in district size and the degree of urbanisation. More densely populated districts often benefit from better infrastructure, a wider range of services and different economic conditions compared to less populated areas. These factors may influence regional development independently of EU funding. Including population density helps reduce omitted-variable bias and improve the reliability of the estimated results. The estimated model is specified as:

$$\text{DevelopmentIndex}_{it} = \alpha + \beta_1 \ln(\text{EUFunds}_{i,t-k}) + \beta_2 \ln(\text{PopulationDensity}_{it}) + \mu_i + \lambda_t + \epsilon_{it}$$

where:

- $DevelopmentIndex_{it}$ represents the regional development index for district i in year t ,
- $EU Funds_{i,t-k}$ - lagged EU funding per capita for district i in year t ,
- $PopulationDensity_{it}$ is a control variable,
- μ_i - district fixed effects,
- λ_t - time specific effects,
- ε_{it} represents the idiosyncratic error term.

Possible heteroskedasticity and serial correlation within districts cannot be ignored, as they can lead to incorrect statistical conclusions. Therefore, clustered robust standard errors were implemented. This ensures robustness to problems within units over time (Wooldridge, 2010). A potential limitation of the analysis is endogeneity and reverse causality between EU funds and regional development. The allocation of EU Structural Funds partly depends on the development level of regions, since less developed regions are generally eligible for higher levels of support. As mentioned in Chapter 2, Austria did not have any classified less developed regions during the 2014-2020 programming period, which reduces concerns related to funding allocation based on development status. However, the possibility of endogeneity cannot be completely excluded. To partly address this issue, several lagged specifications of EU funding were estimated, allowing for the possibility that the effects of funded projects appear only after a certain period.

5. Empirical Results and Discussion

5.1. Principal Component Analysis Results

From the correlation matrix can be concluded that correlations within variables are high enough to include them in the analysis (≥ 0.30 in absolute value with at least one another variable) ([Appendix 3](#)).

Before selecting the final PCA model, several model specifications were tested to find the best factor structure. Initial iterations included all selected variables across different numbers of retained components ([Appendix 2](#)). During this process, two variables, the unemployment rate and the number of start-ups, had low and unstable factor loadings across multiple components,

making their interpretation difficult. These variables were excluded, and the final PCA model was estimated using the remaining indicators.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were run. The KMO result was 0.71, which, according to the [interpretation of KMO measure](#), means that the data are acceptable for factor analysis.

Additionally, Bartlett's test of sphericity was statistically significant. The null hypothesis that the correlation matrix is an identity matrix is rejected. This confirms that the variables are correlated and PCA can be used.

Table 3. KMO and Bartlett's test of sphericity results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			.71
Bartlett's Test of Sphericity	Approx. Chi-Square		7,204.21
	df		66
	Sig.		< .001

Source: Own calculations

Eigenvalues, cumulative explained variance, and a scree plot were used to determine the optimal number of factors. The first four components had eigenvalues greater than 1: 4.53, 2.71, 1.65, and 1.01. According to the Kaiser criterion discussed in the methodology chapter, these four components were retained for further analysis. Together, they explain approximately 83% of the total variance in the dataset. The scree plot also confirmed the decision to retain four components, as there is a visible break in the slope after the fourth component.

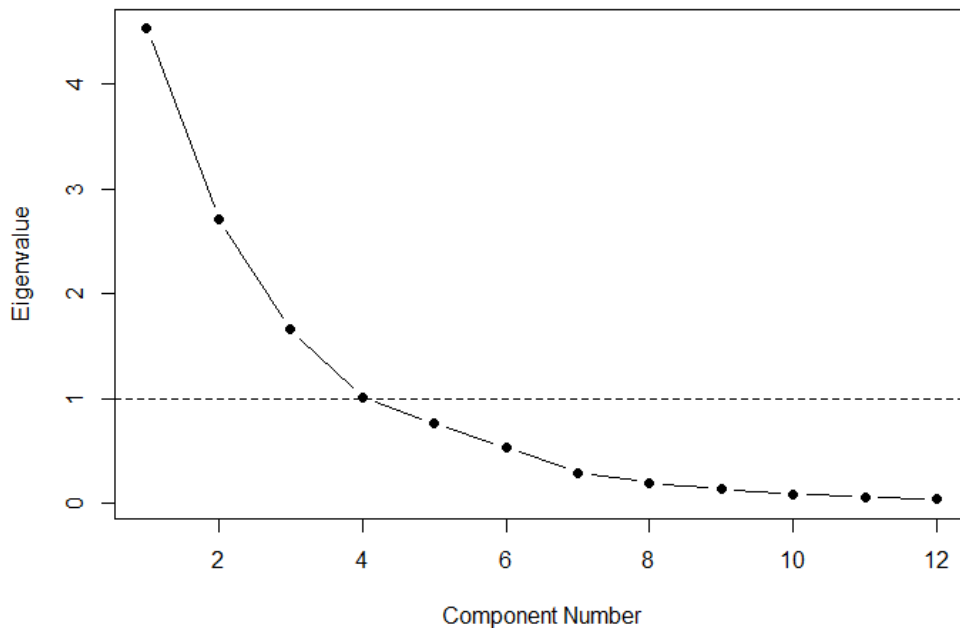


Figure 2. Scree Plot for determining the number of components

Source: Own illustration based on the collected dataset

After determining the number of components, a Varimax rotation was applied to obtain a simpler and more interpretable factor structure. The table below presents the rotated factor loadings of variables with the highest loadings within each retained component.

Table 4. Rotated factor loadings and interpretation of components

Factor 1 - Labour force	Factor Loading	Factor 2 - Income and economic well-being	Factor Loading
workers_retiree	0.94	avg_pension	0.89
vitality_index	0.92	avg_wage	0.87
workage_share	0.80	income_tax	0.67
Factor 3 - Urban structure	Factor Loading	Factor 4 - Tourism dimension	Factor Loading
highrise_share	0.87	accom_1000	0.96
lowrise_share	-0.84	hotelbeds_1000	0.95
long_commute_share	-0.71		

Source: Own calculations

High positive loadings for the *workers-retiree ratio*, the *vitality index* and the *working-age population share* define the first component. These indicators show strong demographic sustainability and labour force potential, which is why this factor was interpreted as a “Labour force”.

Average wages, pensions and income tax levels correlate with the second component. These variables reflect income levels and the overall economy of the districts. This factor was labelled as “Income and economic well-being”.

The third factor, labelled "Urban structure", has a positive, high loading on the variable *share of high-rise residential buildings* and negative loadings on the variables *share of low-rise residential buildings* and *share of long-commuting workers*.

The fourth component has very high positive loadings on *accommodation establishments* and *hotel beds per 1,000 inhabitants*. These variables clearly reflect tourism infrastructure and tourism intensity. This factor was named a “Tourism dimension”.

The labour force dimension explains 24% of the total variance, followed by the urban structure dimension (22%), the income and economic well-being (19%) and the tourism dimension (18%).

5.2. Construction of the PCA-Based Regional Development Index

The next step was to calculate factor scores for each district and year. They represent composite measures of each retained factor for every observation (Hair et al., 2010). A higher score indicates that a district has strong characteristics related to that specific component, driven by high values on its underlying variables (Hair et al., 2010). A composite PCA-based development index was constructed using weighted factor scores. The weights correspond to the proportion of explained variance of each retained component:

$$\text{PCAIndex}_{it} = 0.24F_{1it} + 0.19F_{2it} + 0.22F_{3it} + 0.18F_{4it}$$

where:

- F_{jit} is the factor score of the retained component j for district i in year t .

Higher values of this index indicate a relatively higher level of regional development. Austrian political districts were ranked based on their average PCA-based development index during the observed period ([Table](#)). The average PCA development index values range from -0.84 to 1.32. This range shows disparities between districts.

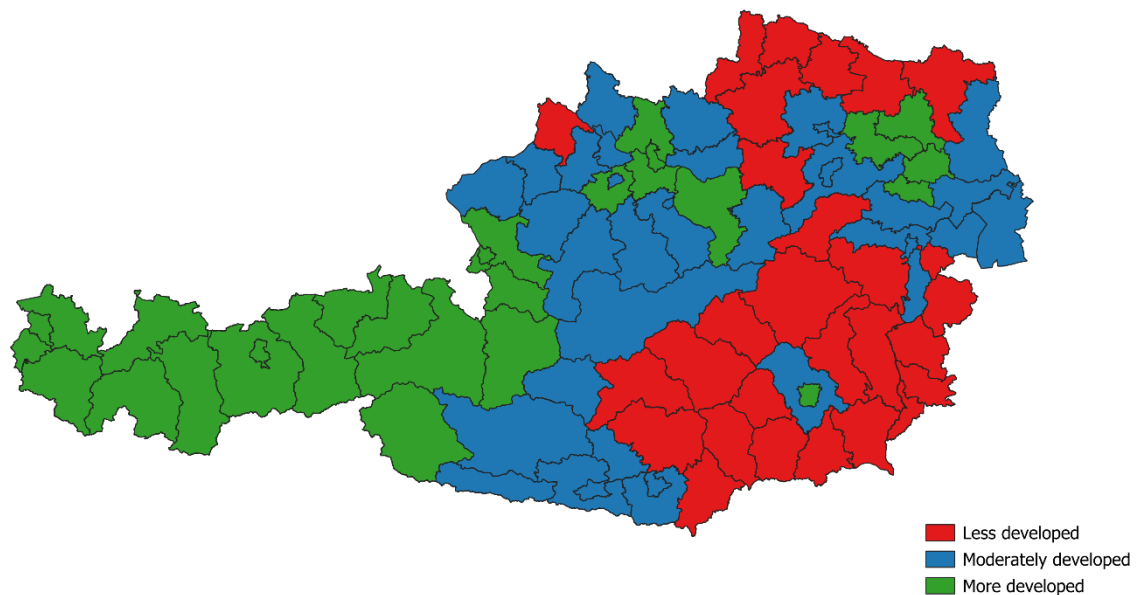


Figure 3. Classification of Austrian Districts by Level of Regional Development (PCA-Based Index)

Source: Own illustration based on Statistics Austria using QGIS

From Figure 3, a visible difference between East and West in regional development across Austrian districts is evident. The most developed districts are mostly in western Austria, especially in the provinces of Tyrol and Vorarlberg. Highly developed areas are also around major cities such as Vienna, Graz, and Salzburg. Less developed districts are mostly located in eastern and south-eastern Austria.

Based on the PCA-average index, the highest-ranked districts are Landeck, Schwaz, Innsbruck Urban, Graz Urban and Kitzbühel. Some of these top-ranked western districts (e.g. Landeck and Kitzbühel) are strongly associated with the tourism dimension. Kitzbühel had on average 48 accommodation establishments per 1,000 inhabitants and 70,383 overnight stays. Landeck recorded an average of 69 hotels and private accommodations per 1,000 inhabitants and 129,073 stays. In comparison, the average number of accommodations across all districts during 2016-2022 was only 9 per 1,000 inhabitants. This big difference shows that tourism is a major reason why western districts rank so high. On the other hand, highly ranked urban districts such as Vienna, Graz Urban and Innsbruck Urban depend less on tourism. They rank high because of their urban structure and income levels (higher salaries and a stronger labour market).

The lowest index values were observed in Güssing, Gmünd, Waidhofen an der Thaya, Jennersdorf and Oberpullendorf. These districts are mostly rural and peripheral, located near national borders with Slovenia, Hungary and the Czech Republic. All of them had strongly negative scores in Factor 1, indicating ageing populations and lower labour force potential. In addition, several districts also showed low scores in the urban structure dimension, reflecting weaker infrastructure and lower urban concentration.

At the end, the simple arithmetic average index and the PCA index were compared. Both show a similar regional pattern, with western Austria remaining more developed and eastern districts less developed. However, the simple average classified a larger number of districts into the less developed category. This is shown in Figure 4 below:

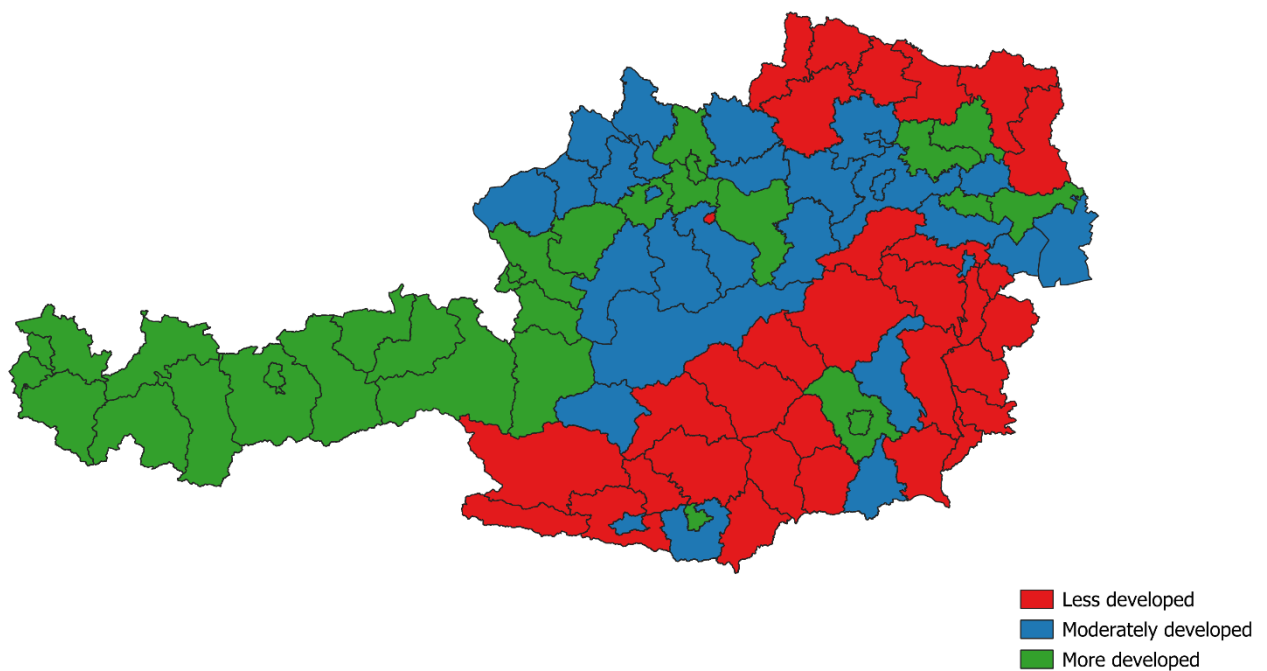


Figure 4. Classification of Austrian Districts by Level of Regional Development (Simple Average Index)

Source: Own illustration based on Statistics Austria using QGIS

Although the PCA-based and simple average indices are highly correlated (Pearson's $r = 0.919$), ranking differences are still visible. Table 5 shows the districts with the largest rank changes when different index construction methods are applied.

Table 5. Largest Rank Changes Across Index Construction Methods

District	PCA-Based Rank	Simple Average Rank	Rank Difference
Lienz	27	59	32
Hermagor	38	69	31
Weiz	65	37	28
Spittal an der Drau	56	83	27
Reutte	23	2	21

Source: Own calculations

The PCA-based index is statistically more robust, since it accounts for correlations between variables and weights dimensions according to their contribution to overall variance. In contrast, the simple average index gives equal importance to all dimensions. This approach may be too simple for examining regional development. The comparison proves that regional development cannot be captured by a single indicator or by treating all indicators equally. The PCA-based index provides a more realistic representation of regional development and better captures its multidimensionality. This index is used as the dependent variable in the following regression analysis.

5.3. Fixed Effects Panel Regression Results

To examine the effects of European Union funds on regional development across Austrian districts, a two-way fixed effects panel regression model was estimated. The main explanatory variable is the lagged logarithmic value of EU funds per capita. The model includes both district and year fixed effects, with logarithmic population density added as a control variable. Clustered robust standard errors were applied to account for possible heteroskedasticity and serial correlation within districts. The regression results are visible in the table below.

$$PCAIndex_{it} = \alpha + \beta_1 \ln(EUFunds_{i,t-k}) + \beta_2 \ln(PopulationDensity_{it}) + \mu_i + \lambda_t + \epsilon_{it}$$

Table 6. Fixed Effects Regression Results for the PCA-Based Development Index

Coefficients:				
	Estimate	Std.Error	t-value	Pr(> t)
ln_eufunds_percapita	0.00579	0.00627	0.9227	0.35659
ln_density	0.47445	0.15706	3.0207	0.00264 **
Total Sum of Squares:	10.698			
Residual Sum of Squares:	10.507			
R-Squared:	0.01782			
F-statistic:	4.88226 on 2 and 538 DF	p-value:	0.0079191	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Source: Own calculations

The regression results indicate that EU cohesion funds per capita do not have a statistically significant effect on the regional development index during the observed period ($p = 0.3565$). The population density shows a positive and statistically significant effect on the development index at the 1% significance level. This means that districts with a higher population density generally achieve higher levels of development. This result is intuitive, as more populated districts (Vienna, Graz Urban, Salzburg Urban) usually have more economic activity, better infrastructure, larger labour markets and a higher concentration of public services. The overall model is statistically significant according to the F-statistic ($p = 0.008$).

As a robustness check, the fixed effects regression was re-estimated using the simple average development index as the dependent variable. The results remain consistent with the previous specification, as EU cohesion funds remain statistically insignificant ($p = 0.511$). However, unlike the PCA-based model, population density is no longer statistically significant. In addition, the model shows very low explanatory power, indicating that the simple average index is not well-suited for this panel regression.

Alternative Lag Structures and Joint Significance Test

Additional model specifications with different lag structures were also estimated. Since the effects of cohesion policy projects may become visible only after several years, lagged values of EU funds ranging from 1 to 4 years were included in the model. Since EU funding data are available only for 2014-2020, while the development index covers 2016-2022, the number of observations decreases as additional lags are included.

The estimated coefficients remain very small in all lag models. Even when looking at longer time lags, no evidence of delayed effects of EU cohesion funds on regional development was found.

Table 7. Fixed Effects Regression Results Using One- to Four-Year Lagged EU Funds

Variable	Coefficient	Std. Error	p-value
EU Funds (t-1)	0.0014	0.0076	0.853
EU Funds (t-2)	0.0021	0.0078	0.784
EU Funds (t-3)	-0.0058	0.0097	0.553
EU Funds (t-4)	-0.0088	0.0130	0.502

Source: Own calculations

To further examine whether EU funds may have a cumulative delayed effect, a joint significance test was performed under the null hypothesis that all lag coefficients are jointly equal to zero:

$$H_0: \beta_{lag1} = \beta_{lag2} = \beta_{lag3} = \beta_{lag4} = 0$$

The null hypothesis cannot be rejected ($\chi^2 = 1.45, p = 0.836$), indicating that lagged EU funding variables are not jointly significant. The joint significance test further shows that lagged EU funding is not statistically significant even when considered simultaneously, with no evidence of a cumulative delayed effect on regional development.

These findings are consistent with the main fixed effects model and further support the conclusion that no measurable impact of EU cohesion funds on the constructed PCA regional development index can be identified during the observed period.

Component-Level Analysis

Each retained dimension was used as a separate dependent variable in additional fixed effects regressions. This was done to examine whether EU funds affect any of these components individually. The results show that EU funds remain statistically insignificant across all four regressions.

On the other hand, as in previous findings, population density has a positive and statistically significant effect on income and economic well-being, as well as on urban structure and tourism dimensions. This means that more populous districts show stronger economic performance, more developed urban infrastructure, and greater tourism capacity.

These results further confirm the conclusion that no measurable effect of EU cohesion funds on regional development can be found, either for the overall development index or for its individual components.

Table 8. Fixed Effects Regression Results for Individual PCA Components

Component	EU funds	p-value	Population density	p-value
Labour force	0.0044	0.521	-0.199	0.036*
Income and economic well-being	-0.0058	0.162	1.371	0.030*
Urban structure	0.0030	0.794	0.709	0.002**
Tourism	0.00048	0.880	0.475	0.00075***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Source: Own calculations

Discussion of Results and Limitations

The existence of regional disparities within a highly developed country such as Austria is clearly demonstrated through various approaches. These differences are reflected across multiple aspects of development, the economy, demography, infrastructure and tourism. Using Principal Component Analysis, it was confirmed that regional development is multidimensional and cannot be observed with simple indicators. PCA helped to clearly divide Austria into less, moderately and more developed regions.

The significant impact of European Union funds could not be found through all model specifications. Comparing different lags to account for longer delays or examining the joint significance of short- and medium-term effects did not change the initial results. This finding is not surprising, since Austria is a more developed EU country, meaning cohesion support per capita is relatively limited compared to less developed member states. Hagen and Mohl (2008) also found in their study that the effects of EU cohesion funding on growth are much stronger in less developed regions. Austria did not have any Objective 1 regions during the observed period, where cohesion funds are typically highest; therefore, growth effects are difficult to measure. Additional funding in a highly developed country may not yield large marginal gains because the baseline is already high.

In this study, the focus was on the amount of EU funds, not their distribution. Rodriguez-Pose & Fratesi (2004) and many others have argued that the effectiveness of Cohesion Policy also

depends on how resources are allocated across development dimensions. These authors also suggest that these funds may be used as a redistributive instrument rather than a driver of economic growth.

Another possible explanation for these results is the short time available to evaluate the full effects. Even studies using panel datasets covering more than ten years have considered the observation period a limitation. Cohesion Policy effects are delayed because funded projects often need to go through the project preparation and approval phase, as well as implementation and operationalisation. After these stages, a significant time period is needed for effects to become measurable.

Despite these findings, several limitations of this study should be mentioned. A major limitation is the potential endogeneity of EU cohesion funding. The two-way fixed effects model helps control for district-specific characteristics that do not change over time. However, endogeneity may remain if EU funds are correlated with unobserved factors that change over time (e.g. local administrative changes) (Wooldridge, 2010). The allocation of funds is unlikely to be fully exogenous since less developed areas may receive more support.

A related concern is reverse causality. One important source of potential bias is administrative capacity. It refers to the institutional, bureaucratic and human resource capacity required to absorb funding (Incaltarau et al., 2020). In this study, districts with stronger administrative capacity, better project preparation and stronger institutions may be more successful in absorbing EU funds. Therefore, it is difficult to determine whether EU funds have an impact on regional development or whether more developed districts are simply better at absorbing available funds.

Another limitation relates to the construction of the development index. Previous studies often include a broader set of socioeconomic indicators across multiple dimensions. However, the number of variables in this study was limited due to data availability at the district level. Some potentially relevant dimensions of regional development may not have been fully captured. For the same reason, some relevant control variables might not be included in the regression analysis, leaving out factors that could affect regional development. In addition, EU funding was measured based on the year the project finished, which may reduce precision when the funding effects actually occurred.

Despite these limitations, the study provides valuable insights into regional disparities in Austria at the district level and highlights the challenges of evaluating the impact of EU cohesion funding on regional development.

6. Conclusion

The aim of this thesis was to analyse regional development disparities across 91 Austrian political districts and to examine the relationship between EU cohesion funds and regional development. Since regional development is a multidimensional concept, a development index was constructed using two approaches: a simple average and a PCA-based index. Variables for construction were taken from socioeconomic, demographic, infrastructural and tourism-related dimensions for the 2016-2022 period.

Four main aspects of development were identified: labour force, associated with a higher workers-retiree ratio, vitality index and working-age population share; income and economic well-being, reflected in higher average wages, pensions and income tax per capita; urban structure, mainly characterized by the share of high-rise and low-rise residential buildings together with the share of long commuting workers; and finally tourism-related dimension, strongly associated with a higher number of accommodation establishments and hotel beds per 1,000 inhabitants. Districts were ranked according to the values of the PCA-based development index. Higher-ranked districts were mainly urban and tourism-oriented areas in western Austria, while lower-ranked districts were mostly peripheral rural areas located in eastern and south-eastern Austria. These spatial patterns were also clearly visible in the regional maps.

In the second part of the analysis, different panel data specifications were used to test the relationship between EU funds and regional development. The two-way fixed effects model results did not show a statistically significant effect of EU funds on the development index. This result remained consistent across several lag structures and when one- to four-year lagged effects were tested jointly. This evidence suggests that the impact of EU cohesion funds on regional development in Austria may be limited or difficult to detect over the seven-year period observed. However, the control variable, population density, showed a positive, statistically significant effect.

The effects of Cohesion Policy projects usually take longer to become visible. Another explanation for these results is that, compared to less developed EU member states, regional differences within Austria are relatively small. Because of that, additional financial support from the EU is insufficient to create noticeable changes in development at the district level.

Future research could extend the observation period to cover two EU programming periods to better capture lagged funding effects on development. A broader set of regional indicators could be included, for instance, from the culture and health dimension (e.g., the number of dentists and medical doctors, hospital beds, and pharmacies).

Overall, this study provides one of the few district-level analyses of the multidimensional nature of development and highlights the challenges of evaluating the impact of Cohesion Policy funding at this level. It also contributes to the literature by combining the construction of regional development using Principal Component Analysis with an examination of the effects of EU funds using a fixed-effects panel data regression model.

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Appendices

Appendix 1.

Table A1.1. Names and IDs of Austrian Districts

ID	Name	ID	Name
1	Eisenstadt (Urban+Surrounding Area) + Rust (Urban)	47	Gmunden
2	Güssing	48	Grieskirchen
3	Jennersdorf	49	Kirchdorf
4	Mattersburg	50	Linz (Rural)
5	Neusiedl am See	51	Perg
6	Oberpullendorf	52	Ried
7	Oberwart	53	Rohrbach
8	Klagenfurt (Urban)	54	Schärding
9	Villach (Urban)	55	Steyr-Land
10	Hermagor	56	Urfahr-Surrounding Area
11	Klagenfurt (Rural)	57	Vöcklabruck
12	Sankt Veit an der Glan	58	Wels-Land
13	Spittal an der Drau	59	Salzburg (Urban)
14	Villach Land	60	Hallein
15	Völkermarkt	61	Salzburg-Surrounding Area
16	Wolfsberg	62	St. Johann im Pongau
17	Feldkirchen	63	Tamsweg
18	Krems an der Donau (Urban)	64	Zell am See
19	St. Pölten (Urban)	65	Graz (Urban)
20	Waidhofen an der Ybbs (Urban) + Amstetten	66	Deutschlandsberg
21	Wiener Neustadt (Urban)	67	Graz-Surrounding Area
22	Baden	68	Leibnitz
23	Bruck an der Leitha	69	Leoben
24	Gänserndorf	70	Liezen
25	Gmünd	71	Murau
26	Hollabrunn	72	Voitsberg
27	Horn	73	Weiz
28	Korneuburg	74	Murtal
29	Krems (Rural)	75	Bruck-Mürzzuschlag
30	Lilienfeld	76	Hartberg-Fürstenfeld
31	Melk	77	Südoststeiermark
32	Mistelbach	78	Innsbruck (Urban)
33	Mödling	79	Imst
34	Neunkirchen	80	Innsbruck (Rural)
35	St. Pölten (Rural)	81	Kitzbühel
36	Scheibbs	82	Kufstein
37	Tulln	83	Landeck
38	Waidhofen an der Thaya	84	Lienz
39	Wiener Neustadt (Rural)	85	Reutte
40	Zwettl	86	Schwaz

41	Stadt Linz	87	Bludenz
42	Stadt Steyr	88	Bregenz
43	Stadt Wels	89	Dornbirn
44	Braunau	90	Feldkirch
45	Eferding	91	Vienna
46	Freistadt		

Table A1.2. Summary Statistics for All District-Year Observations (2016-2022)

Variable	Mean	SD	Min	Max
unemp_rate	5.23	2.19	1.64	13.99
income_tax	1,153.41	459.53	482.18	3,406.66
avg_wage	34,046.38	3,637.63	24,939	50,250
avg_pension	23,899.55	2,907.57	17,923	34,868
workers_retiree	2.17	0.33	1.40	2.93
vitality_index	92.05	26.13	35.69	172.45
workage_share	65.73	1.51	61.07	70.47
regvehicles_1000	184.92	21.00	103.73	276.32
long_commute_share	37.23	12.11	8.36	70.38
accom_1000	9.61	14.84	0.22	73.08
hotelbeds_1000	87.47	122.53	6.44	723.51
lowrise_share	0.80	0.16	0.02	1
highrise_share	0.19	0.14	0.00	0.88

Source: Own calculations

Appendix 2: Factor Analysis Full Data Set

Table A2.1. KMO and Bartlett's Test of Sphericity Results for Initial Data Set

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.				.71
Bartlett's Test of Sphericity	Approx. Chi-Square			7,882.393
	df			91
	Sig.			< .001

Source: Own calculations

Table A2.2. Rotated Component Matrix and Communalities for the Initial PCA Specification

	Component				Communalities
	1	2	3	4	
unemp_rate	-0.06	0.00	-0.14	0.82	0.69
income_tax	0.53	0.69	0.05	0.10	0.77
avg_wage	-0.22	0.75	-0.48	0.28	0.92
avg_pension	-0.01	0.88	-0.26	-0.09	0.85
workers_retiree	0.88	-0.01	0.08	0.33	0.90
startups_1000	-0.24	-0.04	-0.40	-0.45	0.42
vitality_index	0.89	-0.08	0.12	0.24	0.88
workage_share	0.89	-0.12	-0.13	-0.15	0.84
regvehicles_1000	-0.05	-0.52	-0.33	0.16	0.41
long_commute_share	0.63	0.14	0.32	-0.13	0.54
accom_1000	0.06	-0.10	0.94	-0.02	0.89
hotelbeds_1000	0.13	-0.08	0.91	-0.08	0.86
lowrise_share	-0.66	-0.32	-0.19	0.38	0.72
highrise_share	0.68	0.32	0.26	-0.43	0.81

Source: Own calculations

Table A2.3. Rotated Component Matrix and Communalities for the Final PCA Model (12 Variables)

	Component				Communalities
	1	2	3	4	
income_tax		0.67	0.67		0.79
avg_wage		0.87	0.87		0.94
avg_pension		0.89	0.89		0.86
workers_retiree	0.94				0.94
vitality_index	0.92				0.92
workage_share	0.80				0.81
regvehicles_1000					0.43
long_commute_share			-0.71		0.63
accom_1000				0.96	0.97
hotelbeds_1000				0.95	0.95
lowrise_share			-0.84		0.80
highrise_share			0.87		0.86

Source: Own calculations

Table A2.4. Total Variance Explained by the Retained Principal Components

	Component			
	1	3	2	4
SS loadings	2.89	2.64	2.24	2.14
Proportion Var	0.24	0.22	0.19	0.18
Cumulative Var	0.24	0.46	0.65	0.83
Proportion Explained	0.29	0.27	0.23	0.22
Cumulative Proportion	0.29	0.56	0.78	1

Source: Own calculations

Appendix 3.

Table A3.1. Ranking of Austrian Districts by Average PCA-Based Development Index

Rank	District	Average PCA-Based Development Index
1	Landeck	1.323
2	Schwaz	0.995
3	Innsbruck (Urban)	0.987
4	Graz (Urban)	0.936
5	Kitzbühel	0.890
6	Bludenz	0.842
7	St. Johann im Pongau	0.815
8	Innsbruck (Rural)	0.814
9	Imst	0.787
10	Zell am See	0.778
11	Feldkirch	0.773
12	Bregenz	0.741
13	Vienna	0.722
14	Salzburg (Urban)	0.671
15	Dornbirn	0.655
16	Mödling	0.652
17	Kufstein	0.625
18	Salzburg-Surrounding Area	0.546
19	Linz (Urban)	0.508
20	Hallein	0.438
21	Waidhofen an der Ybbs (Urban) + Amstetten	0.421
22	Urfahr-Surrounding Area	0.357
23	Reutte	0.354
24	Korneuburg	0.294
25	Tulln	0.291
26	Linz (Rural)	0.201
27	Lienz	0.143
28	Wels (Rural)	0.124
29	Baden	0.117
30	Klagenfurt (Urban)	0.069
31	Krems an der Donau (Urban)	0.062
32	Tamsweg	0.048
33	St. Pölten (Rural)	0.046
34	Klagenfurt (Rural)	0.040
35	Vöcklabruck	0.030
36	Graz-Surrounding Area	0.029
37	Gmunden	0.024

38	Hermagor	0.016
39	Villach (Urban)	-0.002
40	Eferding	-0.030
41	Wiener Neustadt (Urban)	-0.045
42	Perg	-0.045
43	Steyr (Rural)	-0.059
44	Wels (Urban)	-0.062
45	Ried	-0.081
46	St. Pölten (Urban)	-0.089
47	Kirchdorf	-0.098
48	Bruck an der Leitha	-0.100
49	Freistadt	-0.130
50	Liezen	-0.131
51	Grieskirchen	-0.152
52	Braunau	-0.159
53	Eisenstadt (Urban+Surrounding Area) + Rust (Urban)	-0.170
54	Neusiedl am See	-0.178
55	Krems (Rural)	-0.197
56	Spittal an der Drau	-0.210
57	Scheibbs	-0.229
58	Villach (Rural)	-0.240
59	Wiener Neustadt (Rural)	-0.248
60	Gänserndorf	-0.252
61	Rohrbach	-0.271
62	Steyr (Urban)	-0.287
63	Feldkirchen	-0.290
64	Schärding	-0.303
65	Weiz	-0.303
66	Leibnitz	-0.313
67	Mattersburg	-0.321
68	Melk	-0.332
69	Mistelbach	-0.366
70	Deutschlandsberg	-0.388
71	Murau	-0.407
72	Neunkirchen	-0.422
73	Hartberg Fuerstenfeld	-0.440
74	Völkermarkt	-0.472
75	Hollabrunn	-0.477
76	Sankt Veit an der Glan	-0.481
77	Wolfsberg	-0.501
78	Murtal	-0.513
79	Lilienfeld	-0.532
80	Bruck-Mürzzuschlag	-0.551

81	Südoststeiermark	-0.558
82	Leoben	-0.562
83	Horn	-0.580
84	Oberwart	-0.587
85	Voitsberg	-0.596
86	Zwettl	-0.650
87	Oberpullendorf	-0.683
88	Jennersdorf	-0.694
89	Waidhofen an der Thaya	-0.767
90	Gmünd	-0.777
91	Güssing	-0.836

Source: Own calculations

Table A3.2. Ranking of Austrian Districts by Simple Average Development Index

Rank	District	Simple Average Development Index
1	Schwaz	0.779
2	Reutte	0.704
3	Graz (Urban)	0.700
4	Salzburg (Urban)	0.668
5	Mödling	0.658
6	Innsbruck (Rural)	0.650
7	Imst	0.650
8	Kitzbühel	0.642
9	Innsbruck (Urban)	0.636
10	Salzburg-Surrounding Area	0.624
11	Feldkirch	0.587
12	Bludenz	0.566
13	Kufstein	0.525
14	Landeck	0.519
15	St. Johann im Pongau	0.465
16	Wels (Rural)	0.459
17	Dornbirn	0.441
18	Zell am See	0.438
19	Bregenz	0.409
20	Linz (Rural)	0.389
21	Urfahr Surrounding Area	0.293
22	Linz (Urban)	0.291
23	Hallein	0.270
24	Korneuburg	0.267
25	Tulln	0.206
26	Waidhofen an der Ybbs (Urban) + Amstetten	0.204
27	Graz Surrounding Area	0.196
28	Bruck an der Leitha	0.184
29	Klagenfurt (Urban)	0.178
30	Vöcklabruck	0.154
31	Ried	0.141
32	Vienna	0.105
33	Krems an der Donau (Urban)	0.087
34	Eferding	0.081
35	Gmunden	0.059
36	Braunau	0.053
37	Weiz	0.053
38	Wiener Neustadt (Urban)	0.043

39	Klagenfurt (Rural)	0.038
40	Perg	0.030
41	Grieskirchen	0.026
42	Wels (Urban)	0.025
43	Liezen	-0.004
44	Steyr (Rural)	-0.012
45	St. Pölten (Rural)	-0.015
46	Baden	-0.032
47	Freistadt	-0.038
48	Tamsweg	-0.046
49	Kirchdorf	-0.047
50	Scheibbs	-0.051
51	Leibnitz	-0.056
52	Eisenstadt (Urban+Surrounding Area) + Rust (Urban)	-0.065
53	Villach (Urban)	-0.107
54	Melk	-0.115
55	Rohrbach	-0.116
56	Neusiedl am See	-0.117
57	St. Pölten (Urban)	-0.157
58	Schärding	-0.175
59	Lienz	-0.176
60	Krems (Rural)	-0.178
61	Wiener Neustadt (Rural)	-0.178
62	Hartberg Fuerstenfeld	-0.204
63	Deutschlandsberg	-0.259
64	Feldkirchen	-0.269
65	Mattersburg	-0.301
66	Gänserndorf	-0.306
67	Villach (Rural)	-0.317
68	Mistelbach	-0.323
69	Hermagor	-0.327
70	Wolfsberg	-0.340
71	Südoststeiermark	-0.355
72	Horn	-0.357
73	Murtal	-0.366
74	Jennersdorf	-0.371
75	Steyr (Urban)	-0.386
76	Zwettl	-0.404
77	Sankt Veit an der Glan	-0.409
78	Murau	-0.447
79	Oberwart	-0.448

80	Neunkirchen	-0.464
81	Völkermarkt	-0.466
82	Hollabrunn	-0.484
83	Spittal an der Drau	-0.502
84	Voitsberg	-0.507
85	Güssing	-0.541
86	Leoben	-0.555
87	Lilienfeld	-0.558
88	Oberpullendorf	-0.587
89	Waidhofen an der Thaya	-0.595
90	Bruck-Mürzzuschlag	-0.607
91	Gmünd	-0.759

Source: Own calculations

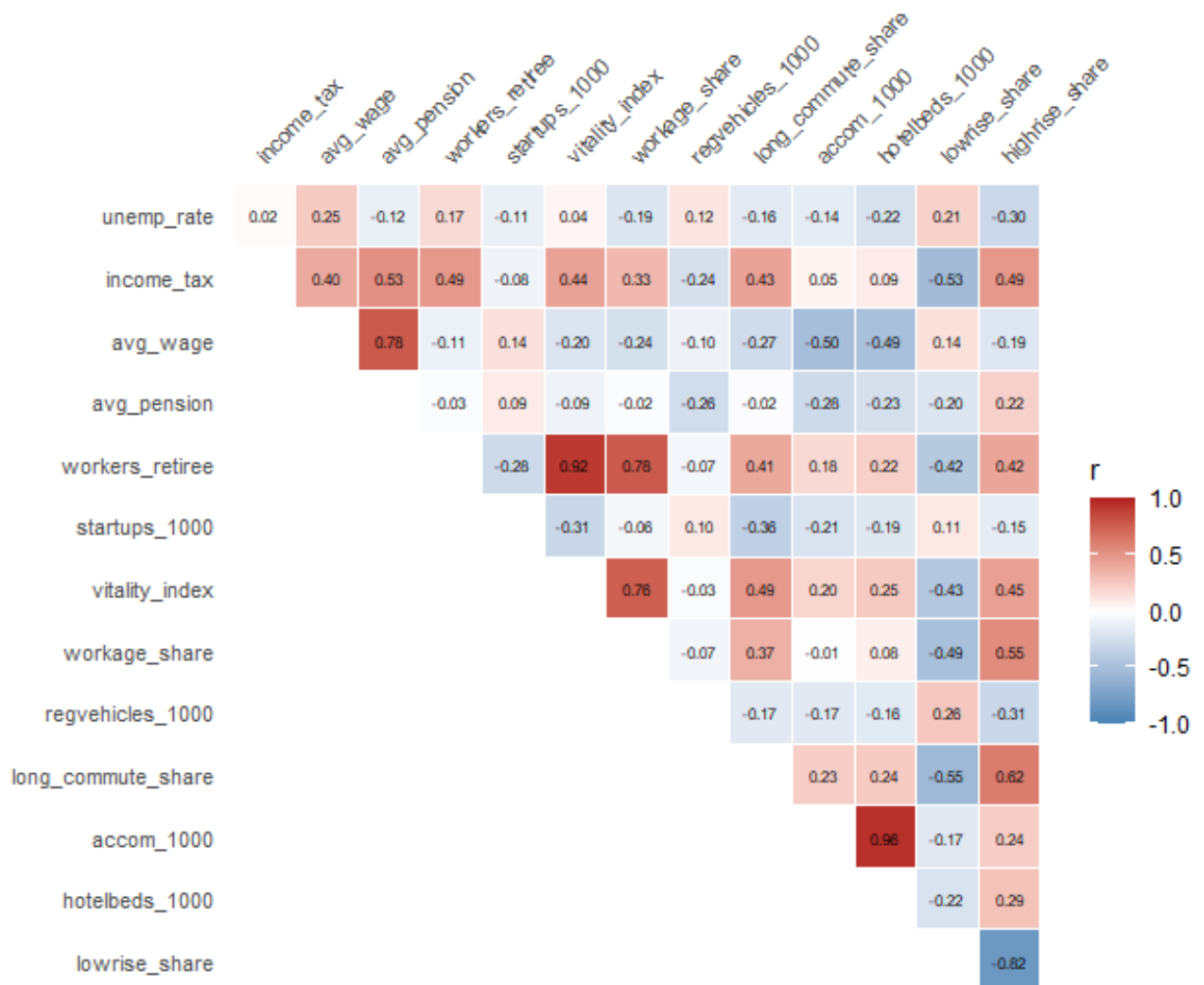


Figure A3.1. Correlation Matrix

Source: Own calculations in R Studio

Table A3.3. Fixed Effects Regression Results for the Simple Average Development Index

Coefficients:				
	Estimate	Std.Error	t-value	Pr(> t)
ln_eufunds_percapita	-0.00172	0.00238	-0.7212	0.4711
ln_density	-0.09038	0.05972	-1.5133	0.1308
Total Sum of Squares:	1.5271			
Residual Sum of Squares:	1.5194			
R-Squared:	0.00504			
F-statistic:	1.36267 on 2 and 538 DF	p-value:	0.25686	

Source: Own calculations