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A REGIONAL APPROACH TO THE METROPOLITAN ECONOMIC GROWTH: EVIDENCE FROM THE EUROPEAN UNION

Florin Teodor Boldeanu, Ileana Tache
Lucian Blaga University of Sibiu, Transilvania University of Brasov (Romania)
boldeanuflorinteodor@yahoo.com, ileanatache@unitbv.ro

Abstract: *The main goal of this study is to contribute to metropolitan economic growth literature by carrying out an analysis for 271 areas located in the EU between 2000 and 2013. For this objective the study uses several panel data estimation techniques, namely the GMM, System GMM and the QML estimation. To check the robustness of the results, the time period is divided in two (post and ante economic crisis) and by splitting the sample of metropolitan regions in two components, the Western more developed regions and the Central and South-Eastern (the formal communist states, except for Cyprus) areas. The results indicate that the industrial, construction and wholesale and retail trade sectors are positively linked with metropolitan growth. The agricultural, fishery and forestry sector is negatively influencing growth. The manufacturing and ITC sectors and migration are not statistically significant. Furthermore population density and size is more important than population growth and European enlargement did not have a substantial positive impact on metropolitan growth for the Central and South-Eastern regions.*

Key words: metropolitan economic growth, GMM, QML, EU, Economic sectors
JEL classification: C5, O15, O18, O47, R11

1. INTRODUCTION

The notion that cities are a source of economic growth is gaining more and more focus in the recent period. Cities and urban areas are considered to be the fundamental sites for the concentration of economic activity. This is in part because of the new research done by many

scholars in the field of new economic geography (agglomeration economies) or the ones involved in the "new growth theory" (Glaeser et al. 1992; Combes 2000; Melo et al. 2009).

Cities are human centres that allow for the exchange of goods, ideas and people and in turn the society reaps the benefits from trade and specialization (Christiaensen and Todo 2013; Glaser et al. 1992; Combes 2000). Cities facilitate all this factors to come together to allow for more production and labour specialization. Towns and cities rose to become market places in which goods and services are transferred faster and more efficiently.

When focusing on Europe it's important to state that more that 75% of its citizens are living in urban areas. From this number we can affirm that Europe has the highest density of urban zones in the world. Urbanization is a fast growing trend in the EU even if population growth is small compared with many other regions (Asia, Africa or Latin America). Half of European cities are small with between 50 000 and 100 000 inhabitants and only two can be considered global cities - London and Paris. Smaller cities have more than 40 % of the EU population (OECD 2012).

The focus of this study is to contribute to metropolitan economic growth literature by implementing an analysis for 271 areas located in the European Union. For this endeavour the investigation uses several empirical methods to quantify and statistically demonstrate the link between the independent variables and GDP measured in per capita and in PPS per inhabitant. To investigate the robustness of the results, the empirical model is also estimated by dividing the time period in two parts (post and ante economic crisis) and by splitting the sample of metropolitan regions in two components – the Western more developed regions and the Central and Eastern (the formal communist states, except for Cyprus) metropolitan areas.

In order to achieve the results of the empirical investigation the rest of this study is structured around six sections. First, this short introduction is followed by the literature review on urban economic growth. Section 3 highlights the methodology used and the data sources with some graphical illustrations of some of the variables utilised for the analysis. Section 4 presents the findings of the empirical methods used. Section 5 conducts some robustness checks. The analysis ends with the conclusions.

2. LITERATURE REVIEW

At the end of the 19th century Alfred Marshall (1890) argued that urban agglomeration has many benefits for regional and state development. These benefits can be summed up as follows: providing easier goods and services to firms and also to consumers, knowledge spillovers and labour market pooling. The early 1990s saw a revitalization of the urban economics and economic geography literature (Porter 1990; Krugman 1991) and continued in the new millennium especially by North American researchers (Henderson 2010; Glaeser 2011). These seminal works mostly concentrated on North American cities and some on the ones in the developing countries. Because of the important shifts that are now taking place regarding the importance of cities in driving economic growth this study will try to offer future insight and answer some important questions.

The research literature has found some important aspects regarding the role of cities in shaping economic growth and the different ways by which they can affect the development of countries. It is well known that urban centres are the engines of regional economic growth. States with more dispersed urban centres with medium size population have reduced poverty compared with countries that have a big concentration of population and large cities (Christiaensen and Todo 2013).

Rapid urbanization has occurred extensively after the second half of the 20th century. This process is unprecedented in human history and has manifested more in countries with low per capita income (Cohen 2004). We can attribute the fast pace of urbanization to changes in the economic system and mostly to globalization. In the case of India, Sridhar (2010) pointed out that at the beginning of the 19th century only Calcutta had a population of more than 1 million inhabitants. This process was intensified after the half of the 20th century in India. In 1991 there were 23 cities with a population of over 1 million inhabitants and by 2001 the number rose to 35 cities (38% of the total urban Indian population).

Urban economists have shown that larger cities have high population density because of the increasing competition for capital gains (returns) and labour. Large cities also have higher productivity and per capita income compared with the smaller ones, but this statement is highly dependent on the political and economic system in the country (Polèse 2005). According to Combes (2000) large cities growth more if the infrastructure endowment is better (better schools, roads, hospitals). Au and Henderson (2006) found that because of

migratory restriction a big number of Chinese cities are not growing as fast as they should, in turn affecting urban economic growth and income.

The size of a city can be also detrimental to its growth. There are negative outcomes of becoming too large as a city. These are being defined by the literature as "agglomeration diseconomies" (Henderson and Becker 2000). These diseconomies can range from increased crime rates, air pollution (some examples can be the Chinese mega cities), higher costs of living, social inequality or traffic congestion due to too many cars and lagging infrastructure.

According to the agglomeration economies theory there are productivity gains for companies and citizens by the fact that they are clustered in an urban community. For example companies which are located in an urban zone benefit from the economy of scale (a bigger market size), lower transaction, information and infrastructure costs, a bigger sampling pool for recruitment and more skilled workers or more suppliers to choose from. The human capital accumulation of skilled workers determined the fast growth of Indian cities by making them more attractive for companies (Sridhar 2010).

As stated above agglomeration economies are mostly beneficiary for companies, but urbanization, and especially the formation of large cities brings more competition. It is still argued if higher competition is going to lead to future economic growth for urban areas (Glaser et al. 1992; Usai and Paci 2003).

The rapid growth of urban centres in India and China in the past years can be attributed to a mix of economic reforms and the extent of the manufacturing sector vis-à-vis to the service sector. The fast city growth in the south of India is linked with the employment surge in the service sector (Paul and Sridhar 2015).

There are many research contributions that focused on the urban economic growth in China and what determines city growth. Between 1991 and 1998 urban economic growth was influence by foreign direct investment, infrastructure endowment and investment in human capital. Population growth and domestic investment had a negative impact on GDP per capita (Lin and Song 2002). Population growth was found to influence real urban GDP growth in 220 Chinese cities, but to negatively influence GDP/capita (Anderson and Ge 2004). Compared to the government sector, the private sector contributed the most to city growth in China. Au and Henderson (2006) stated that in China agglomeration economies (diversified

industries and population), the accumulation of capital and foreign direct investment were significant sources of growth.

Urban centres are very important for rural inhabitants in many ways. First of all they provide a market for their products and in turn cities provide for rural inhabitants specialised goods and services. Secondly commuting from rural area to urban areas for employment reasons is a common fact in the modern era. Many people in the developing countries of Eastern Europe, Latin Africa, Africa and Asia increase their rural income by working in the medium and large urban centres (Reardon et al. 2001). Cities can be considered also hubs for fostering cultural, economic and social communication between citizens of the same country or from different corners of the work. This is because usually the infrastructure is more developed in urban areas than in rural areas, offering more connectivity between people.

In accordance with the endogenous growth theory it is important to state that urban centres are essential for knowledge formation and diffusion. They promote the flow of new ideas and facilitate innovation (McCann 2007). The knowledge diffusion of cities is beneficial for creating spatial externalities and spillovers that can contribute more to regional and state development. Knowledge spillovers are increased if companies in the same industry are geographically proximate.

According to McCann and Acs (2011) productivity increases with the size of the city in US, Korea and Japan, but in general productivity is more related to growth if the city is better connected with other cities/regions.

Cities are also socially diverse, with inhabitants from different backgrounds, with different religions, norms or habits. This is more common in large urban areas like London, Paris, New York or Beijing. Audretsch et al. (2010) have found that urban social diversity has an important effect on regional economic growth.

Berdegue et.al (2015) confirmed that the presence of a city in a rural-urban region has a positive outcome on economic growth in Columbia and Chile and that it reduces poverty. They found that cities favour territorial development by the diffusion of ideas, the flow of information and knowledge and providing access to specialized services.

In the case of Brazil, the rise in rural population supply, the development of inter-regional infrastructure and higher levels of education for the work force has a big impact on the growth

of a city (Da Mata et al. 2005). The increase in criminality rates has a negative impact on the growth rate of a Brazilian urban area.

Climate also plays an important factor in urban population growth and can affect the economic growth of a city. Urban areas that are less favourable for human inhabitants tend to grow slower that the ones with climate endowed (Haurin 1980).

There are also scholars that, contrary to the literature, consider that cities do not influence growth and that the evidence so far is not conclusive. Polèse (2005) considers that cities do not cause income to rise in the long run, but the rise in income is a result of an adjustment process of national economic growth.

3. METHODOLOGY AND DATA

The aim of this study is to evaluate the factors determining urban economic growth at metropolitan level between 2000 and 2013 in the European Union for 271 metropolitan regions. The Directorate General for Regional Policy of the European Commission defines metropolitan regions as NUTS 3 regions or a combination of NUTS 3 regions which represent all agglomerations of at least 250.000 inhabitants. These agglomerations were described using the Urban Audit's Functional Urban Area (FUA). Each metropolitan agglomeration is represented by at least one NUTS 3 region.

The analysis at metropolitan level is important in the context of increasing urbanization in the EU. The study will investigate the role of some important economic sectors like agriculture, industry, manufacturing, construction, service activities and information and communication services in facilitating urban development. Other variables that are examined are the number of employees, population density, population size and growth and net migration. The study will use also a dummy variable to control for the importance of EU enlargement on metropolitan areas.

The analysis is based on a growth equation with the dependent variable being the metropolitan GDP per capita or metropolitan GDP at purchasing power standard per inhabitant. All the monetary values are expressed at current market prices and denominated in euros.

The variables will be transformed using the neglog transformation. Some of the variables in the study are negative (net migration, population growth) and the utilization of normal

logarithm will result in data loss. The neglog transformation behaves like ln (z) when z is positive and like – ln (-z) when z is negative (Whittaker et al. 2005). So the investigation will use a logarithm called "L" = sign(z)*ln(|z| + 1, where z is the value of the variable.

The economic growth equation has the following form:

$$LY_{it} = \beta_0 + \beta_1 Ly_{i,t-1} + \beta_2\, LGVAagr_{\ it} + \beta_3\, LGVAind_{it} + \beta_4\, LGVAmauf_{it} + \beta_5\, LGVAconst_{it} + \beta_6\, LGVAserv_{it} + \beta_7\, LGVAitc_{it} + \beta_8\, LEMPL_{it} + \beta_9\, LDENSITY_{it} + \beta_{10}\, LEAP_{it} + \beta_{11} LPOP_{it} + \beta_{12} LPOPgr_{it} + \beta_{13} LMIGRATION_{it} + \beta_{14} D_{it} + \eta_i + \varepsilon_{it} \quad (1)$$

where:

LY: the neglog of metropolitan GDP per capita or GDP at PPS standard per inhabitant;

Ly: represents the neglog of one lag metropolitan GDP per capita or one lag metropolitan GDP in PPS standard per inhabitant. It is usually introduced in the growth equation to measure the convergence or divergence hypothesis;

LGVAagr: represents the neglog of the share of metropolitan gross value added of agriculture, forestry and fishing in total metropolitan gross value added;

LGVAind: represents the neglog of the share of metropolitan gross value added of industry in total metropolitan gross value added;

LGVAmanuf: represents the neglog of the share of metropolitan gross value added of manufacturing in total metropolitan gross value added;

LGVAconst: represents the neglog of the share of metropolitan gross value added of construction in total metropolitan gross value added;

LGVAserv: represents the neglog of the share of metropolitan gross value added of wholesale and retail trade, transport, accommodation and food service activities in total metropolitan gross value added;

LGVAitc: represents the neglog of the share of metropolitan gross value added of information and communication in total metropolitan gross value added;

LEMPL: the neglog of the total number of employees at metropolitan level. This indicator will measure the impact of employed persons on metropolitan economic growth;

LDENSITY: the neglog of metropolitan population density (persons per km2). It is a proxy for regional agglomeration;

LEAP: the neglog of economically active population (inhabitants); LPOP: the neglog of metropolitan population (inhabitants). It measures the impact of population size on metropolitan economic output;

LPOPgr: the neglog of metropolitan population (inhabitants) growth;

LMIGRATION: the neglog of metropolitan net migration (%);

D: represents the dummy variable for European enlargement. This dummy variable will assess if EU enlargement had an impact on the economic growth of metropolitan areas. Because the study analyses all the 28 EU metropolitan areas between 2000 and 2013, some of them were not part of the EU before 2004, 2007 or 2013. The variable will take the value 1 if the metropolitan area was part of the EU and 0 if the metropolitan area was not;

η: is the unobserved regional-specific effect;

ε: is the disturbance term;

i is the individual regional dimension and t is the time period dimension.

Data are taken from the Eurostat database, more specifically from the metropolitan regions database. All monetary data are expressed at current market prices and denominated in common currency (ECU).

Before starting the empirical investigation it is essential to present some key facts about the metropolitan areas in the European Union. The biggest metropolitan areas by population are Paris and London. In 2013 the population of London was approximately 13.6 million, of which 24% were living in Inner London. Paris had approximately 11.9 million people. The third and fourth places are held by two major metropolitan areas from Spain. Madrid had in 2013 a population of 6.4 million and Barcelona a population of 5.4 million.

Germany has the following places in the list of the biggest metropolitan areas with more than 5 million residents (Rhine area and Berlin). Both metropolitan areas have a population of 5.1 million. Table 1 presents the top ten metropolitan areas in the EU by population size.

Tab. 1 Top ten metropolitan areas in the EU by population in 2013

London	13.879.757,0
Paris	11.952.061,0

Madrid	6.414.620,0
Barcelona	5.493.081,0
Berlin	5.145.576,0
Ruhrgebiet	5.126.013,0
Milano	4.151.565,0
Roma	4.039.813,0
Athina	3.912.849,0
Warszawa	3.281.740,0

Source: Eurostat database

The metropolitan areas in the countries that joined the EU after 2004 have higher population density compared with the old EU countries. This difference occurred because of the stronger central planning in the metropolitan areas of the former socialist countries in Eastern Europe.

Compared with the US, Europe has almost twice as many major metropolitan areas, with a total population of 207 million. In comparison the US has 173 million inhabitants leaving in major metropolitan areas. But large metropolitan areas represent almost 55% of the US population and in Europe they represent only 40%.

Migration from the new members of the EU and also from the other parts of the developing world and the continuing move from rural to urban regions are driving the fast growth of metropolitan zones. For example the metropolitan region of Madrid is the fastest growing in the EU with 1.5% growth annually. Rome is the second highest fastest growing metropolitan area, followed by Brussels, London, Prague and Valencia, each increasing with more than 1% per year. But there is also stagnation or even a reduction in population for some important metropolitan areas like Essen and Katowice (Upper Silesian area of Poland) and Naples.

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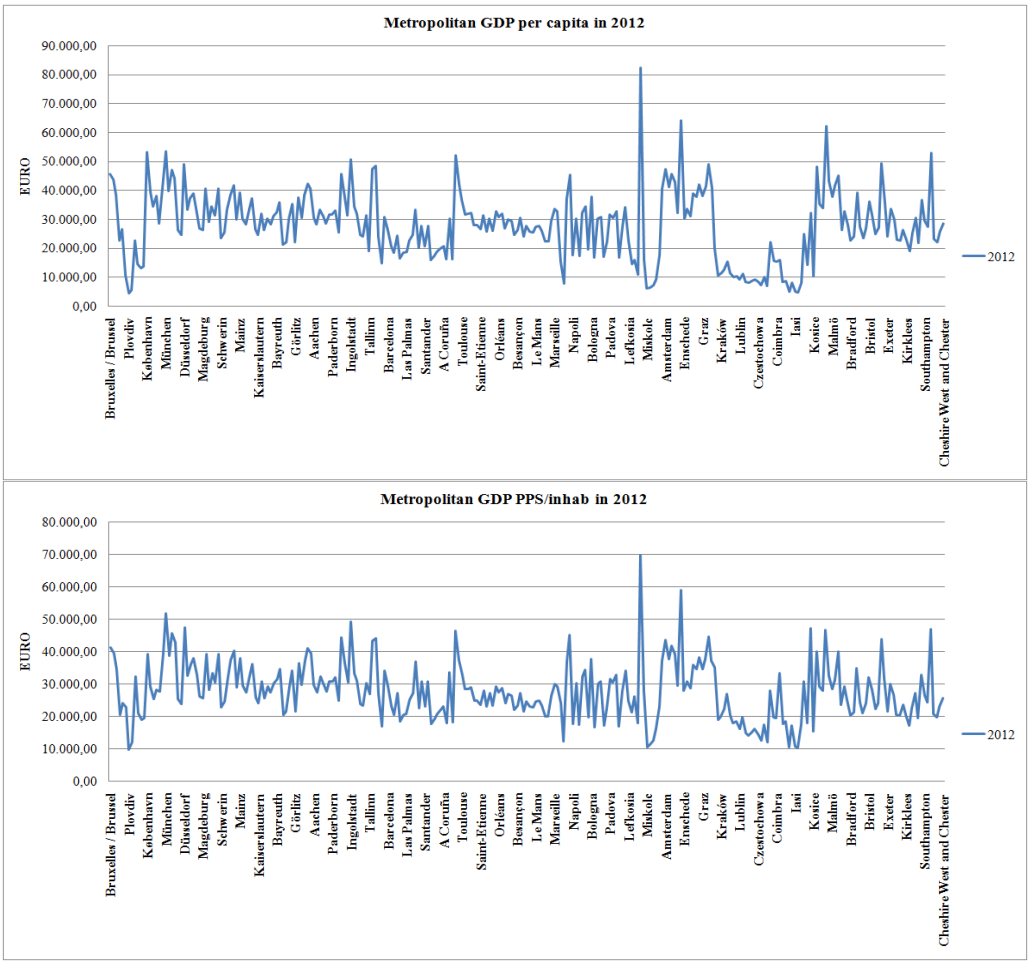

Fig. 1 Metropolitan GDP per capita and in PPS/inhabitant in 2013

Source: Eurostat database

From Figure 1 it is obvious that there is variation between metropolitan areas in the EU regarding economic development. There is divergence in GDP/capita (GDP at PPS/inhab.) between Western European metropolitan regions and Eastern European ones. Table 2 also presents a top ten and bottom ten list related to urban area GDP/capita and GDP at PPS/inhab. Luxembourg, Oslo and Groningen are in the top 3 urban regions by GDP/capita and GDP at PPS/inhabitant. The only metropolitan region from Central and Eastern Europe that is in the top ten is Bratislava. Furthermore, only one of the two global metropolitan areas (Paris and London) is in the top ten. Paris has a GDP/capita in 2012 of more than 52 210 euro and ranks the ninth in the list.

Regarding the regions in the bottom ten Plovdiv (Bulgaria) is the last one, with a GDP/capita 18 times smaller than that of Luxembourg. The other underperforming urban areas are located in Romania, Bulgaria, Hungary, Poland and Croatia.

Tab. 2 Top ten and bottom ten metropolitan areas by GDP/capita and GDP PPS/inhab in 2012

Metropolitan area	2012	Metropolitan area	2012
Top 10–GDP/capita (EURO)		Top 10-GDP PPS/inhab (EURO)	
Luxembourg	82 430,86	Luxembourg	69 795,25
Oslo	81 442,61	Groningen	58 903,03
Groningen	64 285,62	Oslo	51 873,05
Bergen	64 111,18	München	51 756,12
Stockholm	62 337,34	Ingolstadt	49 144,37
München	53 478,68	Düsseldorf	47 445,61
København	53 264,00	Bratislava	47 274,41
Reading	53 050,99	Reading	47 049,12
Paris	52 210,61	Stockholm	46 774,28
Ingolstadt	50 780,00	Paris	46 521,92
Bottom 10–GDP/capita (EURO)		Bottom 10-GDP PPS/inhab (EURO)	
Debrecen	7 335,09	Radom	12 592,53
Radom	7 258,56	Split	12 274,45
Tarnów	6 983,54	Varna	12 140,62
Pécs	6 535,72	Tarnów	12 115,42
Miskolc	6 148,15	Pécs	11 233,30
Varna	5 707,78	Iasi	10 720,26
Iasi	5 106,35	Craiova	10 590,45
Craiova	5 044,51	Miskolc	10 567,17
Galati	4 829,75	Galati	10 139,58
Plovdiv	4 560,79	Plovdiv	9 700,96

Source: Eurostat database

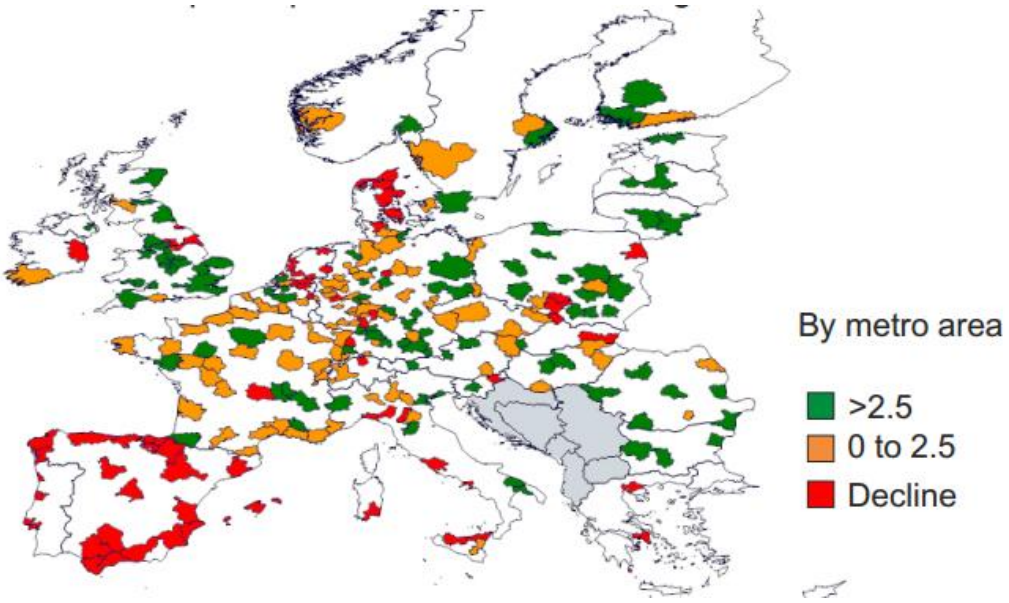

Fig. 2 Retail sales per capita, annual % change, 2009-2012

Source: Eurostat database, Moody's analytics

Consumer spending has fallen in Spanish, Portuguese, Irish, Greek and many Italian metropolitan areas (Figure 2). Also Czech and many French metropolitan areas saw a very small rise in retail sales between 2009 and 2012. Consumer spending was high in Romanian, Polish, Bulgarian and the Baltic metropolitan regions.

According to Table 3 the highest crude rate of net migration was in Luxembourg, followed by two cities in Italy, specifically Florence and Bologna. The list is completed with other metropolitan areas from Germany, Italy and France. The urban areas that registered the highest negative migration in 2012 were Thessaloniki, Barcelona and Coimbra.

Tab. 3 Top ten and bottom ten metropolitan areas crude rate of net migration plus adjustment in 2012

Metropolitan area	2012
Top 10 (%)	
Luxembourg	18,9
Firenze	18,2
Bologna	17,9

München	12,7
Milano	12,6
Prato	12,2
Bordeaux	11,7
Parma	11,4
Perpignan	11,3
Roma	11,2
Bottom 10 (%)	
Pécs	-4,4
Bradford	-4,6
Bilbao	-5,1
Miskolc	-5,3
Porto	-5,4
Nancy	-5,7
Madrid	-5,8
Coimbra	-6,3
Barcelona	-6,5
Thessaloniki	-6,7

Source: Eurostat database

Gross value added from the sector of agriculture, forestry and fishing contributes differently to economic growth across metropolitan regions in the EU. The most GVA produced by this sector was in Reims followed by another region of France, Bordeaux. The contribution of GVA from agriculture, forestry and fishing was insignificant for four metropolitan regions of south and central England and for the German region of Wuppertal.

Tab. 4 Top five and bottom five metropolitan areas by gross value added from agriculture, forestry and fishing in 2012

Metropolitan area	2012	
Top 5 (million euro)		% of Total GVA
Reims	1.566,58	9,332%
Bordeaux	1.284,83	2,999%
Amsterdam	1.221,00	1,179%
London	1.196,25	0,215%
Sevilla	1.131,10	3,440%
Bottom 5 (million euro)		% of Total GVA
Wuppertal	3,79	0,038%
Portsmouth	3,70	0,060%
Brighton and Hove	3,70	0,049%
Derby	2,47	0,030%
Southampton	1,23	0,019%

Source: Eurostat database

Table 5 highlights the top 5 regions with the most GVA generated from industry (except construction). The total value of goods and services produced by the industry sector in the metropolitan area of Paris adds up to almost 50.000 million euro (approximately 50 billion), but the share of this sector in total GVA is roughly 9%. The urban areas of Stuttgart and Ruhrgebiet are also high producers of industrial goods and services, with the share in total GVA being higher. The top five list is completed by London and Milan. The smallest GVA generated from industry is obtained in the metropolitan region of Slit (Croatia), followed by Pecs (Hungary).

Tab. 5 Top five and bottom five metropolitan areas by gross value added from industry in 2012

Metropolitan area	2012	
Top 5 (million euro)		% of Total GVA
Paris	49.688,73	8,876%
Stuttgart	39.289,70	36,525%
Ruhrgebiet	36.517,12	26,134%
London	33.461,59	6,025%
Milano	29.513,87	17,112%
Bottom 5 (million euro)		% of Total GVA
Southampton	550,03	8,665%
Varna	494,13	21,231%
Brighton and Hove	414,37	5,504%
Pécs	380,92	18,323%
Split	352,44	11,605%

Source: Eurostat database

The metropolitan region of Paris is again the most important region regarding GVA obtained by the manufacturing sector. In the top five we also find 3 German metropolitan areas – Stuttgart, Munchen and Ruhrgebiet and the Italian region of Milan. The smallest value of goods and services produced by the manufacturing sector is attained by the metropolitan region of Brighton and Hove. A smaller value of manufacturing GVA is obtained also in Split (Croatia), Varna (Bulgaria), Pecs (Hungary) and Perpignan (France).

Tab. 6 Top five and bottom five metropolitan areas by gross value added from manufacturing in 2012

Metropolitan area	2012	
Top 5 (million euro)		% of Total GVA
Paris	37.755,52	6,744%
Stuttgart	37.549,56	34,907%
Milano	24.982,52	14,485%
München	24.849,72	18,838%
Ruhrgebiet	23.828,39	17,053%
Bottom 5 (million euro)		% of Total GVA
Perpignan	436,65	4,708%
Pécs	275,26	13,240%
Varna	256,35	11,014%
Split	254,65	8,385%
Brighton and Hove	205,95	2,735%

Source: Eurostat database

An important sector for the economy is construction. Because of the financial crisis many construction projects were closed or abandoned and many companies had to go bankrupt. The highest GVA from the construction sector is obtained by the metropolitan region of London. Paris comes second with more than 25 billion euro. Madrid, Milan and Barcelona occupy the third, fourth and fifth places, but at considerable distance from London. The smallest GVA from construction is attained by four metropolitan areas of Hungary and by Plovdiv (Bulgaria).

Tab. 7 Top five and bottom five metropolitan areas by gross value added from construction in 2012

Metropolitan area	2012	
Top 5 (million euro)		% of Total GVA
London	31.964,43	5,755%
Paris	25.353,99	4,529%
Madrid	8.857,70	4,854%
Milano	7.920,18	4,592%
Barcelona	6.510,60	4,865%
Bottom 5 (million euro)		% of Total GVA
Miskolc	150,42	4,252%
Debrecen	142,48	4,267%
Plovdiv	130,41	4,888%
Székesfehérvár	106,33	3,223%
Pécs	94,88	4,564%

Source: Eurostat database

Yet again the Paris metropolitan region is first in Europe regarding GVA obtained from wholesale and retail trade, transport, accommodation and food service activities. The share of this sector in total GVA is more than 18%. London is second in the list with more than 92 billion euro. The ranking is completed by Madrid, Barcelona and Milan. The urban regions that are underachieving in regards to GVA from wholesale and retail trade, transport, accommodation and food service activities are from Hungary and Romania.

Tab. 8 Top five and bottom five metropolitan areas by gross value added from wholesale and retail trade, transport, accommodation and food service activities in 2012

Metropolitan area	2012	
Top 5 (milion euro)		% of Total GVA
Paris	100.802,52	18,007%
London	92.606,71	16,673%
Madrid	63.304,00	34,688%
Barcelona	39.803,60	29,742%
Milano	35.566,80	20,621%
Bottom 5 (milion euro)		% of Total GVA
Craiova	532,68	18,307%
Miskolc	522,71	14,776%
Székesfehérvár	453,11	13,734%
Galati	386,54	17,105%
Pécs	323,77	15,574%

Source: Eurostat database

Another essential sector for the economy is information and communication. Paris metropolitan area had the highest value of goods and services produced by the ITC sector in the EU adding up to more than 56 billion euro. At a small distance we find the metropolitan area of London. Milan, Rome and Dublin are in the top five ranking in regards to ICT, but at a major distance between them and Paris. The underperforming urban regions are found in Romania, Hungary and Bulgaria. For example the total gross value added produced by the ICT sector in Varna adds to almost 35 million euro.

Tab. 9 Top five and bottom five metropolitan areas by gross value added from Information and communication in 2012

Metropolitan area	2012	
Top 5 (milion euro)		% of Total GVA
Paris	56.780,40	10,143%
London	50.773,86	9,142%
Milano	14.131,62	8,193%
Roma	13.896,28	9,980%
Dublin	13.790,72	17,461%
Bottom 5 (milion euro)		% of Total GVA
Galati	56,13	2,484%
Pécs	50,52	2,430%
Székesfehérvár	46,18	1,400%
Plovdiv	35,95	1,347%
Varna	34,83	1,497%

Source: Eurostat database

As stated in the beginning of the study, the aim of this investigation is to determine what variables influence metropolitan economic growth. The analysis is focused on 271 metropolitan regions from the European Union within a time frame of 14 years (2000-2013).

The next part of the analysis offers a summary statistics of the variables used and the correlation matrix.

Table 10 of this study highlights the summary statistics of the variables used, starting with the number of observations, the mean, standard deviation and the minimum and maximum. Because the time range is between 2000 and 2013 and there are 271 metropolitan regions used in this investigation, the maximum number of observations is 3794.

Tab. 10 Summary statistics of the variables used

Variable	Obs	Mean	Std.Dev	Min	Max
GDP/capita	3561	9.97863	.607702	7.22766	11.3272
GDP PPS/inhab	3561	10.0376	.384813	8.23383	11.1533
Share of Agriculture, forestr	3519	.869583	.558289	0	3.08979
Share of Industry	3519	3.04074	.394229	1.52532	4.09692
Share of Manufacturing	3285	2.84295	.462394	1.16698	4.02526
Share of Construction	3518	1.94278	.318383	.76463	3.06388
Share of Wholesale and retail	2101	3.01489	.185749	2.07528	3.63091
Share of Information and comm	2032	1.65345	.39841	.531216	3.17651
Employees	3556	12.6209	.740682	11.2542	15.5578
Population density	3432	5.60222	.9481	3.60278	8.54611
Economically active populatio	3323	12.8407	.719984	11.4219	15.8101
Population size	3555	13.576	.714621	12.1431	16.4459
Population growth	3547	1.00452	1.50446	-3.97781	4.22391
Net migration	3477	.887805	1.34193	-3.97218	4.22244

Source: Stata v14

4. EMPIRICAL RESULTS

For analysing the influence of the independent variables presented in the methodology, the study will use several panel data estimation techniques. The panel data techniques used are the first difference GMM estimator, the system GMM estimator and the quasi-maximum likelihood estimation. The study uses a linear dynamic panel data. The QML estimation was developed by Kripfganz (2016). The ML (maximum likelihood) approach was pioneered by Bhargava and Sargan (1983), future developed by Hsiao, Pesaran and Tahmiscioglu (2002) and is suited also for panel data with missing values. Missingness can be solved by implemented a ML estimation or a multiple imputation technique.

Quasi-maximum likelihood estimation does not use any instruments like the GMM or system GMM methods. Also the weak instruments that may be used in the GMM and SysGMM are avoided in the QML estimation. The estimators in a QML technique are extended to accommodate for unbalance panel data, like in the present investigation related to metropolitan economic growth.

Before applying the regression models it is important to make some preliminary investigations. Some of the variable may be nonstationary. The regressions that involve independent nonstationary variables can generate “spurious” results (Ghosh 2012). For testing the stationary hypothesis the investigation applies the Fisher-type unit-root test which is suited for this panel data. The results are presented in Table 11.

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Tab. 11 Unit-root test results for the variables used

Variables	Fisher-type unit-root test							
	Un-differenced Variable				First Difference			
	P	Z	L*	Pm	P	Z	L*	Pm
GDP/capita	340.29	10.65	10.86	-6.12	1621.47***	-21.96***	-24.74***	32.78***
lag GDP/capita	355.42	11.65	11.63	-5.66	1544.76***	-20.13***	-22.87***	30.45***
GDP PPS/inhab	512.69	5.07	4.77	-0.89	2420.16***	-30.77***	-38.62***	57.04***
lag GDP PPS/inhab	501.67	5.91	5.54	-1.22	2451.76***	-31.16***	-39.15***	58.00***
% GVA agriculture, forestry and fishing	828.79***	-2.67***	-3.95***	8.71***				
% GVA industry	748.39***	-0.40	-1.41*	6.26***				
% GVA manufacturing	652.97***	0.13	-0.57	4.62***				
% GVA construction	429.78	10.51	10.99	-3.40	2141.43***	-28.42***	-34.00***	48.57***
% GVA wholesale and retail trade, transport, accommodation and food service activities	447.90***	-2.47***	-3.13***	3.27***				

% GVA information and communication	354.53**	0.07	-0.47	1.61**				
total number of employees	419.56	11.68	11.92	-3.71	2078.67***	-25.38***	-32.07***	46.67***
metropolitan population density	954.72***	-6.60***	-8.21***	12.53***				
economically active population	2729.82***	-25.73***	-41.74***	66.81***				
population (inhabitants)	2459.32***	-29.12***	-37.61***	58.23***				
population (inhabitants) growth	1202.01***	-3.12***	-8.81***	20.04***				
net migration	1061.70***	-2.63***	-6.74***	16.33***				

Legend: *, **, *** denote significance at 1%, 5%, and 10%, respectively

Source: Stata v14

Table 11 details the results of the Fisher test. It confirms the presence of a unit root for several variables. The test is also conducted for the first differenced variables. By doing so, the nonstationary variables become stationary in first difference. The model will be rewritten with all the variables in first difference except for the dummy one. The metropolitan specific effects are removed when the first difference is implemented.

The economic growth equation with the differenced variables is as follows:

$$\Delta LY_{it} = \beta_1 \Delta Ly_{i,t-1} + \beta_2 \Delta LGVAagr_{it} + \beta_3 \Delta LGVAind_{it} + \beta_4 \Delta LGVAmauf_{it} + \beta_5 \Delta LGVAconst_{it} + \beta_6 \Delta LGVAserv_{it} + \beta_7 \Delta LGVAitc_{it} + \beta_8 \Delta LEMPL_{it} +$$

$$\beta_9\,\Delta LDENSITY_{it} + \beta_{10}\,\Delta LEAP_{it} + \beta_{11}\,\Delta LPOP_{it} + \beta_{12}\,\Delta LPOPgr_{it} + \beta_{13}\,\Delta LMIGRATION_{it} + \beta_{14}D_{it} + \eta_i + \varepsilon_{it} \quad (2)$$

The study will compute the Hausman test to determine if the quasi-maximum likelihood will be a fixed effects or a random effects method. The results confirm that the study should use a quasi-maximum likelihood method with fixed effects.

Tab. 12 Hausman test for the QML method

GDP/Capita	GDP at PPS/inhab
chi(14) = 52.92 Prob>chi2 = 0.0000	chi(15) = 425.68 Prob>chi2 = 0.0000

Source: Stata v14

To eliminate the common sources of cross-sectional dependencies the investigation will include also time dummies. To see if time fixed effects are needed the Parm test will be computed. The results of the Parm test from Table 13 confirm the null hypothesis of the importance of time fixed effects.

Tab. 13 Parm test

GDP/Capita	GDP at PPS/inhab
chi(12) = 67.46 Prob>chi2 = 0.0000	chi(12) = 75.66 Prob>chi2 = 0.0000

Source: Stata v14

According to the economic growth literature, for the GMM and system GMM the lagged values of the dependent variable (GDP/capita and GDP at PPS/inhab.) and the variables that are weakly exogenous are used for GMM style instruments. The six variables that measure the shares of different economic sectors in total metropolitan gross value added, population density and population size were used as GMM style instruments with lag two and also with all available lags. The rest of the regressors were used for the IV style instruments. The investigation will also introduce time dummy variables in the models. To limit the number of

instruments (as a rule the number of panel data units should be higher than the number of instruments), the *collapse* option is used in Stata. The first to the fifth lag of the dependent variables are used in the GMM style instruments. The analysis will also include the "robust" command to control for heteroskedasticity and autocorrelation within panels.

The two tables below (Table 14 and 15) present the results for the GMM and system GMM estimations. In Table 14, columns (1) and (2) highlight the results for the model with GDP/capita as dependent variable, whereas columns (3) and (4) focus on the results for the model with GDP at PPS/inhab as dependent variable.

Tab. 14 The results of the GMM estimator

	(1)	(2)	(3)	(4)
L.GDP/capita	0.800***	0.589***		
	(3.99)	(14.92)		
L.GDP PPS/inhab			1.049***	0.676***
			(7.37)	(11.49)
Share of Agriculture, forestry and fishing	0.0800	-0.171***	0.123	-0.0720**
	(0.30)	(-3.32)	(1.14)	(-2.05)
Share of Industry	2.001**	0.511***	0.265	0.213*
	(2.37)	(3.03)	(0.68)	(1.79)
Share of Manufacturing	-1.217**	-0.229*	-0.332	-0.101
	(-2.24)	(-1.93)	(-1.33)	(-0.78)
Share of Construction	0.594***	0.243***	0.124	0.0901***
	(3.19)	(5.44)	(1.29)	(3.24)
Share of Wholesale and retail trade, transport,	1.061	0.180	0.131	0.00708

accommodation and food service activities				
	(1.49)	(1.60)	(0.59)	(0.10)
Share of Information and communication	0.539	0.0502	-0.135	0.0236
	(1.49)	(1.23)	(-0.76)	(0.80)
Employees	0.129	0.291***	0.138	0.249***
	(0.58)	(4.23)	(1.54)	(4.61)
Population density	7.968	0.952	-0.185	-0.365
	(0.77)	(0.92)	(-0.06)	(-0.75)
Economically active population	-0.0583**	-0.0130	-0.0226	-0.0101
	(-2.02)	(-1.00)	(-0.94)	(-0.75)
Population size	-5.549	-1.316	0.534	-0.0439
	(-0.60)	(-1.29)	(0.18)	(-0.09)
Population growth	-0.0337	-0.00290	-0.00431	-0.00412
	(-1.31)	(-0.48)	(-0.44)	(-1.28)
Net migration	0.00729	0.000163	0.00273	0.00379
	(0.52)	(0.03)	(0.47)	(1.16)
Enlargement	0.0253	0.0413***	0.00123	0.0313**
	(0.40)	(2.62)	(0.05)	(2.33)
Observations	1360	1360	1360	1360
p-value for Sargan test	0.507	1.30e-34	0.465	2.87e-17
p-value for Hansen test	0.109	0.00440	0.379	0.0232
AR(1)	0.326	1.27e-09	0.00000111	3.68e-10
AR(2)	0.356	0.00307	0.991	0.956
Number of	30	118	30	118

instruments

Notes: t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include time dummies

Source: Stata v14

As seen from the above table the coefficients of the lagged dependent variable (GDP per capita and GDP at PPS per inhabitant) are positive, with a significance level of 1%. This suggests that metropolitan regions are not converging to the steady state of growth. This is true when we consider the different levels of development among metropolitan areas and the gap between Western regions and Eastern regions. For example according to Eurostat the only metropolitan region from Central-Eastern Europe that is in the top ten list regarding GDP in purchasing power per inhabitant in the year 2012 is Bratislava. In this regard underperforming urban areas are located in Romania, Bulgaria, Hungary, Poland and Croatia. The Plovidv metropolitan area of Bulgaria has a GDP/capita 18 times smaller than that of Luxembourg. This paints a negative picture regarding the measures taken by the EU to limit the gaps between regions and it seems that the process of integration is difficult.

Concentrating now on determining what economic sectors are important for EU metropolitan growth we can see different results from Table 14. The sector of agriculture, forestry and fishing appears to have a small but negative effect on metropolitan growth. This result was obtained when the GMM methodology used all the available lags of the IV instruments. Two important sectors that are driving metropolitan growth in the EU are industry and construction. The fact that industry has such an important contribution on metropolitan growth is not startling when we consider that most of the countries in the EU are very industrialized. A 1 % rise in the share of industry in total GVA will determine the metropolitan GDP to rise between 0.2% and 2%.

Even if the construction sector was severely hit by the crisis that started in 2008 this sector is still an important and one that contributes to metropolitan development. The same statement cannot be said about the manufacturing sector. From the results obtain by the GMM estimation the share of manufacturing has a big negative effect on metropolitan growth. An interesting outcome was the fact that the wholesale, retail trade, transport, accommodation and food service activities and the ITC sectors hadn’t statistically significant coefficients even

if they were positive. It means that these two sectors are not contribution to metropolitan economic growth.

As expected, the number of employees positively influences economic growth. If the number of employed persons rises by 1%, metropolitan GDP rises by almost 0.25-0.29%. Economically active population size has a small negative influence on growth, but is statistically significant only in column (1).

European enlargement appears to have contributed to metropolitan development, but the coefficients are not too considerable (0.0413 and 0.0313). Population density, population size, population growth and net migration did not have any statistical significance in Table 14.

The Arellano-Bond test has detected first order serial correlation for the estimation in the first column. Second order serial correlation has also been detected for the GMM estimation. The p-values for the Sargan and Hansen tests validate the use of the instruments only for the results in columns (1) and (3). The use of instruments with all the lags included appears to be weak.

Tab. 15 The results of the system GMM estimator

	(1)	(2)	(3)	(4)
L.GDP/capita	0.786***	0.789***		
	(10.05)	(25.36)		
L.GDP PPS/inhab			0.903***	0.882***
			(11.70)	(22.86)
Share of Agriculture, forestry and fishing	-0.185*	-0.175***	0.00648	-0.0403**
	(-1.73)	(-4.69)	(0.13)	(-1.99)
Share of Industry	-0.0251	-0.0266	0.0120	0.0555
	(-0.34)	(-0.29)	(0.26)	(1.19)
Share of Manufacturing	-0.0299	-0.0161	-0.0249	-0.0291
	(-0.45)	(-0.19)	(-0.49)	(-0.64)
Share of	0.0238	0.00224	0.00287	0.0201

Construction				
	(0.57)	(0.08)	(0.14)	(1.08)
Share of Wholesale and retail trade, transport, accommodation and food service activities	0.00410	0.0493	0.0727	0.0575*
	(0.04)	(0.89)	(1.23)	(1.79)
Share of Information and communication	-0.112**	-0.0826***	0.0195	0.0133
	(-2.16)	(-3.30)	(0.66)	(0.91)
Employees	0.328*	0.168**	0.0835	0.0497
	(1.93)	(2.31)	(0.54)	(0.95)
Population density	-0.0453	-0.0371**	-0.0164	-0.0198**
	(-1.49)	(-2.01)	(-1.01)	(-2.30)
Economically active population	0.125	0.0496	-0.0261	-0.0280
	(1.09)	(1.15)	(-0.42)	(-1.35)
Population size	-0.466*	-0.228***	-0.0523	-0.0141
	(-1.79)	(-2.69)	(-0.24)	(-0.21)
Population growth	0.0242**	0.0314***	0.00856	0.00992**
	(2.04)	(3.67)	(1.53)	(2.39)
Net migration	-0.0265**	-0.0238***	-0.00628	-0.00564*
	(-2.51)	(-3.68)	(-1.34)	(-1.85)
Enlargement	0.0486	0.0531**	0.0257	0.0206
	(1.50)	(2.47)	(1.35)	(1.41)
Constant	3.396**	2.884***	0.838	0.946**
	(2.16)	(5.23)	(0.72)	(1.98)
Observations	1525	1525	1525	1525

p-value for Sargan test	6.62e-15	4.17e-50	0.00164	2.04e-15
p-value for Hansen test	0.0000903	0.0143	0.299	0.0641
AR(1)	1.29e-12	1.24e-14	2.40e-11	2.10e-11
AR(2)	0.0201	0.000959	0.852	0.673
Number of instruments	40	128	40	128

Notes: t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include time dummies

Source: Stata v14

In Table 15 columns (1) and (2) highlight the results for the model with GDP/capita as dependent variable, whereas columns (3) and (4) focus on the results for the model with GDP at PPS/inhab as dependent variable. The coefficients of the lag dependent variables are positive implying that there is a gap between metropolitan regions regarding development.

Compared with the results of the GMM estimator, the only sectors that had statistically significant coefficients were agriculture, forestry and fishing and information and communication. Both of them had small but negative coefficients which imply that these two sectors do not contribute to metropolitan economic growth.

The number of employees is positively influencing metropolitan growth. If the number of employed persons rises by 1%, metropolitan GDP rises by almost 0.17-0.33%. Economically active population size had statistically insignificant coefficients. It is interesting to see that population density has a small (less than 0.05%) negative influence on metropolitan development. Population density is used as a proxy for agglomeration. According to Puga (2002) high agglomeration in capital cities and large urban areas can have an influence on growth increasing labour specialization and productivity. van Oort, de Geus and Dogaru (2015) showed that agglomeration plays an important role for 15 EU countries at regional level, specifically for 205 EU NUTS2 regions. The results obtain by the system GMM estimator are in contrast with the agglomeration economies theory that sees the increase in

urban population as a stimulus of economic growth (Rosenthal and Strange 2004; van Oort, de Geus and Dogaru 2015).

Population size measured by the number of inhabitants has a significant negative effect on metropolitan growth, which is in correlation with the results obtained for population density. An interesting fact is that the coefficients for population growth were positive, but the overall impact is very small which implies that density and size is more important than the growth of the population.

Net migration appears to be negatively influencing metropolitan economic growth. European enlargement appears to have contributed to metropolitan development, but only one coefficient was accepted since it was in the confidence interval.

The Arellano-Bond test has detected second order serial correlation for the estimation in the first column. Second order serial correlation has also been detected for the GMM estimation. The p-values for the Sargan and Hansen tests imply that the instruments used might be weak.

The next method applied in this study is the Quasi-maximum likelihood (QML). Compared with the GMM methods, the QML estimation does not use instruments which can bypass many problems identified by Roodman (2009) like for example instrumental selection. The QML estimators can also raise efficiency. The paper will use quasi-maximum likelihood with fixed effects and time dummies. The results are presented in Table 16.

Tab. 16 The results of the QML-FE method

	(1)	(2)
L.GDP/capita	0.815***	
	(40.36)	
L.GDP PPS/inhab		0.808***
		(35.41)
Share of Agriculture, forestry and fishing	-0.0415**	-0.00686
	(-2.36)	(-0.55)
Share of Industry	0.0980*	0.0945***
	(1.71)	(2.66)
Share of Manufacturing	0.00580	-0.0263
	(0.13)	(-0.91)

Share of Construction	0.0972***	0.0561***
	(5.44)	(4.34)
Share of Wholesale and retail trade, transport, accommodation and food service activities	0.112***	0.0450**
	(4.30)	(2.35)
Share of Information and communication	0.00272	0.0133
	(0.25)	(1.62)
Employees	0.224***	0.175***
	(5.64)	(6.38)
Population density	0.0829***	-0.00913
	(2.64)	(-0.31)
Economically active population	-0.00955*	-0.00484
	(-1.68)	(-0.62)
Population size	-0.111	-0.246**
	(-1.09)	(-2.46)
Population growth	0.00817**	-0.000638
	(2.01)	(-0.22)
Net migration	-0.00454	0.00210
	(-1.27)	(0.82)
Enlargement	0.0357**	0.0379***
	(2.52)	(4.93)
Constant	-0.629	2.696*
	(-0.47)	(1.94)
Observations	1374	1374

Notes: Standard errors in parentheses, * p < 0:10, ** p < 0:05, *** p < 0:01. All regressions include time dummies

Source: Stata v14

The coefficients of the lagged dependent variables are again positive, implying that there is divergence between metropolitan regions in the EU. The share of agriculture, forestry and

fishing has a small negative impact on growth at a confidence interval of 95%. It seems that raising the share of this sector in the EU would not be so beneficial for metropolitan development. The industrial and construction sectors are two domains that add value to the EU economy, but compared with the results of the GMM estimator, the coefficients are smaller. By increasing the share of industry for example with 1% the metropolitan GDP will rise with approximately 0.1%. The manufacturing sector was not statistically significant which is in line with the results obtained so far for the other two methods.

Compared with the GMM and system GMM results for the sector of wholesale and retail trade, transport, accommodation and food service activities, the coefficients of the QML-FE are in the confidence intervals of 95% and 99%. The results suggest that this sector has a bigger impact on metropolitan growth than the other sectors of the economy.

Even if the EU has put a lot of emphasis on the importance of investing in the field of information technology it appears that this sector has not a big impact especially on metropolitan regions.

Yet again we see that the number of employees is positively influencing metropolitan growth. If the number of employed persons rises by 1%, metropolitan GDP rises by almost 0.18-0.22%.

Economically active population size had statistically insignificant coefficients, with only one being in the confidence interval. Population density, the proxy for agglomeration, has in the case of the QML-FE estimation a positive coefficient of 0.08, but still the effect is not so considerable. Yet again population size has a negative coefficient. A fast increase in population can be associated with a rise in public expenditure (child care and other contributions) that can put a strain on the economy. Population growth has a very small effect on metropolitan economic growth and the significance level is only at 5%.

Net migration is not statistically significant. European enlargement appears to have contributed to metropolitan development, but the coefficients are small. This can be a concern for EU authorities in light of rising euro scepticism and the 2016 British referendum for the Brexit

5. ROBUSTNESS CHECK

In the final part of the investigation, to gain some robustness, the time period is split in two parts and also the list of metropolitan areas is divided so as to measure the difference between the Western part of the continent and the Central and Eastern part of Europe.

The first robustness check will analyse the econometric model by dividing the period in two samples, one being the period from 2000 to 2007 and the other the period after the economic crisis, from 2008 to 2013. By doing so, the study will determine if the period before the crisis was totally different compared with the period after the crisis. This methodology will be conducted only for the QML-FE estimation.

In Table 17 columns (1) and (2) highlight the results for the QML-FE estimation with GDP/capita as dependent variable, whereas columns (3) and (4) present the results for the estimation with GDP at PPS/inhab as dependent variable.

Tab. 17 The results of the QML-FE estimation with the time period divided in ante and post economic crisis periods

	(1)	(2)	(3)	(4)
	2000-2007	2008-2013	2000-2007	2008-2013
L.GDP/capita	1.203***	0.252***		
	(40.74)	(6.87)		
L.GDP PPS/inhab			0.888***	0.460***
			(13.88)	(7.10)
Share of Agriculture, forestry and fishing	0.0106	-0.0597**	-0.00196	-0.0277
	(0.61)	(-2.38)	(-0.11)	(-1.35)
Share of Industry	-0.0839*	0.133**	-0.0135	0.144***
	(-1.75)	(2.47)	(-0.20)	(2.81)
Share of Manufacturing	0.0817**	0.0354	0.0152	-0.00736
	(2.00)	(0.97)	(0.27)	(-0.25)
Share of	-0.00205	0.0913***	0.0466**	0.000888

Construction				
	(-0.11)	(3.14)	(1.99)	(0.03)
Share of Wholesale and retail trade, transport, accommodation and food service activities	0.0402*	0.0154	-0.0119	0.00515
	(1.71)	(0.39)	(-0.35)	(0.13)
Share of Information and communication	0.0250**	-0.0161	0.0303*	-0.0115
	(1.98)	(-0.75)	(1.72)	(-0.48)
Employees	0.133***	0.251***	0.249***	0.247***
	(3.32)	(3.90)	(4.40)	(4.62)
Population density	0.0794***	1.461**	0.0527**	-0.659
	(2.93)	(2.48)	(1.96)	(-1.40)
Economically active population	-0.0390**	0.0137	-0.0512**	0.0226**
	(-2.26)	(1.57)	(-2.18)	(2.15)
Population size	0.267*	-1.367**	-0.299	-0.122
	(1.66)	(-2.00)	(-1.43)	(-0.25)
Population growth	0.00387	0.00501	0.000915	-0.00106
	(0.93)	(0.63)	(0.26)	(-0.17)
Net migration	-0.00232	-0.00888	0.00247	-0.00109
	(-0.65)	(-1.35)	(0.84)	(-0.23)
Enlargement	0.0245***	.	0.0313***	.
	(3.21)	.	(4.86)	.
Constant	-7.413***	13.95**	2.319	7.102
	(-3.01)	(2.26)	(0.72)	(1.56)
Observations	811	637	811	637

Notes: Standard errors in parentheses, * p < 0:10, ** p < 0:05, *** p < 0:01. All regressions include time dummies

Source: Stata v14

The results in Table 17 suggest that there is still divergence between the 271 metropolitan areas used in this study, but the interesting point is that the coefficients for the 2000-2007 sample period were much bigger than the ones for 2008-2013. This implies that the economic crisis has smoothened the gap between the metropolitan regions analysis in this study.

Regarding the impact of the different economic sectors on metropolitan growth, from Table 17 we can see that agriculture, forestry and fishing had a significant coefficient only in the after crisis period, with a negative value. The coefficients for the industrial sector were negative before the crisis, but after 2008 it seems that this sector has a positive correlation with metropolitan economic growth. Concerning the role of manufacturing in boosting metropolitan development, the results show that only one coefficient was statistically significant and quite small. This suggests that this sector is not detrimental in influencing regional development.

As to the importance of construction, the results of Table 17 imply that this sector is among the driving factors that play a role in metropolitan development, but its impact is not so substantial because of the small coefficients.

According to the results in the above mentioned table, the sector of wholesale, retail trade, transport, accommodation and food service activities and the one for information and communication were influencing metropolitan economic growth only in the ante crisis period. Their statistical coefficients were small and the significance level was only at 5% or 10%.

Same as in section 4 the number of employees is an influential determinant for metropolitan economic growth. Economically active population size had negative coefficients before the economic crisis, but after the crisis the values are positive. This implies that the work force is more important in stimulating growth in periods of turmoil. Population density (proxy for agglomeration) has a considerable effect on metropolitan GDP/capita after the 2008 and slightly smaller coefficients before the economic crisis. Population size seems to put pressure on metropolitan development if we consider the big impact it had after 2008. Population growth and net migration were not statistically significant. Also the dummy variable that

measures the influence of EU enlargement has statistically significant coefficients, but quite small. The ones for the subsample period 2008-2013 are blank because the data for Croatian regions is missing. The GDP for the year 2013 for Croatian metropolitan regions was not available on Eurostat, which was the year when Croatia entered the EU.

The second robustness check conducted in this study involves the division of the sample data into Western metropolitan areas and Central-Eastern metropolitan area. What does Western and Central-Eastern mean in this case? Western metropolitan regions are the areas of the sample data from the following countries: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxemboug, Malta, Netherlands, Austria, Portugal, Finland, Sweden and United Kingdom. Central-Eastern metropolitan areas are the regions from the following countries: Bulgaria, Czech Republic, Estonia, Croatia, Cyprus, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia and Slovakia.

In the below table (Table 18), columns (1) and (2) highlight the results for the QML-FE estimation for the Western metropolitan areas, whereas columns (3) and (4) present the results for the Central-Eastern ones. Columns (1) and (3) have GDP/capita as the dependent variable. Columns (2) and (4) have GDP at PPS/inhabitant as the dependent variable.

Tab. 18 The results of the QML-FE estimation for Western European and Central-Eastern Europe

	(1) Western areas	(2) Western areas	(3) Central and Eastern areas	(4) Central and Eastern areas
L.GDP/capita	0.776***		0.652***	
	(24.08)		(9.83)	
L.GDP PPS/inhab		0.758***		0.642***
		(17.39)		(10.67)
Share of Agriculture, forestry and fishing	-0.0521***	0.00248	-0.0226	0.0114
	(-2.78)	(0.20)	(-0.55)	(0.42)
Share of Industry	0.102**	0.108***	0.137	0.0595

	(2.09)	(3.15)	(1.01)	(0.58)
Share of Manufacturing	-0.0378	-0.0705**	0.0229	0.0300
	(-0.90)	(-2.41)	(0.20)	(0.32)
Share of Construction	0.0670***	0.0241	0.152***	0.122***
	(3.80)	(1.42)	(3.55)	(3.67)
Share of Wholesale and retail trade, transport, accommodation and food service activities	0.0271	-0.00418	0.0174	-0.00665
	(0.90)	(-0.15)	(0.39)	(-0.18)
Share of Information and communication	-0.00109	0.00110	0.00685	0.0294
	(-0.09)	(0.13)	(0.16)	(1.14)
Employees	0.159***	0.197***	0.140	0.304***
	(3.52)	(5.11)	(0.55)	(3.07)
Population density	0.0215	-0.0181	-1.452	-1.409**
	(1.18)	(-1.26)	(-1.33)	(-2.15)
Economically active population	0.00664	0.0106	-0.214*	-0.120
	(1.22)	(1.37)	(-1.67)	(-1.17)
Population size	-0.0932	-0.132	0.882	0.603
	(-0.80)	(-1.14)	(0.78)	(1.07)
Population growth	-0.00557	-0.00563	-0.00296	0.0000699
	(-1.14)	(-1.59)	(-0.25)	(0.01)
Net migration	0.00125	0.00230	0.00309	0.00368

	(0.34)	(0.85)	(0.28)	(0.43)
Enlargement	0	0	-0.0641***	0.0176
	.	.	(-3.53)	(1.36)
Constant	1.010	1.589	-1.320	-0.527
	(0.64)	(0.99)	(-0.16)	(-0.10)
Observations	1069	1069	305	305

Notes: Standard errors in parentheses, * p < 0:10, ** p < 0:05, *** p < 0:01. All regressions include time dummies

Source: Stata v14

The results of Table 18 show that there is divergence between metropolitan regions in Western and also in the Central-Eastern Europe. The coefficients were statistically significant for both the samples. Regarding the impact that certain economic sectors have on metropolitan growth, the study demonstrates that for Western regions agriculture, industry, manufacturing and construction are the most important determinants. Wholesale and retail trade, transport, accommodation and food service activities and information and communication sectors were not statistically significant. Agriculture and manufacturing had a negative impact on metropolitan growth, whereas the industrial and construction sectors had a positive one.

The only economic sector that influences metropolitan development in Central-Eastern Europe is construction. The other branches of the economy were not statistically significant.

The number of employees has a determinant impact on metropolitan growth. Moreover the coefficients for the Central and Eastern regions were much higher. Population density and the number of economically active population appear to be statistically significant only for the Central-Eastern metropolitan regions. The coefficients for these variables were negative.

Net migration, population size and growth were not statistically significant. The results for the dummy variable show that enlargement did not have a positive impact on metropolitan growth.

6. CONCLUSIONS

The principal goal of this paper is to contribute to metropolitan economic growth literature by implementing an analysis for 271 areas located in the European Union. For this endeavour the study uses several empirical methods to quantify and statistically demonstrate the link between the independent variables and GDP measured in per capita and in PPS per inhabitant and to answer some important questions.

The key questions that this study will want to answer are:

1. What are the most important economic sectors for metropolitan growth?
2. Does population size, population density or population growth have an effect on metropolitan regions?
3. Is migration a positive influence on development?
4. Are metropolitan regions diverging and did the European enlargement substantially influenced growth in these areas?

For investigating the robustness of the results, the empirical model is also estimated by dividing the time period in two parts (post and ante economic crisis) and by splitting the sample of metropolitan regions in two components – the Western more developed regions and the Central and Eastern (the formal communist states, except for Cyprus) metropolitan areas.

The results of this study clearly show that metropolitan regions are not converging to the steady state of growth. There are considerable differences in development among metropolitan areas and there is a visible gap between Western regions and Eastern regions. For example the only metropolitan region from Central-Eastern Europe that is in the top ten list regarding GDP in purchasing power per inhabitant in the year 2012 is Bratislava. In this regard underperforming urban areas are located in Romania, Bulgaria, Hungary, Poland and Croatia. The Plovidv metropolitan area of Bulgaria has a GDP/capita 18 times smaller than that of Luxembourg. This paints a negative picture regarding the measures taken by the EU to limit the gaps between regions and it seems that the process of integration is difficult.

The main findings of this research regarding the influences of economic sectors on metropolitan growth are that agriculture, forestry and fishing can have a negative impact on economic growth. A considerable portion of EU funds is employed for stimulating investment in agricultural production and the big countries are also subsidizing this sector so as to be

more competitive. The results of this study suggest that these allocations appear to not be efficient for metropolitan growth.

Industry, construction and wholesale and retail trade, transport, accommodation and food service activities are positively related to metropolitan growth. It is true that in the system GMM the coefficients where not significant, but for the GMM estimator and QML-FE estimation the values are significant. The manufacturing and information and communication sectors were, in general, statistically insignificant. These findings have considerable policy implications for policymakers in the sense that EU funds must stimulate mostly the economic branches with the most value added for the economy.

The number of employees positively influences EU metropolitan economic growth. If the number of employed persons rises by 1%, metropolitan GDP rises by almost 0.25-0.29%. European enlargement appears to have contributed to metropolitan development, but the coefficients are not too considerable.

The results also show that population density has a small influence on metropolitan development. Population density is used as a proxy for agglomeration. The results obtain by the system GMM estimator are in contrast with the agglomeration economies theory that sees the increase in urban population as a stimulus of economic growth (Rosenthal and Strange 2004; van Oort, de Geus and Dogaru 2015). Population size measured by the number of inhabitants has a significant negative effect on metropolitan growth and the coefficients for population growth were positive, but the overall impact is very small which implies that density and size is more important that the growth of the population.

Net migration appears to be negatively influencing metropolitan economic growth when using the System GMM method and is not statistically significant for the other two techniques.

The robustness check also offered considerable outcomes. First of all it showed that the agriculture, forestry and fishing sector had a significant negative coefficient only in the after crisis period (2008-2013). The coefficients for the industrial sector were negative before the crisis, but after 2008 this sector has a positive correlation with metropolitan economic growth. Concerning the role of manufacturing in boosting metropolitan development, the results show that only one coefficient was statistically significant and quite small. This suggests that this sector is not detrimental in influencing regional development.

The construction sector is among the driving factors that play a role in metropolitan development, but its impact is not so substantial because of the small coefficients. The sector of wholesale, retail trade, transport, accommodation and food service activities and the one for information and communication were influencing metropolitan economic growth only in the ante crisis period.

Secondly the robustness check showed that for Western European regions agriculture, industry, manufacturing and construction are the most important determinants. Wholesale and retail trade, transport, accommodation and food service activities and information and communication sectors were not statistically significant. Agriculture and manufacturing had a negative impact on metropolitan growth, whereas the industrial and construction sectors had a positive one. The only economic sector that influences metropolitan development in Central-Eastern Europe is construction. Population density and the number of economically active population appear to be statistically significant only for the Central-Eastern metropolitan regions. European enlargement did not have a substantial positive impact on metropolitan growth for the Central-Eastern regions.

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