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The Crisis and Regional Resilience in Europe: On the Importance of Urbanization and Specialization

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Abstract

Using a rich data set on the EU regions, we analyze the relevance of two possible determinants of a region's resilience to shocks, the degree of urbanization and specialization. We take the Great Recession, the economic and financial crisis that started in 2008, as our shock and then analyze how the NUTS II EU regions differ in their resilience to the crisis in terms of unemployment and real GDP per capita. In prior research it has been well established that (EU) regions differ in their resilience to shocks but it typically remains unclear as to why regions differ in this respect. For the 2008- 2012 period, we find that the degree and nature of regional urbanization and specialization are important drivers of the resilience of EU regions. More in particular, we find that that EU regions with a relatively large share of its population in commuting areas in combination with a specialization in medium high tech industries are relatively resilient, that is were less affected by the crisis, a result that suggests a relationship with international trade.

JEL-Code: R110, R120, R150.

Keywords: resilience, shock sensitivity, urbanization.

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1 Introduction

Some regions are more resilient when confronted with economic shocks than others. These regions are either less affected by such shocks on impact and/or they recover more quickly. A prime example of an economic shock is the economic and financial crisis that began in 2008, which turned into what is now labelled 'The Great Recession'. The literature on the meaning, causes and consequences of regional resilience has been booming in recent years, see for a survey the 2010 special issue of The Cambridge Journal of Regions, Economy, and Society on *The resilient Region*. From an empirical perspective, it is by now well established that regions differ in their resilience in terms of regional growth or (un)employment. Garretsen, Fingleton and Martin (2012), for instance, find considerable differences in regional resilience as measured by employment patterns for the UK regions. Evidence into the determinants of regional resilience is however rather scarce (see Gardiner et al., 2013, for an exception for the UK) and when it exists it is confined to regions within a single country.

For the 2008 crisis, it is clear that the impact of the crisis varies across the EU regions (see Groot et al., 2011) but systematic evidence whether and why the impact of the crisis varied across Europe and what might account for these variations is still lacking. It is here that the present paper comes in. The contributions of the paper are twofold. First, we provide systematic evidence for the years 2008-2012 how the crisis impacted differently on the 255 EU NUTS 2 regions by looking at regional unemployment and GDP differences, Second, and more importantly, our paper is the first paper to try to establish the relevance of two possible determinants of regional resilience for the current crisis and the EU regions. These determinants are regional urbanization and specialization. As to the latter, the sector composition of a region's economy is traditionally thought to be a key determinant of regional growth and employment, and thus also a co-determinant of resilience. Regions that have a specialization pattern that is on average less sensitive to external shocks will ceteris paribus display more resilience. The Great Recession went for instance along with an unprecedented collapse of international trade in 2009, so regions that have a specialization pattern for which international trade is relatively important may be more affected by the crisis. For our sample of NUTS 2 EU regions, we will estimate the relevance of a region's specialization for the impact of the crisis on regional unemployment and GDP. But we will first look into our other determinant of regional resilience, the degree and nature of regional urbanization. There is a large body of literature (see f.i. Glaeser and Kahn, 2004, or Duranton and Puga, 2013) in urban and regional economics, that links regional growth to the degree of

regional urbanization. Both the composition and the size of the population of a region are seen as being among the most important determinants of regional growth. Regions that have a more skilled population or work force do perform better and, by and large, regions that are more urbanized do also outperform less urbanized regions. Various agglomeration economies that are as such hard to measure are thought of as being summarized by the degree of urbanization. The possible relevance of the degree and composition of urbanization for resilience is to be found in the fact that urbanization also signals the degree to which cities or regions are able to adjust to shocks (see for instance Glaeser, 2004, for a detailed study on the resilience of Boston, or Martin et al., 2013 for French clusters). Furthermore, Martin, et al. (2013) show that firms in clusters have a higher probability to survive a crises and have higher growth rates; from the map in their paper one can concluse that clusters and cities can be found in the same areas (Figure 1, p.4). We will use urbanization data for the NUTS 2 regions to assess whether the degree of urbanization may be associated with a region's plight in the wake of the Great Recession. After we have looked into the relevance of urbanization and specialization separately, we will also test for the joint effect of urbanization and specialization on regional unemployment and real GDP per capita for the NUTS 2 EU regions for 2008-2012. The reason is that urbanization and specialization are two sides of the same coin in the sense that more urbanization goes along with more specialization.[2] As we will explain in more detail in section 4, where we will test for this joint effect, between an uneven spatial distribution of production factors and urbanization.

Our main findings are that EU regions with a relative large share of its population in commuting areas are relatively resilient. In contrast, regions with a large share of its people living in rural areas or cities do not absorb shocks as easily. Furthermore, the correlation between commuting areas and medium high tech industries suggest a link with exports; spatial concentration of production factors determine trade patterns, and those export oriented sectors are less susceptible for shocks. Note, that because we do not have trade data on a sub-regional level this link is an implied link (see the appendix).

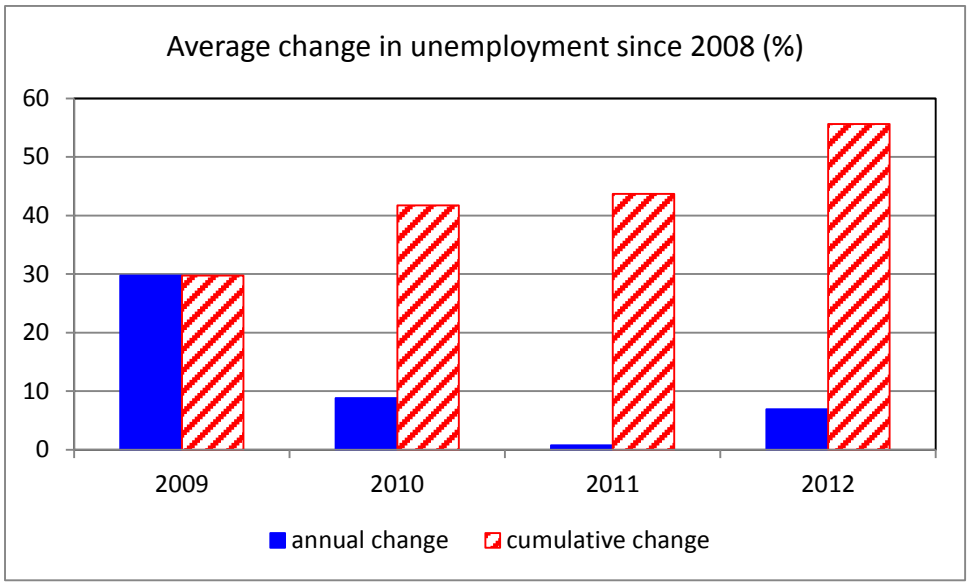
[2] This reasoning is based on the Heckscher-Ohlin trade models applied to smaller spatial scales than countries (see Courant and Deardorf, 1992, 1993). They use the term 'lumpiness' for the uneven distribution of factors of production over space.

The paper is structured as follows. Section 2 focuses on the relationship between urbanization and unemployment using NUTS 2 data for 2008 – 2012 for the EU regions. Section 3 does the same regarding the relationship between specialization composition and unemployment. Section 4 analyzes the joint effects of both urbanization and sector composition. Section 5 briefly repeats the analysis regarding the role of urbanization and sectors during the Great Recession by using real GDP (both total and per capita) as an indicator, rather than unemployment. Section 6 concludes.

2 Regional Unemployment and Urbanization

We use urbanization information from Eurostat (kindly provided to us by Lewis Dijkstra – OECD, and Dirk Stelder), for 283 NUTS 2 regions. We can connect this to unemployment level information for 254 up to 271 regions. Starting from 2008, the regional unemployment level increases on average by about 30, 9, 1, and 7 per cent in 2009, 2010, 2011, and 2012, respectively, see Figure 1. Measured this way, the Great Recession continues throughout this period, although the effect is small in 2011. The *cumulative* effect since the start of the crisis (2008), measured as the average change in unemployment since 2008, increases uninterrupted at 30, 42, 44, and 56 per cent in 2009, 2010, 2011, and 2012, respectively.

Figure 1 Average change in unemployment since 2008 (%)



Our urbanization information for the NUTS 2 regions focuses on three types of urbanization indicators per NUTS 2:

(i) the population living in (big) *cities*,

(ii) the population living in *commuting areas* (defined as 'at least 15% of the workforce works/comes from elsewhere'),

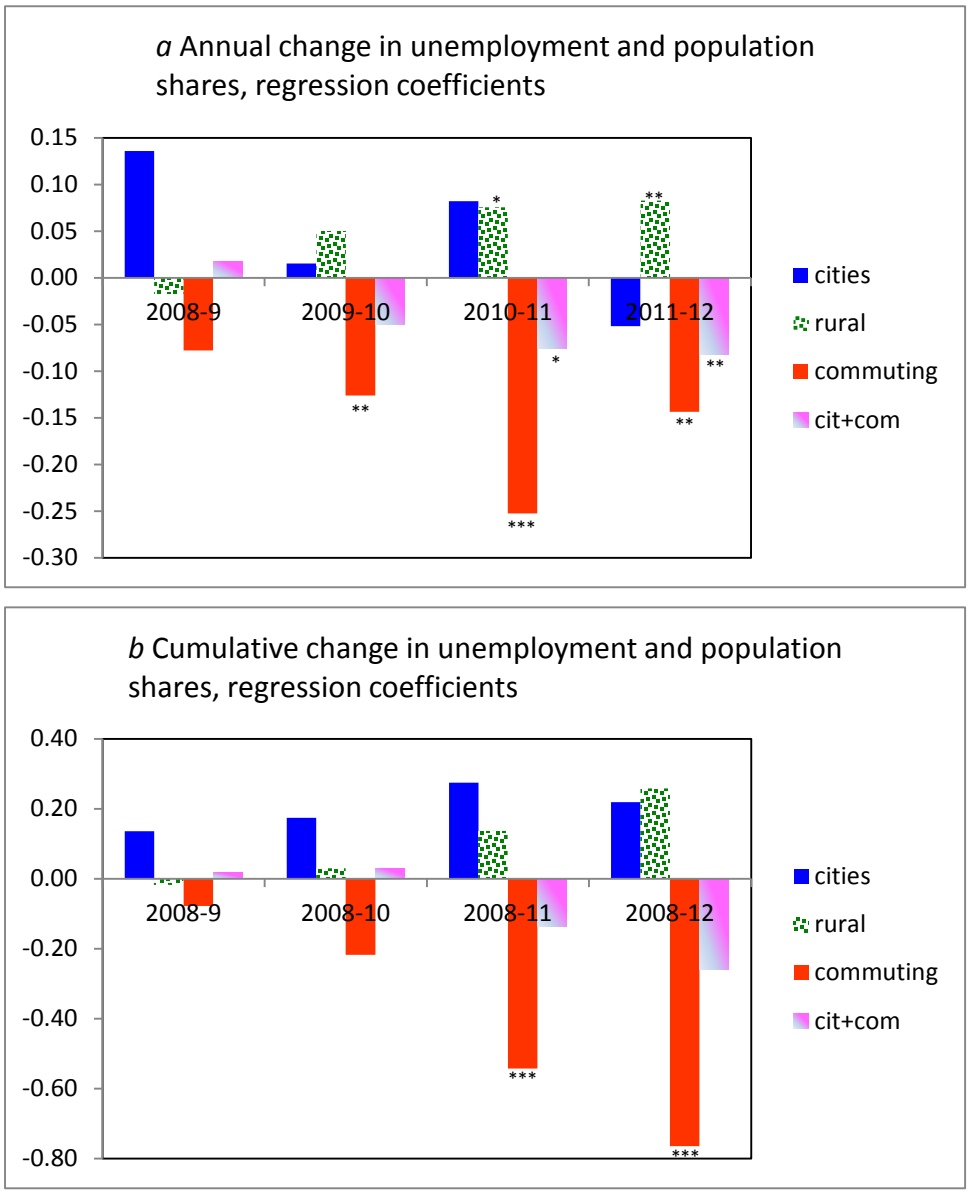
(iii) the population living outside cities and commuting zones, which we will label '*rural' population*.

On average across our whole sample of NUTS 2 regions, the share of people living in cities is 24.4 per cent and the share living in commuting zones is 37.1 per cent, so the share living either in cities or commuting zones is 61.5 per cent and the share living in rural areas is 38.5 per cent.[3]

To assess the impact of a region's urbanization pattern as summarized by categories (i)-(iii) above, on regional unemployment resilience, we ran a series of regressions with the relative change in a region's unemployment level as the variable to be explained, both annually and cumulatively since 2008, regressed on the share of the population (in per cent) living in cities, commuting areas, rural areas, or urbanized areas (either cities or commuting areas) as explanatory variables. Figure 2 provides information on the coefficients for the various regressions, panel *a* for the annual changes and panel *b* for the cumulative changes. Note, the vertical axis depicts unemployment. In general, a high share of the population living in cities worsens the impact of the crisis. In 2009, for example, a one per cent higher share of the population living in cities leads to a 0.136 per cent *higher* change in unemployment. This effect of the city population on unemployment becomes smaller in 2010, increases in 2011, and reverses in 2012. The cumulative effect of the city population therefore rises from 2009 to 2011 and reaches a peak in 2011. But none of these effects is statistically significant. Rural areas seem to have a delayed, but similar impact during the crisis. The initial annual effect (in 2009) is negative, while the subsequent annual effects are positive, indicating that unemployment rises faster for rural areas. These effects are (just) significant in 2011 and 2012. The *cumulative* impact of rural areas therefore rises over time, but these effects are not statistically significant.

[3] These are unweighted regional averages. When we weigh by population the share of the population living in cities is 29.9 per cent, the share in commuting zones is 40.9 per cent, and the share in rural areas is 29.2 per cent.

Figure 2 Change in unemployment and urbanization: regression coefficients

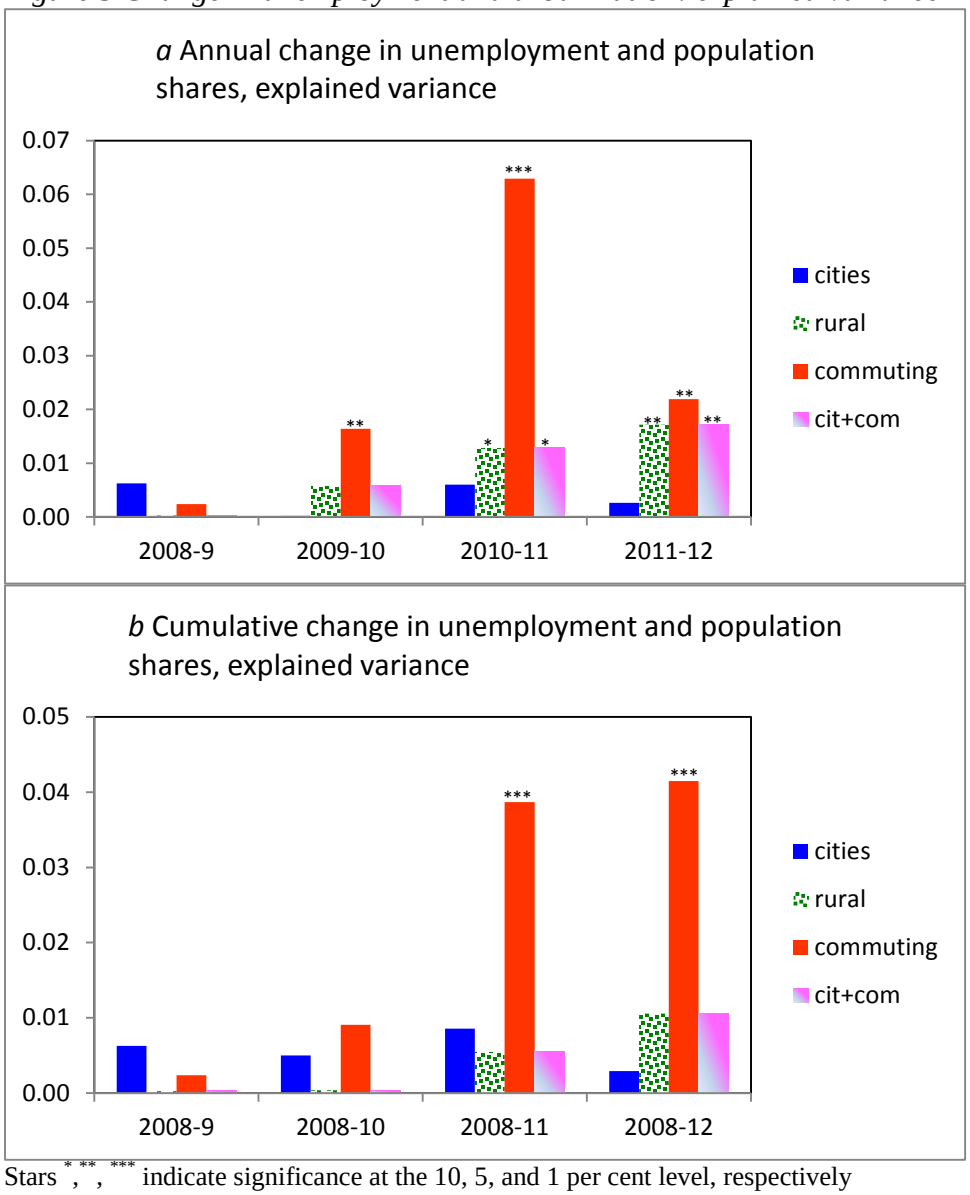


Stars *, **, *** indicate significance at the 10, 5, and 1 per cent level, respectively

This brings us to the impact of the share of the population living in commuting areas. Panel a indicates that the annual impact is always negative and except for the initial year also significant, indicating that *unemployment rises less fast for commuting areas*. In 2011, for example, a one per cent higher share of the population living in commuting areas leads to a 0.25 per cent *lower* change in unemployment. Panel *b* indicates that the cumulative effect on unemployment therefore rises over time. From 2011 onwards the cumulative effect of the commuting population is highly significant, at the 1% level (none of the other cumulative effects are significant). In 2012 a one per cent higher share of the population living in

commuting areas *lowers* the cumulative change in unemployment by 0.76 per cent. Figure 2 also illustrates that it is not proper to merge the city population together with the commuting population because the negative coefficient for the commuting population is partially cancelled by the positive coefficient for the city population. The net effect is, of course, the mirror image of that of the share of the rural population. The reason for higher resilience in areas with a large share of commuting areas can be manifold: these areas can be home to a more mobile workforce, the workforce can be relatively high-skilled (and less susceptible for unemployment), or these areas are attractive for location of a specific type of firm. The latter explanation is consistent with the findings of Martin et al. (2013) who find that clusters of exporting firms – near cities, are more resilient than areas that do not have such clusters (see also section 4 for a similar line of reasoning).

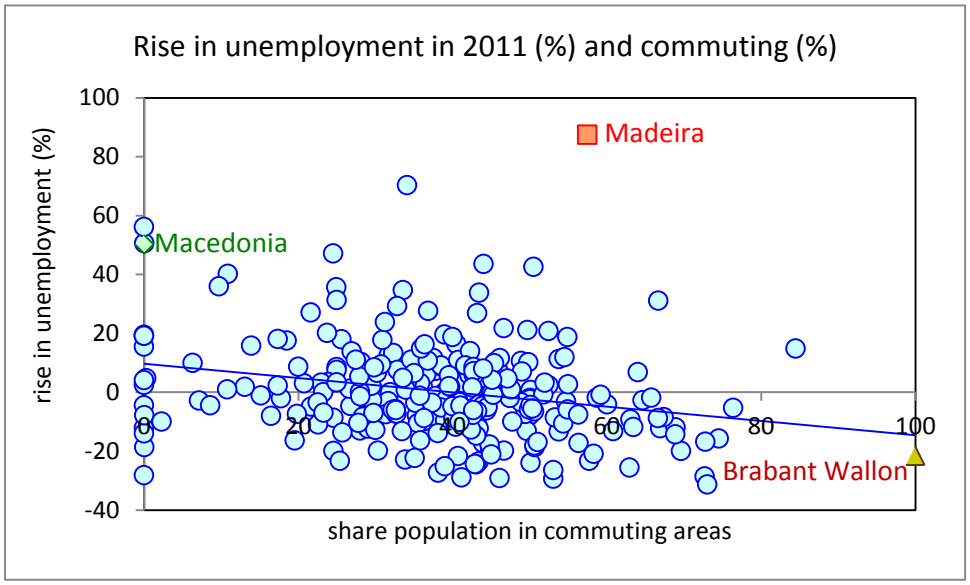
Figure 3 Change in unemployment and urbanization: explained variance



Stars *, **, *** indicate significance at the 10, 5, and 1 per cent level, respectively

Figure 3 summarizes the share of the variance in the relative change of unemployment explained by the regressions. Panel *a* does so for annual changes and panel *b* for the cumulative effects. Not surprisingly in these types of cross-section regressions, the explanatory power of a single variable is limited. In both panels, however, the impact of the share of commuting population clearly dominates that of the other effects. Figure 4 provides an example of the relationship between the relative change in unemployment in 2011 and the share of the population living in cities. Typical examples are (Greek) Macedonia, where the share of the commuting population is zero per cent and the increase in unemployment is 50 per cent, and (Belgian) Brabant Wallon, where the share of the commuting population is 100 per cent and the fall in unemployment is 22 per cent. An outlier is Madeira.

Figure 4 Change in unemployment and share of population in commuting areas, 2011



3 Regional Unemployment and Specialization

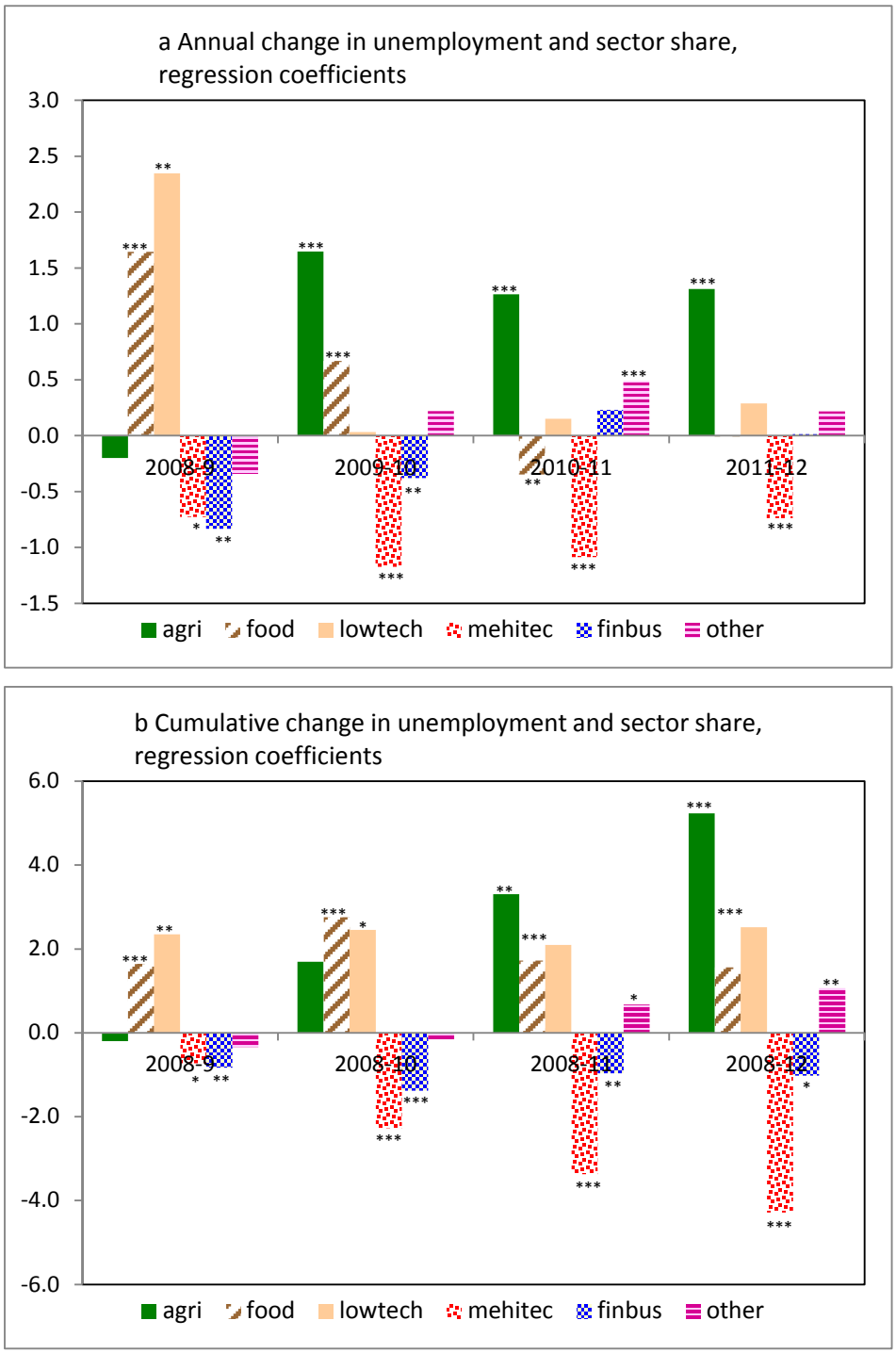
We perform a similar annual and cumulative analysis of changes in regional unemployment in relation to the sectoral specialization of the regions for the NUTS 2 regions for 2008-2012. As we explained in our introduction to this paper, a region's specialization is a main candidate to explain why regions differ in their resilience to shocks like the Great Recession. To this end, we use the input-output information from Thissen, Diodata, and van Oort (2013a). We can match the unemployment data with the sectoral composition data for 207 EU NUTS–2 regions. Based on information from Andries Brandsma and Mark Thissen

(2013b), we identify six main sectors, together covering total regional output in 2008 as follows (codes refer to Thissen et al, 2013a, Table 3):

- Agri – *agriculture*; agriculture, hunting, forestry, and fishing (AA01, AA02, BA05).
- Food – *food*; food products and beverages (DA15).
- Lowtech – *low technology*; tobacco, textiles, wearing apparel, leather, wood, pulp, paper, printed matter (DA16, DB17, DB18, DC19, DD20, DE21, DE22).
- Mehitec – *medium high technology*; chemical, electrical machinery, motor vehicles, other transport equipment (DG24, DL31, DM34, DM35).
- Finbus – *financial and business services*; (services auxiliary to) financial intermediation, insurance and pension, computer services, research and development, other business services (JA65, JA66, JA67, KA72, KA73, KA74).
- Other – all *other* output; all remaining categories.

Figure 5 summarizes the regressions coefficients for the relative changes in regional unemployment as explained by the share (in per cent) of output in a certain sector, both annually (panel a) and cumulatively since 2008 (panel b). Figure 6 is similarly organized regarding the explained variance. The most important initial impact (in 2009, see figures 5a and 6a) is the *rise* of unemployment of food-intensive regions. A one per cent higher share of output in the food sector leads to a 1.64 per cent *higher* change in unemployment. This explains about 12.4 per cent of the variance of the change in unemployment (more on this below). In contrast, the other initially significant effects, namely higher unemployment for lowtech-intensive regions and lower unemployment for mehitech-intensive and finbus-intensive regions, only explain about 3 per cent of the variance.

Figure 5 Change in unemployment and sector share: regression coefficients

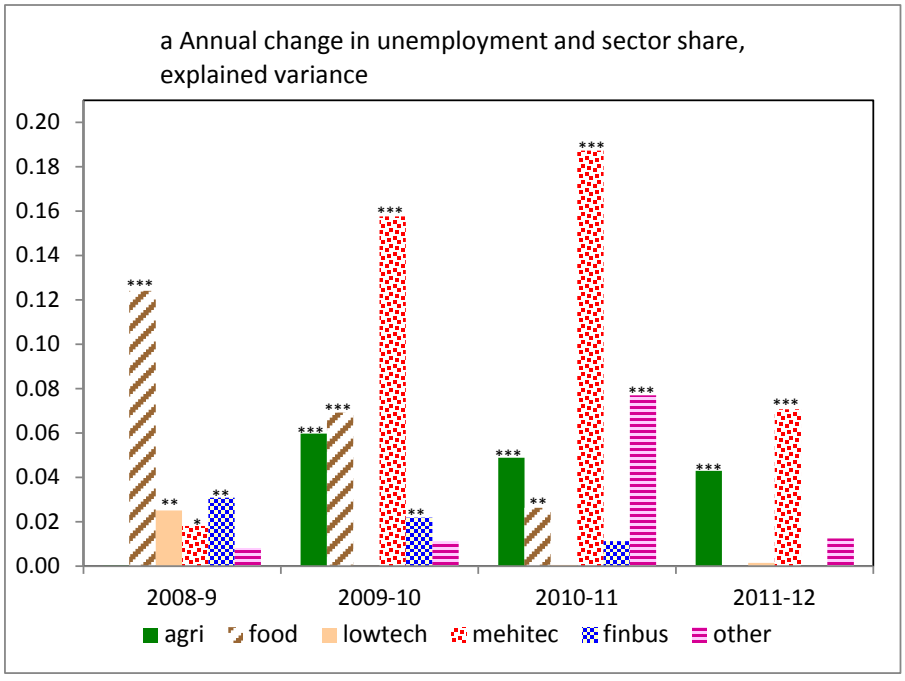


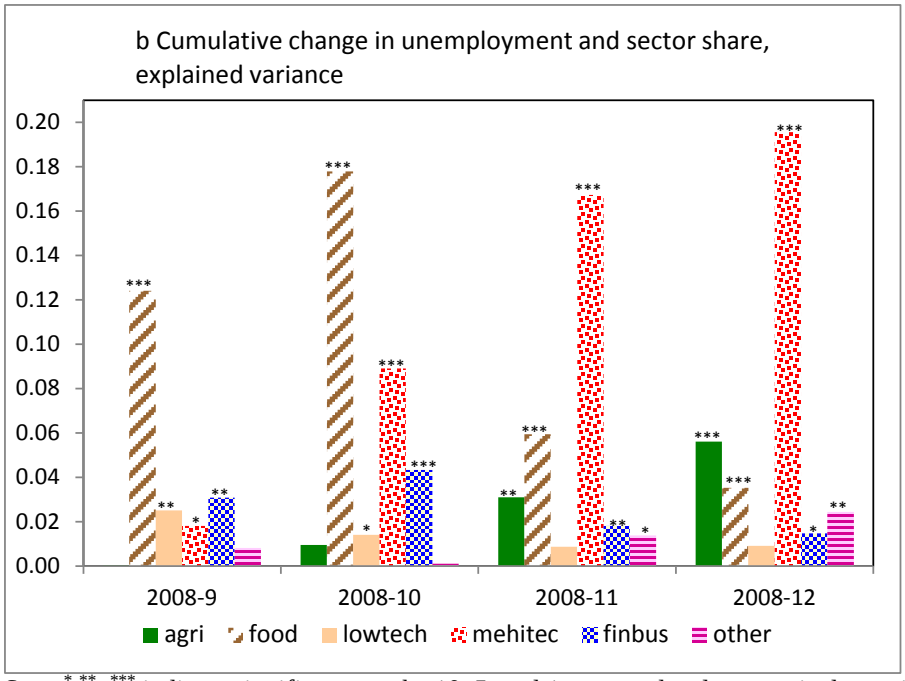
Stars *, **, *** indicate significance at the 10, 5, and 1 per cent level, respectively; agri = agriculture; lowtech = low technology sectors; mehitec = medium and high technology sectors; finbus = financial and business services

The initial impact of the crisis for the food-intensive regions in terms of raising unemployment continues in 2010, is reversed in 2011, and disappears in 2012. The cumulative effect remains, however, statistically significant throughout the entire period, but

the share of explained variance falls to only 3.5 per cent by 2012. From the second crisis year on (since 2010) the dominant sector effect on unemployment switches to the mehitec sector: in 2010, for example, a one per cent higher share of output in the mehitec sector leads to a 1.17 per cent *lower* change in unemployment. Similar results hold in 2011 and 2012. The cumulative impact of the mehitec sector thus rises over time, such that by 2010 a one per cent *higher* share of output in the mehitec sector leads cumulatively to a 4.3 per cent *lower* change in unemployment, which explains about 20 per cent of the variance in unemployment. As can be seen in figures 5 and 6, a *reverse* role is played by agriculture-intensive regions since 2010. In this case, a higher share of output in agriculture raises unemployment by more than 1 per cent per year and by more than 5 per cent cumulatively by 2010. The cumulative share of variance explained rises to almost 6 per cent by 2012. The impact of other sectors is of second-order importance in comparison.

Figure 6 Change in unemployment and sector share: explained variance





Stars *, **, *** indicate significance at the 10, 5, and 1 per cent level, respectively; agri = agriculture; lowtech = low technology sectors; mehitec = medium and high technology sectors; finbus = financial and business services

To give an impression of the relationship between the change in unemployment and the sector composition, figure 7 gives two examples. Panel a illustrates the cumulative relative change in unemployment from 2008 to 2010 and the share of output in the food sector. This figure makes clear that the relatively strong relationship is essentially based on the high food shares in output of Lithuania (56 per cent) and Latvia (60 per cent), combined with a sharp rise in unemployment in these country-regions (209 and 139 per cent, respectively) in this period. Excluding these two regions would mean that food-intensity is not very informative regarding the change in unemployment in the initial phase of the crisis.

Figure 7 Change in unemployment, food, and medium-high tech

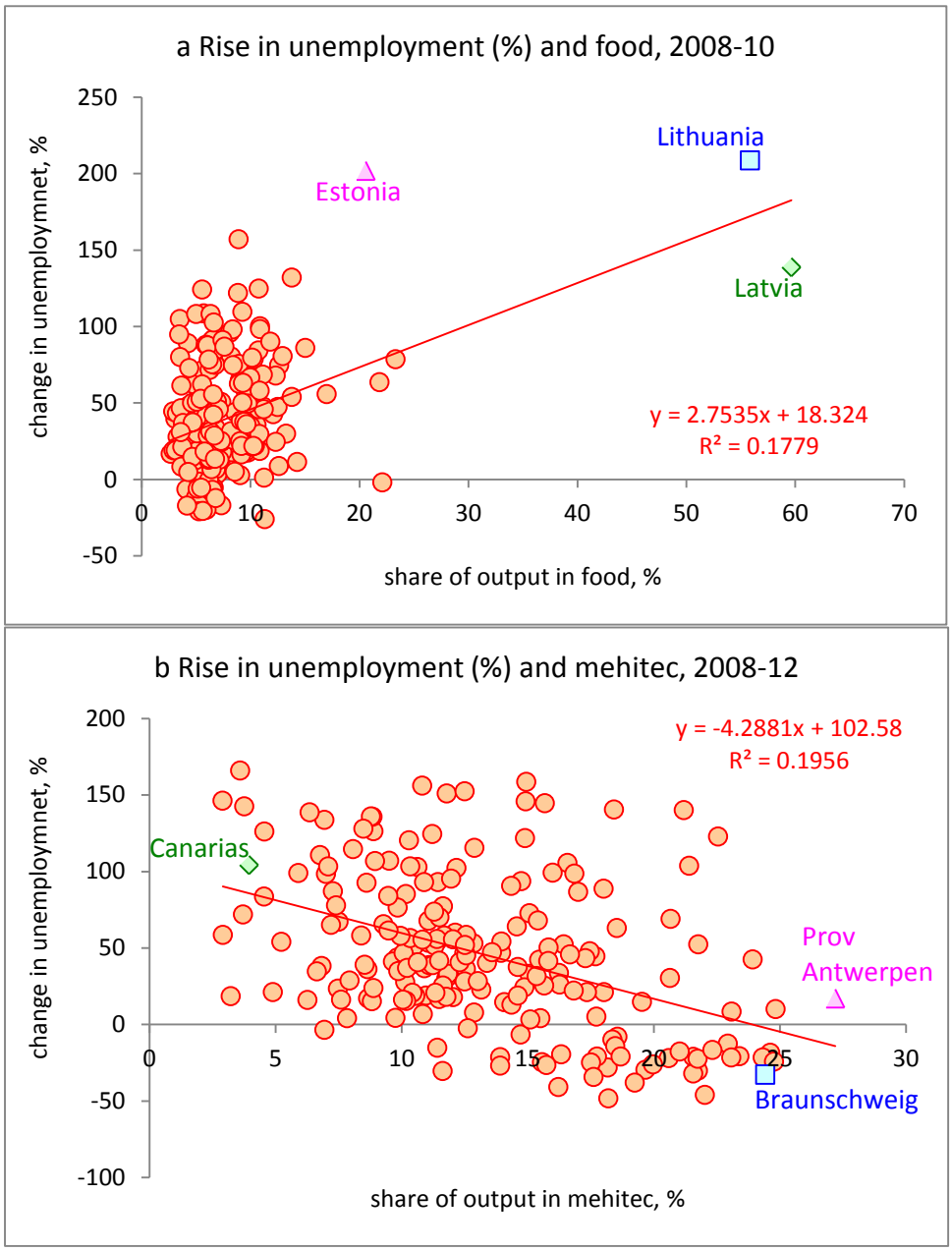


Figure 7b illustrates the relative change in unemployment in the period 2008-2012 and the share of output in the mehitec sector. The contrast with panel a is that we now see a rather robust negative relationship, not caused by a few outliers. Typical examples are the Canary Islands of Spain (4 per cent mehitec and 104 per cent rise in unemployment), the Province of Antwerp in Belgium (27 per cent mehitec and only 17 per cent rise in unemployment), and Braunschweig of Germany (24 per cent mehitec and a 33 per cent *fall* in unemployment).

Our Mehitec and finbus sectors cope relatively well with the Great Recession. These are also the sectors that dominate exports. Sectors that are less well able to diversify their markets of destination and which are relatively more inward oriented, such as the agri/ food and low tech industries are more susceptible for economic recessions. Although the sector definitions are not the same, Martin et al. (2013, Table A-1, p.17) find similar results for France using micro-firm data.

4 Lumpiness and the Joint Effects of Urbanization and Specialization

Because both the degree of regional urbanization (section 2) and the sector composition (section 3) are empirically relevant to understand the changes in regional unemployment following the 2008 crisis, it is worthwhile to jointly investigate them. This is also appropriate because, as we explained in the introduction, regional urbanization and specialization are probably not interdependent. On rather general level, we know for instance that more urbanized areas are more and differently specialized (see Brakman and Van Marrewijk, 2013). But there are also more intricate reasons why regional urbanization, specialization and the crisis impact can be seen as interdependent, as the spatial concentration of production factors (or lumpiness), and regional specialization are strongly connected.

Lumpiness of production factors leads to a concentration of certain types of economic activity within certain regions. This provides a possible extension of the standard trade model that might add to the understanding of international trade flows, which is traditionally omitted in the empirical literature. Within the Heckscher-Ohlin (factor abundance) framework, the uneven distribution of production factors within a country can potentially affect the structure of trade flows in complex ways (Courant and Deardorff, 1992, 1993). The indeterminate-ness of trade patterns, and the difficulty to find detailed data on factor endowments and trade flows within countries are reasons for the neglect of this explanation. This does not imply that lumpiness might not be an issue. We would like to argue that the most apparent manifestation of clustering is the concentration of production factors in cities or regions. If mobile factors of production are clustered in urban areas, the consequence could be that trade patterns, as predicted by this model, can both be magnified or even reversed by uneven concentration of production factors within a country. Cities are the most characteristic manifestation of lumpiness of production factors and as a consequence different patterns of

urbanization between countries might cause trade patterns to differ from the Heckscher-Ohlin model's predictions on the basis of the overall availability of production factors (Brakman and van Marrewijk, 2013). This leads to the conclusion that the lumpy distribution of factors of production within countries could affect international trade flows.

As within country lumpiness or agglomeration of production factors determines, at least to some extent, specialization patterns of regions, it can also affect the resilience of regions to cope with economic shocks, like the economic and financial crisis that began in 2008 and the subsequent trade collapse to which this gave rise in 2009. Hence, the crisis, via its impact on international trade, can affect regions differently according to the degree in which regions are via their availability of production factors more or less specialized in trade-related activities and this in turn is dependent on the degree of urbanization. Unfortunately, see Figure A1 in the Appendix, there are no inter-regional trade data available for the EU regions so that one could directly assess the impact of trade on regions.

Given the various ways, lumpiness or otherwise, that regional urbanization and specialization can be seen as interdependent, we start with Table 1, which provides simple information on the correlation between output shares of the six identified sectors and the three types of population dwellings identified in section 2. Within the output shares we find the strongest *negative* correlations in the EU regions between the sectors *other & food, other & mehitec,* and *finbus & lowtech*. The strongest *positive* correlations are between *agri & food*, *lowtech & mehitec*, and *lowtech & agri*. Note that both the sectors *other* and *finbus* are negatively correlated with all other sectors. Within the dwelling types we observe a surprisingly low positive correlation between the shares for *cities & commute*. In contrast, we observe a strong negative correlation between the shares for *rural & cities* and *rural & commute*.

When we look at the interaction between dwellings and sectoral output, our main concern here, we observe the strongest positive correlations between agri & rural and cities & finbus, followed by slightly weaker, but still substantial, positive correlation between *rural & lowtech*, *commute & mehitec*, and *commute & finbus*. The strongest negative correlations are between *cities & agri* and *commute & agri*, followed by slightly weaker, but still substantial, negative correlation between *cities & mehitec* and *commute & lowtech*.

Table 1 Correlation coefficients sector output shares and urbanization shares

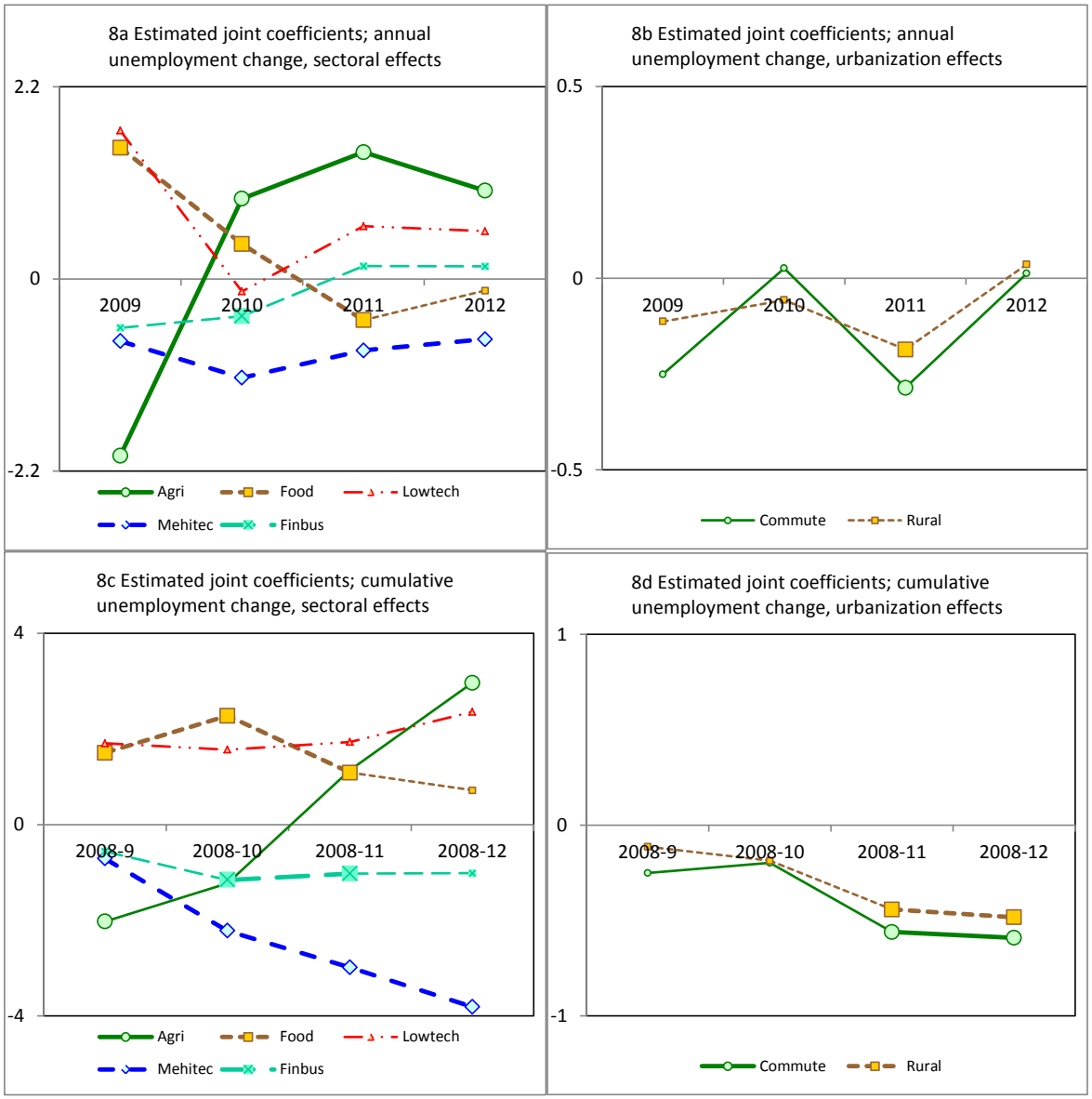
	agri	food	lowtech	mehitec	finbus	other	cities	commute	rural
agri	1								
food	0.180	1							
lowtech	0.142	0.087	1						
mehitec	-0.185	-0.117	0.150	1					
finbus	-0.381	-0.300	-0.434	-0.174	1				
other	-0.055	-0.574	-0.129	-0.448	-0.207	1			
cities	-0.359	-0.095	-0.132	-0.262	0.352	0.123	1		
commute	-0.341	-0.065	-0.201	0.211	0.242	-0.132	0.044	1	
rural	0.484	0.111	0.230	0.036	-0.411	0.006	-0.724	-0.721	1

207 EU NUTS2 regions

On the basis of the above partial results, we will analyze the joint effects of the sectors agri, food, lowtech, mehitec, and finbus (taking 'other' as benchmark) and the urbanization categories commuting and rural (taking 'cities' as benchmark). As before, we will analyze the sectoral and urbanization effects on the annual changes in unemployment as well as the cumulative changes since 2008. Details of the estimates are provided in Table A.1 in the appendix. A graphical summary of the coefficients of this table is provided in Figure 8. To visualize the impact of the various effects, *the figure provides large markers if the effect is at least significant at the 10 per cent level and small markers otherwise*. In addition, Figure 8 connects two large markers by a thick line, and a thin line otherwise.

Regarding the sectoral influences, we see for annual changes (Figure 8a) a large impact for agriculture, food, and mehitec. The initial impact for food is positive, indicating that *un*employment rises faster in food-intensive regions. Similarly, but after a delay of one year, the impact for agriculture is positive, indicating that unemployment rises faster in agriculture-intensive regions. In contrast, the impact of mehitec is always negative, indicating that unemployment is lower in mehitec-intensive regions. This is fully in line with our findings in section 3. When we translate the annual effects to a cumulative experience (Figure 8c), we observe that the high unemployment changes for food-intensive regions disappears after three years and that the low unemployment changes for agriculture in the first year switch to high unemployment changes in the fourth year. Most importantly, the low unemployment changes for mehitec-regions becomes stronger and stronger over the years: again this corroborates our findings in section 3.

Figure 8 Sectoral and urbanization coefficients, joint effects on change in unemployment



Large markers indicate significance at the 10 per cent level; thick lines connect two significant markers.

Regarding regional urbanization, a remarkable change occurs once we control for the regions's sectoral composition. First, we note that for the annual changes (Figure 8b), relative to the city benchmark, the share of a region's rural or commuting population is no longer significantly different, with the exception of the year 2011. Second we note that the impact of commuting population is in line with our findings of section 2, namely lower unemployment changes in 2011, but the impact of the rural population is opposite to that found in section 2 once we control for sectoral composition, namely lower instead of higher unemployment.

Although the annual impact of commuting and rural population already disappears after one year (Figure 8b), the cumulative impact in 2011 is strong enough to last until 2012 (Figure 8d).

All in all, the above discussion leads us to conclude that most of the observed urbanization impacts on unemployment changes that we identified in section 2 can be explained by the sectoral composition of output for the regions once we allow for both urbanization and specialization to matter for regional unemployment resilience in the wake of the 2008 crisis. We only find an occasional lower unemployment effect for the share of commuting and rural population. From a theoretical point of view it is, of course, hard to disentangle the sector impacts from the urbanization effects as they represent two sides of the same coin since the lumpy distribution of factors of production (urbanization) impacts the sector composition of the region. However, the fact that mehitec sectors, in combination with commuting areas cope relatively well with the great recession suggests that lumpiness might be an important absorber of shocks. The implied export orientation of such areas enable regions to diversify their destination markets reducing shock sensitivity.

5 Urbanization, Specialization and their Impact on Real GDP

Next, we look at the relationship between urbanization, sectors and the change in real GDP per capita and real GDP as an indicator of resilience. The disadvantage of using GDP compared to unemployment as an indicator is that we only have information available up to and including 2010, so for only two instead of four years. We can therefore only analyze the annual effects for 2008-9 and 2009-10 and the cumulative effect for 2008-10. The effects for GDP and GDP per capita are usually quite similar, but there are some deviations nonetheless, so we report both measures.

Table A2 in the appendix reports the individual effects of urbanization on GDP, similar to section 2 above for unemployment. We note that in 2008-9 and cumulatively for 2008-10 the impact of cities on GDP growth is negative while the impact of commuting is positive. This is quite in line with the results we found for unemployment. The coefficients are about 0.05, so a one percent higher share of the population in cities or a one percent lower share of

commuting population leads to a 0.05 percent decline in GDP per capita growth.[4] The impact of the rural population is not significant. Neither is any of the annual effects in 2009-10. The highest share of the variance explained by the individual effects is about 4 percent for the cumulative effect of commuting.

Table A3 in the appendix reports the individual effects of sectors on GDP, similar to section 3 above for unemployment. Again, the results are in line with the unemployment results. The annual impact in 2008-9 for food and lowtech is negative, while that for mehitec is positive for GDP per capita and for finbus is positive for GDP. Most results in 2009-10 are not significant, with the exception of a negative impact of food on GDP and a positive impact of lowtech on GDP per capita.[5] In all cases, therefore, the cumulative effect is largely determined by the annual impact of 2008-9. The largest share of the variance explained is about 10-13 percent for the cumulative effect of food.

Table 2 provides the *joint effects* of urbanization and sectoral composition on GDP, similar to section 4 for unemployment. In line with our results for unemployment, we find that the initial impact for food and lowtech is negative. In contrast to the unemployment results, both the initial and the cumulative effect of commuting and rural is positive (relative, of course, to the city population). This difference could be explained by the absence of any significant effect for the finbus and mehitec sectors. Relative to GDP changes these sectors do not provide a lot of explanatory power. Relative to unemployment changes, however, they do: the change in unemployment is lower if the share of workers in mehitec and finbus is higher. *Apparently, the employers in these sectors are willing to hold on to their workers in bad times.* As with the individual results listed in tables A2 and A3 and discussed above, none of the annual resuls in 2009-10 is statistically significant, with the exception of the negative impact of food on the change in GDP. The cumulative results are therefore in line with the initial results, with the exception of agri, where the two non-significant negative effects end up being significant cumulatively. The share of the variance explained is about 9 percent for the initial impact (2008-9), virtually zero the next year (2009-10), and about 16-18 percent cumulatively.

[4] Similarly for GDP growth, with the exception of the cumulative effect for city population.
[5] The latter result contrasts with the finding for unemployment.

Table 2 GDP and GDP per capita joint effect estimates; probabilities in parentheses

a. Change in GDP per capita (per cent)

	2009	2010	Cumulative 2008-10
Agri	-0.1210	-0.1456	-0.2881*
	(0.523)	(0.373)	(0.079)
Food	-0.1521**	-0.0708	-0.2213***
	(0.015)	(0.184)	(0.000)
Lowtech	-0.3446*	0.2494	-0.1454
	(0.097)	(0.162)	(0.416)
Mehitec	0.0671	-0.0071	0.0673
	(0.390)	(0.916)	(0.317)
Finbus	0.0341	-0.0771	-0.0326
	(0.656)	(0.243)	(0.621)
Commute	0.0978***	-0.0005	0.1044***
	(0.004)	(0.986)	(0.000)
Rural	0.0673**	-0.0072	0.0672***
	(0.018)	(0.741)	(0.002)
Adj R2	0.0882	0.0001	0.1609
F-test prob	(0.0006)	(0.4301)	(0.0000)

b. Change in GDP (per cent)

	2009	2010	Cumulative 2008-10
Agri	-0.1745	-0.1889	-0.3958**
	(0.366)	(0.265)	(0.020)
Food	-0.1676***	-0.1226**	-0.2816***
	(0.008)	(0.028)	(0.000)
Lowtech	-0.3635*	0.2340	-0.1887
	(0.085)	(0.207)	(0.305)
Mehitec	0.0228	-0.0745	-0.0435
	(0.774)	(0.285)	(0.530)
Finbus	0.0470	-0.0800	-0.0231
	(0.546)	(0.243)	(0.734)
Commute	0.0966***	-0.0001	0.1041***
	(0.005)	(0.997)	(0.001)
Rural	0.0666***	-0.0113	0.0632***
	(0.010)	(0.617)	(0.005)
Adj R2	0.0899	0.0134	0.1819
F-test prob	(0.0005)	(0.2070)	(0.0000)

Note: shaded cells ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

6 Conclusions

Some regions are more resilient when confronted by economic shocks than others. The literature on regional resilience has been booming in recent years, see for a survey the 2010 special issue of The Cambridge Journal of Regions, Economy, and Society on *The resilient Region*. Evidence into the determinants of regional resilience is however rather scarce.

As urbanization is a key determinant in regional growth we look at the relation between urbanization and resilience, where resilience is confined to the impact of the crisis in the years following 2008. More specifically, we provide systematic evidence for the years 2008-2012 how the crisis impacted differently on the 255 EU NUTS 2 regions by looking at regional unemployment and GDP differences. We try to establish the relevance of 2 possible determinants of regional resilience for the current crisis and the EU regions: regional urbanization and regional specialization. The possible relevance of the degree and composition of urbanization for resilience is to be found in the fact that urbanization also signals the degree to which cities or regions are able to adjust to shocks (see for instance Glaeser, 2005, for a detailed study on the resilience of Boston, or Martin et al., 2013 for the resilience of French clusters). The method in this paper is simple: we start by looking at the relation between unemployment and various elements of urbanization, next do the same for the regional sector composition, and finally we test for the joint effect of urbanization and specialization on regional unemployment and real GDP per capita for the NUTS 2 EU regions for 2008-2012.

Our main findings are that regions with a relatively large share of commuting areas are relatively resilient. In contrast, EU regions with a large share of its people living in rural areas or cities do not absorb shocks as easily. Furthermore, the correlation between commuting areas and medium high tech industries suggest a link with exports; spatial concentration of production factors determine trade patterns, and those export oriented sectors are less susceptible for shocks. Note, that because we do not have trade data on a sub-regional level this link is an implied link (see the appendix).

APPENDIX

Table A1 Unemployment joint effect estimates; probabilities in parenthesis

a. Annual changes in unemployment (per cent)

	2009	2010	2011	2012
Agri	-2.024**	0.920*	1.452***	1.011*
	(0.040)	(0.073)	(0.001)	(0.054)
Food	1.504***	0.399**	-0.471***	-0.132
	(0.000)	(0.018)	(0.001)	(0.438)
Lowtech	1.700	-0.143	0.605	0.546
	(0.113)	(0.798)	(0.176)	(0.338)
Mehitec	-0.711*	-1.130***	-0.818***	-0.689***
	(0.079)	(0.000)	(0.000)	(0.002)
Finbus	-0.560	-0.426**	0.147	0.144
	(0.158)	(0.040)	(0.375)	(0.495)
Commute	-0.251	0.026	-0.286***	0.012
	(0.151)	(0.774)	(0.000)	(0.895)
Rural	-0.113	-0.057	-0.186***	0.036
	(0.385)	(0.401)	(0.001)	(0.602)
Adj R^2	0.158	0.220	0.309	0.075
F-test prob	(0.000)	(0.000)	(0.000)	(0.002)
Durbin-Watson	1.898	1.962	1.637	1.918

b. Cumulative changes in unemployment (per cent)

	2008-9	2008-10	2008-11	2008-12
Agri	-2.024***	-1.224	1.143	2.966*
	(0.040)	(0.343)	(0.419)	(0.072)
Food	1.504***	2.277***	1.088**	0.719
	(0.000)	(0.000)	(0.019)	(0.181)
Lowtech	1.700	1.568	1.729	2.361
	(0.113)	(0.266)	(0.263)	(0.189)
Mehitec	-0.711*	-2.220***	-2.987***	-3.813***
	(0.079)	(0.000)	(0.000)	(0.000)
Finbus	-0.560	-1.157**	-1.026**	-1.015
	(0.158)	(0.027)	(0.073)	(0.128)
Commute	-0.251	-0.197	-0.560**	-0.590**
	(0.151)	(0.390)	(0.027)	(0.044)
Rural	-0.113	-0.186	-0.442**	-0.483**
	(0.385)	(0.277)	(0.019)	(0.028)
Adj R^2	0.158	0.253	0.233	0.250
F-test prob	(0.000)	(0.000)	(0.000)	(0.000)
Durbin-Watson	1.898	2.006	1.937	2.034

Note: shaded cells ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table A2 Real GDP influences and urbanization; individual effects

a. Change in real GDP per capita (per cent)

	2008-9	2009-10	Cumulative 2008-10
Coefficients			
Cities	-0.0504**	0.0041	-0.0509**
Rural	0.0009	-0.0031	-0.0034
Commuting	0.0527**	0.0024	0.0548***
Explained variance			
Cities	0.0243	0.0002	0.0307
Rural	0.0000	0.0003	0.0003
Commuting	0.0264	0.0000	0.0402

b. Change in real GDP (per cent)

	2008-9	2009-10	Cumulative 2008-10
Coefficients			
Cities	-0.0408*	0.0179	-0.0280
Rural	-0.0061	-0.0114	-0.0168
Commuting	0.0538**	0.0060	0.0634***
Explained variance			
Cities	0.0154	0.0041	0.0085
Rural	0.0007	0.0035	0.0066
Commuting	0.0266	0.0005	0.0434

Note: shaded cells ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table A3 Real GDP influences and sectors; individual effects

a. Change in real GDP per capita (per cent)

	2008-9	2009-10	Cumulative 2008-10
Coefficients			
Agriculture	-0.1985	-0.1044	-0.3250**
Food	-0.1746***	-0.0535	-0.2312***
Lowtech	-0.4022**	0.2872*	-0.1714
Mehitec	0.1474**	0.0420	0.1993***
Finbus	0.0194	-0.0566	0.0468
Explained variance			
Agriculture	0.0074	0.0030	0.0245
Food	0.0404	0.0056	0.0876
Lowtech	0.0213	0.0161	0.0048
Mehitec	0.0211	0.0025	0.0477
Finbus	0.0106	0.0061	0.0035

b. Change in real GDP (per cent)

	2008-9	2009-10	Cumulative 2008-10
Coefficients			
Agriculture	-0.2564	-0.1644	-0.4488***
Food	-0.1937***	-0.1028**	-0.2934***
Lowtech	-0.4699**	0.2145	-0.3185*
Mehitec	0.1050	-0.0155	0.1002
Finbus	0.1266**	-0.0182	0.1197**
Explained variance			
Agriculture	0.0119	0.0069	0.0429
Food	0.0480	0.0190	0.1297
Lowtech	0.0280	0.0082	0.0152
Mehitec	0.0103	0.0003	0.0111
Finbus	0.0197	0.0006	0.0208

Note: shaded cells ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

TRADE DATA

Ideally, we would like to report separate measures on the relationship between urbanization, sector composition, and NUTS 2 trade flows. Although we have data available on inter-regional trade flows, the way these data are constructed implies that they are highly correlated with the GDP information we have available. As Thissen, Diodato, and van Oort (2013, p. 3) note regarding this procedure: "The update of the data from 2000 to 2010 is based on the extrapolation of the dataset for 2000 … using constrained nonlinear optimization. The objective function in the nonlinear optimization minimizes the quadratic distance between the coefficients of the new matrix in relation to the coefficients of the matrix of the previous year. .. The optimization is constrained by the regional accounts on gross value added such that total national value added is conform the regional and national accounts."

Figure A1 Production decline is also trade decline, 2009

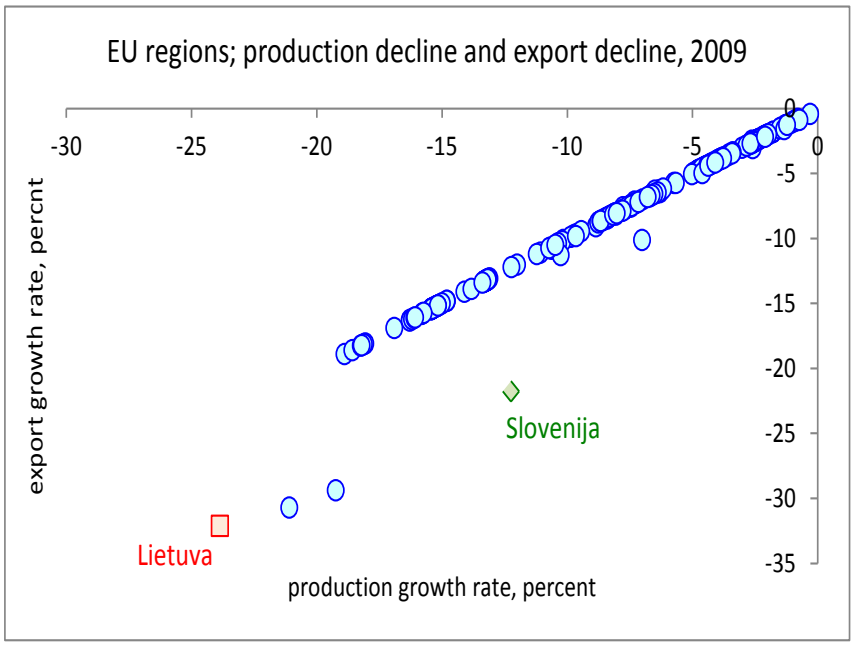


Figure A1 illustrates the implication of this procedure when we relate the relative change in production to the relative change in exports for the regions for which we have data available. In almost all cases the observations are virtually on the same line. It is clear that this information can therefore not be used as a separate indicator on the relation between urbanization, specialization and regional resilience.

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