Institute of Rural Studies

The relation between agricultural and non-agricultural economic development: Technical report on an empirical analysis of European regions

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Zusammenfassung

Die Unterstützung des landwirtschaftlichen Sektors wird unter anderem mit dessen Beitrag für die ländliche wirtschaftliche Entwicklung gerechtfertigt. Die Rolle einer stabilen Landwirtschaft ist aber möglicherweise ambivalent: Positive Impulseffekte könnten ebenso von ihr ausgehen wie negative Konkurrenzeffekte. Unter diesen Bedingungen kann eine sektorale Förderung durch falsche Marktanreize mittel- und langfristig auch negativ auf die allgemeine wirtschaftliche Entwicklung wirken. Der vorliegende Beitrag analysiert den regional differenzierten Zusammenhang zwischen der landwirtschaftlichen und der außerlandwirtschaftlichen Entwicklung empirisch. Das verwendete Panel-Schätzmodel nutzt Daten der regionalen volkswirtschaftlichen Gesamtrechnung der NUTS 3-Regionen der EU27. Es werden verschiedene Entwicklungsregime mit unterschiedlichen Rollen der Landwirtschaft identifiziert. In entwickelten Volkswirtschaften dominieren die Konkurrenzeffekte zwischen den Sektoren, doch gerade in den Regionen Osteuropas mit geringer Produktivität wirkt die Landwirtschaft stabilisierend auf die Entwicklung von Wertschöpfung und Beschäftigung. Daraus ergibt sich die politische Herausforderung, den landwirtschaftlichen Strukturwandel zu unterstützen und gleichzeitig die Entwicklung anderer Sektoren in ländlichen Regionen zu stärken, damit frei werdende Produktionsfaktoren vor Ort genutzt werden können.

JEL: O13, O18, Q10, R12, R15

Schlüsselwörter: Europa, Regionalentwicklung, Strukturwandel, Sektorale Entwicklung, Rolle der Landwirtschaft

Summary

Support of agriculture is justified, among others, by its contribution to rural economic development. Nevertheless, the relation between agricultural and general economic development may be ambiguous. On the one side, agriculture may affect other sectors positively via multiplier and income effects. On the other side, competition effects may arise due to the application of common factors, specifically labour, by agriculture and other sectors. Under these circumstances, support of agricultural production may create distorted market signals and thereby affect the medium and long-term economic development negatively. This research analyses the regionally differentiated relation between the agricultural and the non-agricultural development empirically. The panel estimation model applies data of the common regional accounts from NUTS3 regions of the EU27. It identifies different development regimes with different roles for agriculture. In the most developed economies, competition effects dominate. Nevertheless, in low-productivity regions of Eastern Europe, agriculture stabilises the development of employment and value added. Thereby, policy faces the challenge to support simultaneously structural change in agriculture and the development of other sectors in rural regions.

JEL: O13, O18, Q10, R12, R15

Keywords: Europe, Regional development, structural change, sectoral development, role of agriculture

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1 Introduction

The European Commission partially justifies the Common Agricultural Policy (CAP) of the EU with the CAP's contribution to "viable rural areas": "Agriculture is an irreplaceable element in rural areas and is closely linked to the other driving forces in these regions which determine economic, environmental and social development" (EU COM, 2009). Nevertheless, in fact surprisingly little is known about the true relation between the development of agriculture and the development of the remaining economy in rural areas. The role of agriculture in the rural economy is usually analysed based on cross-sectional or time-series comparisons of the shares of agriculture in regional employment or gross domestic products (GDP) (see for example OECD, 2009a). While the CAP is often superficially justified with reference to the relatively high share of agricultural and food-processing labour in many peripheral regions, it is often criticized for this sectoral approach to rural development, too. Criticism often reflects the generally declining role of agriculture in growing economies. Even scientific studies on rural areas often discuss agricultural employment and employment in other sectors separately, as if they were independent from each other (see e.g., COPUS et al., 2006). Other studies concentrate on specific resource-based industries that are naturally related to agriculture (SABAU and PAQUIET, 2009). Therefore, while it is probably largely undisputed that the "creation of jobs in sectors beyond agriculture can help rural areas in the EU to be part of a smart, sustainable and inclusive economy […]" (FIELDSEND, 2011), the potential role of agriculture in this structural change has been largely unknown thus far. Many critiques of the rural development aims of the CAP therefore oversimplify the discussion of the role of agriculture for the development of rural areas. On the one side, even a declining sector could theoretically be of vital importance for the development of the economy in specific regions. On the other side, a sector's stability may hinder other sectors' growth. Such relations need not be proportional to an industry's share in employment or GDP.

This paper analyses the relationship between the economic developments in- and outside agriculture in the regions of the EU27. This assessment of the actual and potential role of agriculture for the economic development of rural regions must rest on its observed relation to the other sectors' development. However, the observed all-up relation needs to be interpreted with care. An observed positive relation could reflect multiplier- or induction effects of agriculture on other sectors, income- and stabilisation effects of other sectors on agriculture or a common affectedness by general economic development that is not based on a direct causal relation. An observed negative relation, on the other hand, could reflect that the immobility/mobility of agricultural factors restricts/fosters the general economic development or that other sectors with a positive/negative development attract/detract agricultural factors. The reason for the ambiguity of the relation between agricultural development and non-agricultural development therefore lies in the parallel existence of multiplier and income effects on the one hand and competition effects for scarce resources, i.e., land, labour and capital, on the other hand (KILKENNY, 2006).

It has been noticed that multipliers are rarely calculated on a regional level and even less so for rural areas (OECD, 2009b).[1] The reason lies in data restrictions. These restrictions do not allow for a direct calculation of the separate effects that potentially constitute the relation between the developments in the agricultural and in the non-agricultural sector. Moreover, mere multipliers say little about possible allocation effects among different sectors in the process of structural change. The analysis presented in this paper therefore attempts to separate these underlying causes by taking advantage of the time dimension present in the employed panel data. Interpretation further relies on a differentiation of the estimated effects by types of regions or by regional characteristics. Section 2 describes the motivation of the analysis, which creates a solid starting point for a critical assessment of the contribution of agricultural support to the aim of rural development. Section 3 evaluates the state of knowledge about the relation between the regional development of agriculture and other sectors in Europe and Section 4 describes the data situation. Section 5 describes the methodology applied in the analysis; results are presented in Section 6. Section 7 concludes.

[1] Single studies demonstrate that multipliers are higher if there are strong regional ties between agriculture and related sectors (VON MÜNCHHAUSEN, 2006). This is usually much less the case in structurally depressed regions.

2 Support of agriculture on behalf of rural development?

The European Common Agricultural Policy (CAP) is conceptually organised within two pillars. The first pillar addresses the agricultural sector and its market with market interventions, direct income support and other subsidies that may or may not be coupled to production. The second pillar was originally built by three so-called axes with the objectives of improving the competitiveness of the agricultural and forestry sector (Axis 1), the environment and the countryside (Axis 2), and the quality of life in rural areas and encouraging diversification of the rural economy (Axis 3). The 2007-2013 programming period introduced a fourth axis, which is intended to introduce possibilities for innovative governance. Its conceptual importance is currently probably higher than its low budgetary relevance (MARGARIAN, forthcoming).

Originally, the CAP, as implied by its name, had a straight sectoral focus. International pressure to reduce the protection of agricultural markets and especially the General Agreement on Tariffs and Trade (GATT) of the Uruguay Round (1994) brought about needs to replace direct market interventions with ‘green box measures’ that do not directly affect agricultural production. After the Uruguay Round, subsequent pressure from the demands of the World Trade Organisation (WTO) contributed significantly to the Agenda 2000 reforms (SWINBANK and DAUGBJERG, 2006). According to the European Commission, second pillar policies should respond “to needs for structural adjustment generated by reforms in the 1st pillar” (EU COM, 2011). On the farm level, the farm-investment aid and agri-environmental measures address corresponding economic and ecological needs. Related measures originate from early policy reforms in the 1970’s and 1980’s.

Nevertheless, today, one of the main official aims of the CAP is to maintain viable rural areas (see for example EU COM, 2009, 2010). Given this non-sectoral aim, it is quite disturbing that the rural development policy (RP), despite of its multi-dimensional construction, still addresses primarily farms and agricultural production. In the relevant Council regulation[2], the multi-sectoral focus in the economic target-system is restricted to those axis 3-measures that aim at the diversification of the rural economy by “support for the creation and development of microenterprises with a view to promoting entrepreneurship and developing the economic fabric” (EC, 2005: Article 52). A closer look at the opportunities offered under Axis 3 reveals even more restrictions. Support is mainly targeted towards industries related to tourism, recreation, environmental services, traditional rural practices and quality products (EC, 2006: Section 3.3). The quality of life aim of axis 3 seems to rank before the aim of restructuring the rural economy. The

[2] Council regulation on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) (EC, 2005).

competitiveness-target of the horizontal Axis 4 creates other possibilities for support of the wider rural economy. Nevertheless, in total, the concept of multi-functionality of agriculture actually plays a much stronger role than multi-sectorality (MARSDEN und SONNINO, 2008).

The support of agriculture under the aim of rural development in the first and second pillar is usually justified by the relatively large share that agricultural employment still has in many rural European regions (EU COM, 2009), despite its constantly declining relevance. The European Commission (EC) proposed that in "terms of indirect effects, any significant cut back in European farming activity would in turn generate losses in GDP and jobs in linked economic sectors […]. Depopulation in rural areas would probably accelerate." (EU COM, 2010). In a discussion paper by the Directorate-General for Agriculture and Rural Development of the EC (EU COM, 2009) it is argued that "agriculture provides a platform for economic diversification in rural communities". Nevertheless, this actually implies that the decline of agriculture potentially creates an impetus for non-agricultural development. Therefore, while agriculture "is closely linked to the other driving forces in these regions" (ibid.), the direction of this linkage remains open from the dynamic perspective. If non-agricultural sectors were the main drivers of change in rural areas or if it were even the decline of agriculture that opened the potential for the dynamic restructuring of rural areas, subsidies of incomes generated from agricultural activities would not contribute to the necessary restructuring of rural economies but might even inhibit it (KILKENNY, 2006).

All reforms that led from a purely sectoral CAP towards an ambitious Rural Development Policy took place under considerable political pressure from the farmers' well-organised national and supra national interests groups. Thereby, the previous considerations feed the sneaking suspicion that the CAP, at least partly, abuses the official aim of rural development, in order to make excuses for a persisting practice of subsidising farmers' incomes. In light of this situation, the analysis of the true relation between agricultural development and general rural development also serves the aim of creating transparency in a political discussion that is often obscured by the abuse of buzzwords and concepts that are substantiated neither in theory nor in reliable observations.

3 State of knowledge

There are, by now, numerous research projects and studies dealing with employment in rural areas. One is the completed SERA (Study on Employment in Rural Areas) project (COPUS et al., 2006). The report shows that there is significant non-agricultural employment in rural areas. Nevertheless, agricultural and non-agricultural employment is actually discussed in two separate sections of the report. Insights about the relation between agricultural jobs and non-agricultural jobs are not provided. Another project from the European level is RuralJobs, which concentrates on existing examples of rural support measures and thereby applies a relatively traditional, i.e., resource based, view on rural economies (SABAU und PAQUIET, 2009). EDORA is another European research project that deals with the development of rural regions. One of its main propositions is the development towards a New Rural Economy (NRE) with a growing share of secondary and tertiary sector employment (COPUS und HÖRNSTRÖM (eds.), 2011). Nevertheless, the project's concentration on a micro-based case-study approach does not allow for generalisations of its results with respect to the actual role of agriculture in rural development.

Overall, analyses concerning the sectoral dynamics and structural change of rural regions or the dynamic role of agriculture in their development are scarce in Europe. In how far the existing research focus is a reflection of the political environment and especially of the dominance of the CAP in support of rural areas is a question that cannot be answered here. Nevertheless, it is striking that economic research on rural areas has taken quite different routes in North America in the last decades – despite the fact that a sectoral and resource-based approach has often dominated rural policy there, too. This approach is nevertheless unequivocally criticised by some of the main proponents of rural economic analysis (e.g., KILKENNY, 2006; PARTRIDGE et al., 2009). KILKENNY, in her thoughtful discussion of "Linkages between the Agro-food Sector and the Rural Economy" (KILKENNY, 2006), states with respect to North-America that nowadays, cities do not depend on their local farm regions and rural areas do not depend on agriculture any more. Moreover, she also contests the second argument usually proposed by proponents of farm subsidies under the heading of rural development aims: the relation to the important agro-food industry. Her main refutation from a rural development perspective is that the agro-food industry is actually an urban or metropolitan industry (KILKENNY, 2006). At least with respect to the location of headquarters of the large agro-food companies this observation holds true for Europe as well. If, on the other hand, agro-food plants are actually located in farm regions, they are likely to exert monopsonistic market power in opposition to farmers (*ibid.*). One conclusion of PARTRIDGE et al. in their overview on Northern American rural policy and rural policy research is that "[f]arm support programs appear to encourage rural economies to concentrate in sectors that are shedding labour, while weakening nonfarm entrepreneurship. Instead, economic realities of such growing agglomeration economies, technological change, industrial restructuring, and transportation improvements must be central in policy considerations” (PARTRIDGE et al., 2009).

These critical assessments rely on concepts and insights from years of research in northern American rural areas with a spatial rather than a sectoral focus. Irwin et al. give an overview about “A Century of Research on Rural Development and Regional Issues” {IRWIN et al., 2010}. Some of the lessons that the authors find may be drawn from this North American research are:

– “The rural economy is no longer a farm economy”.
– “Rural” vs. ‘urban’ is more than a simple dichotomy. There is a strong interdependence that produces a continuum from dense urban places to remote rural places.”
– “Sector-based policies are neither efficient nor effective rural development policies”.

A striking peculiarity of North American studies on rural economies from a European viewpoint is also the explicit and early consideration of small towns as “economic centres” of rural areas (e.g., DANIELS, 1989; DANIELS and LAPPING, 1987). In Europe, the implicit association of “rural” with villages may partly explain the lack of comprehensive analyses of the rural economy.

4 Data

Another reason for the insufficient knowledge on the dynamics of rural economic development in quantitative terms in Europe is the difficult data situation. While EUROSTAT attempts to provide a homogenous, complete and consistent data basis for all European regions, the gap between aspiration and reality is large. Especially on the lower geographical scales, coverage of time series and geographical areas is usually increasingly incomplete. This might be the main reason why many studies work on the basis of NUTS 2-regions. Nevertheless, such a proceeding is hard to defend if the focus is on rural areas as opposed to urban areas. Most NUTS 2 areas comprise urban as well as rural regions, such that problems of statistical geographical analyses, like the Modifiable Area Unit Problem (MAUP) (OPENSHAW, 1984) and the ecological fallacy (ROBINSON, 1950), become relevant. These statistical problems occur because the observed correlations between variables depend on the size of and the boundaries between the groups of observations that are analysed. Even application of data on the smallest level available on EUROSTAT, remains problematic, because NUTS 3 regions, too, are by no means homogenous entities and the size of NUTS 3 regions in terms of space and population[3] is very heterogeneous.

Despite these problems, the analysis presented in this paper relies on data from the NUTS 3 level due to a lack of alternatives. The database provided by ESPON[4] (the European Observation Network for Territorial Development and Cohesion) is helpful for the assessment of the completeness of data in the dimensions of time, space and industries. Inspection of all data shows that very few indicators simultaneously cover a majority of NUTS 3 regions and enough years to allow for capturing the most rudimentary dynamic effects while at the same time allowing for a broad differentiation among sectors. Therefore, the only data that are acceptable for our panel analysis are data from the regional economic accounts, more precisely the 'Gross value added at basic prices at NUTS level 3' (table nama_r_e3vabp95) and 'Employment (in persons) at NUTS level 3' (table nama_r_e3empl95)[5]. There are significant disadvantages connected with these data, as they are based on different data sources from different spatial levels and often constructed by estimation. Moreover, the creation of regional accounts despite different approaches to homogenise national methods varies technically and in terms of data sources between countries. Current accounts are based on the ESA95 (European System of Accounts) methodology, which is described in annex A of Council Regulation 2223/96.[6]

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3 NUTS 3 regions have between 150,000 and 800,000 inhabitants.

4 Available online at http://database.espon.eu/regional.

5 Available online at http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

6 A reflections of European accounting methods can be found in "Regional Accounts Methods: Gross value-added and gross fixed capital formation by activity" (EUROSTAT, Luxembourg, 1995).

ESA95 uses aggregation levels of the NACE Rev.1.1 classification to define industry breakdowns (NACE stands for Nomenclature générale des Activités économiques dans les Communautés Européennes). Data on Gross Value Added (GVA) and employment are differentiated by the following sectors:

– Agriculture; fishing
– Industry
– Construction
– Wholesale and retail trade; hotels and restaurants; transport
– Services (except extra-territorial organizations)
– Financial intermediation; real estate
– Public administration and community services; activities of households.

Our analysis only differentiates the first sector (agriculture and fishing) and the remaining aggregated sectors. Principally, data are currently (February 2012) available for 1995 to 2008, but for the EU27 data are only sufficiently complete from 2002 on. In the EU, there are 1303 NUTS 3 level regions. The data cover 1287 NUTS 3 level regions. Table 1 supplies descriptive statistics of the most informative indicators on a per country basis.

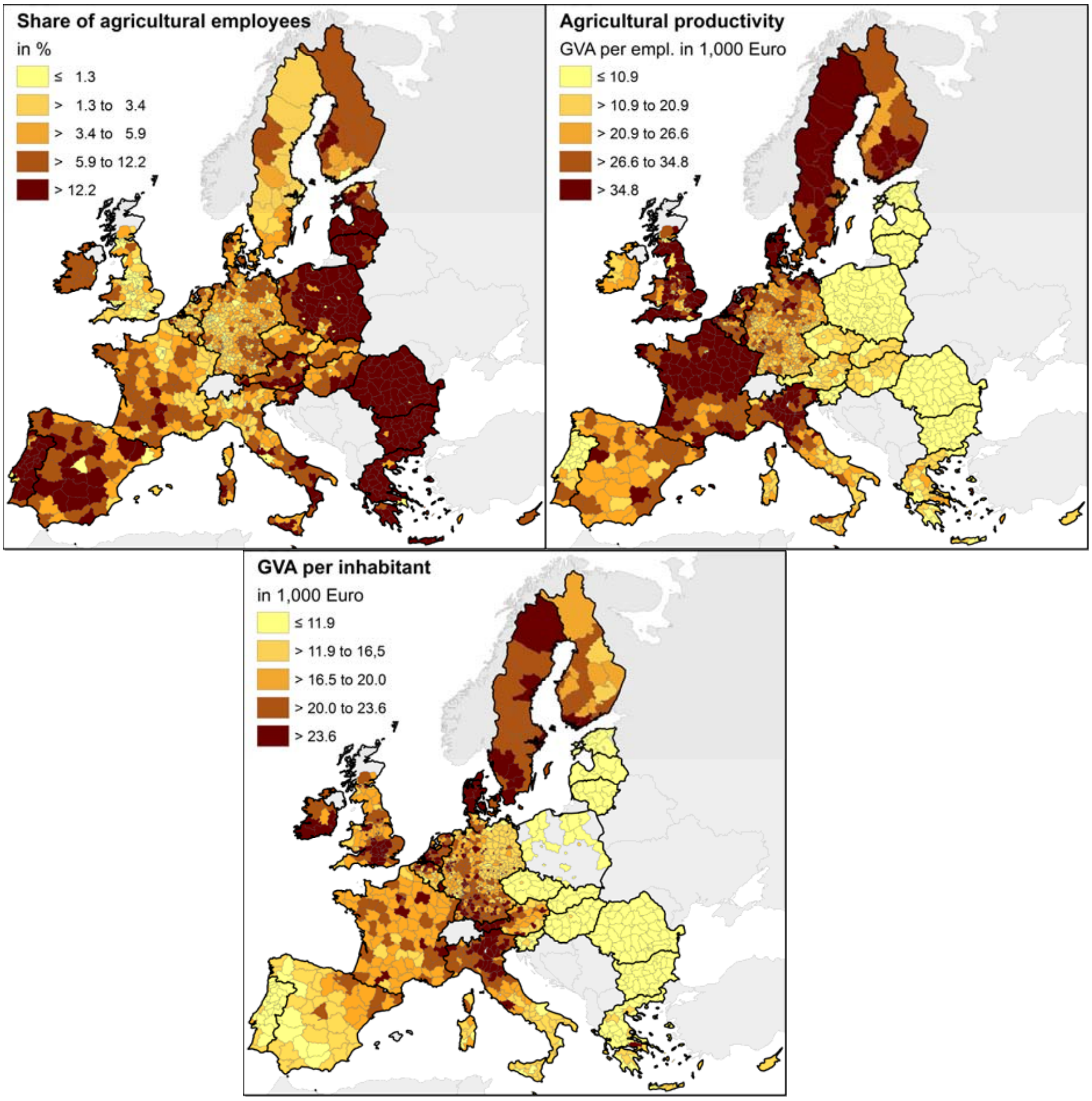
Table 1: Mean values for NUTS 3 regions in countries from the EU27 for 2007 and for changes between 2003 and 2007

Country (Number of Obs.)		Share of agricultural employment %	Share of agricultural GVA %	Agric. GVA per agric. employment 1,000 Euro	GVA per inhabitant 1,000 Euro	Change in scaled agricultural employment %	Change in scaled non-agric. employment %	Change in scaled agric. GVA %	Change in scaled non-agric. GVA %
Austria	AT	10.3	3.2	16.5	25.9	-8.0	6.2	14.3	22.9
	(35)	*(5.9)*	*(2.3)*	*(6.2)*	*(6.9)*	*(4.0)*	*(2.0)*	*(12.6)*	*(4.7)*
Belgium	BE	3.4	1.9	31.9	22.7	-3.0	5.8	-4.1	21.5
	(44)	*(2.5)*	*(1.5)*	*(5.9)*	*(8.2)*	*(4.1)*	*(2.3)*	*(9.8)*	*(3.7)*
Bulgaria	BG	25.1	11.5	2.5	2.6	0.7	9.4	-13.6	53.4
	(28)	*(10.0)*	*(6.0)*	*(1.3)*	*(1.1)*	*(34.1)*	*(9.5)*	*(10.0)*	*(20.2)*
Cyprus	CY	4.5	2.2	17.7	18.5	-6.9	14.1	-15.1	34.6
	(1)	.	.	.	.	.	.	.	.
Czech Republic	CZ	4.1	3.2	16.4	10.4	-11.8	6.0	34.0	53.4
	(14)	*(2.2)*	*(1.8)*	*(5.8)*	*(4.0)*	*(12.9)*	*(3.6)*	*(50.8)*	*(7.3)*
Germany	DE	3.1	1.5	25.0	24.6	-2.4	2.5	12.4	11.8
	(429)	*(2.3)*	*(1.3)*	*(9.1)*	*(9.8)*	*(15.5)*	*(3.2)*	*(24.9)*	*(6.9)*
Denmark	DK	3.1	1.4	29.0	32.6	-6.1	5.6	-5.6	18.1
	(11)	*(1.8)*	*(0.9)*	*(5.5)*	*(7.9)*	*(6.4)*	*(1.6)*	*(49.1)*	*(1.8)*
Estonia	EE	6.5	5.7	15.1	8.4	4.5	9.8	48.9	75.2
	(5)	*(4.7)*	*(4.3)*	*(4.6)*	*(4.0)*	*(53.7)*	*(2.3)*	*(11.2)*	*(4.0)*
Spain	ES	7.2	5.0	29.2	20.3	-3.7	17.6	0.5	35.4
	(59)	*(5.2)*	*(4.0)*	*(6.3)*	*(4.2)*	*(19.6)*	*(6.2)*	*(12.6)*	*(5.9)*
Finland	FI	7.2	4.9	38.8	26.6	0.0	6.2	23.1	23.3
	(20)	*(3.2)*	*(2.7)*	*(9.9)*	*(5.1)*	*(7.6)*	*(2.3)*	*(20.3)*	*(9.2)*
France	FR	4.7	3.8	44.5	23.6	-7.5	3.9	7.0	18.1
	(100)	*(3.0)*	*(2.7)*	*(19.3)*	*(7.9)*	*(7.4)*	*(3.4)*	*(21.8)*	*(4.3)*
Greece	GR	20.9	6.7	14.1	15.7	-10.6	12.8	-17.9	33.3
	(51)	*(10.3)*	*(3.5)*	*(7.0)*	*(3.4)*	*(21.7)*	*(16.0)*	*(16.9)*	*(12.3)*
Hungary	HU	9.8	6.7	11.0	7.0	62.2	2.2	27.7	28.3
	(20)	*(3.8)*	*(3.3)*	*(2.8)*	*(3.2)*	*(49.4)*	*(11.0)*	*(27.2)*	*(9.9)*
Ireland	IE	7.1	2.1	20.5	34.9	-2.6	20.4	-15.5	36.2
	(8)	*(2.9)*	*(1.0)*	*(5.6)*	*(10.7)*	*(9.4)*	*(5.5)*	*(13.8)*	*(9.4)*
Italy	IT	6.0	3.1	30.1	22.3	1.8	4.2	-5.8	17.3
	(107)	*(4.3)*	*(2.0)*	*(10.9)*	*(5.6)*	*(14.8)*	*(4.2)*	*(12.5)*	*(5.0)*
Lithuania	LT	13.9	6.5	6.2	6.2	-37.9	19.9	33.3	64.9
	(10)	*(6.5)*	*(4.0)*	*(1.8)*	*(2.4)*	*(12.5)*	*(8.8)*	*(12.2)*	*(13.5)*
Luxembourg	LU	1.6	0.4	25.9	72.1	8.3	13.9	-4.7	45.8
	(1)	.	.	.	.	.	.	.	.
Latvia	LV	12.6	6.5	8.8	6.8	-19.5	18.8	106.7	120.6
	(6)	*(6.2)*	*(4.2)*	*(7.7)*	*(3.6)*	*(11.5)*	*(9.7)*	*(82.6)*	*(29.2)*
Malta	MT	4.0	3.8	25.9	10.1	8.1	5.9	-8.1	20.3
	(2)	*(2.5)*	*(2.2)*	*(3.5)*	*(2.7)*	*(11.4)*	*(2.3)*	*(23.8)*	*(4.2)*
Netherlands	NL	4.0	3.0	50.4	28.3	-6.6	2.3	7.9	18.8
	(40)	*(2.4)*	*(2.8)*	*(15.2)*	*(6.2)*	*(14.4)*	*(3.5)*	*(12.1)*	*(5.1)*
Poland	PL	16.6	6.1	6.1	7.7	-10.1	16.4	55.8	59.4
	(66)	*(12.1)*	*(4.7)*	*(3.0)*	*(4.1)*	*(14.3)*	*(10.1)*	*(21.2)*	*(10.7)*
Portugal	PT	19.7	4.8	9.0	11.7	-8.3	1.0	-7.0	18.9
	(30)	*(13.8)*	*(3.4)*	*(8.1)*	*(3.6)*	*(14.8)*	*(3.3)*	*(10.6)*	*(8.2)*
Romania	RO	32.9	9.2	3.7	4.5	-17.6	9.5	18.0	151.2
	(42)	*(15.8)*	*(4.0)*	*(2.6)*	*(1.9)*	*(22.4)*	*(8.5)*	*(29.1)*	*(24.1)*
Sweden	SE	3.1	2.8	56.3	29.3	-9.1	3.5	6.3	19.7
	(21)	*(1.5)*	*(1.4)*	*(15.5)*	*(4.1)*	*(16.9)*	*(2.1)*	*(16.2)*	*(4.8)*
Slovenia	SI	11.2	3.6	9.2	13.3	-9.4	4.4	38.0	33.0
	(12)	*(5.0)*	*(2.0)*	*(1.9)*	*(3.2)*	*(8.7)*	*(3.2)*	*(8.9)*	*(4.9)*
Slovakia	SK	4.0	4.8	25.1	9.5	-13.8	6.2	68.7	86.3
	(8)	*(1.7)*	*(2.8)*	*(6.4)*	*(5.3)*	*(7.3)*	*(5.5)*	*(35.7)*	*(20.0)*
United Kingdom	UK	1.9	1.2	23.8	26.9	28.2	3.5	-10.4	23.6
	(128)	*(2.4)*	*(1.9)*	*(20.1)*	*(13.0)*	*(104.3)*	*(17.1)*	*(42.3)*	*(8.7)*

Note: Standard deviations in brackets below values
Source: Own table.

The distribution of some selected indicators in space is shown by the following maps (Map 1 and Map 2).

Map 1: Spatial distribution of selected static indicators for the EU27 (2002)

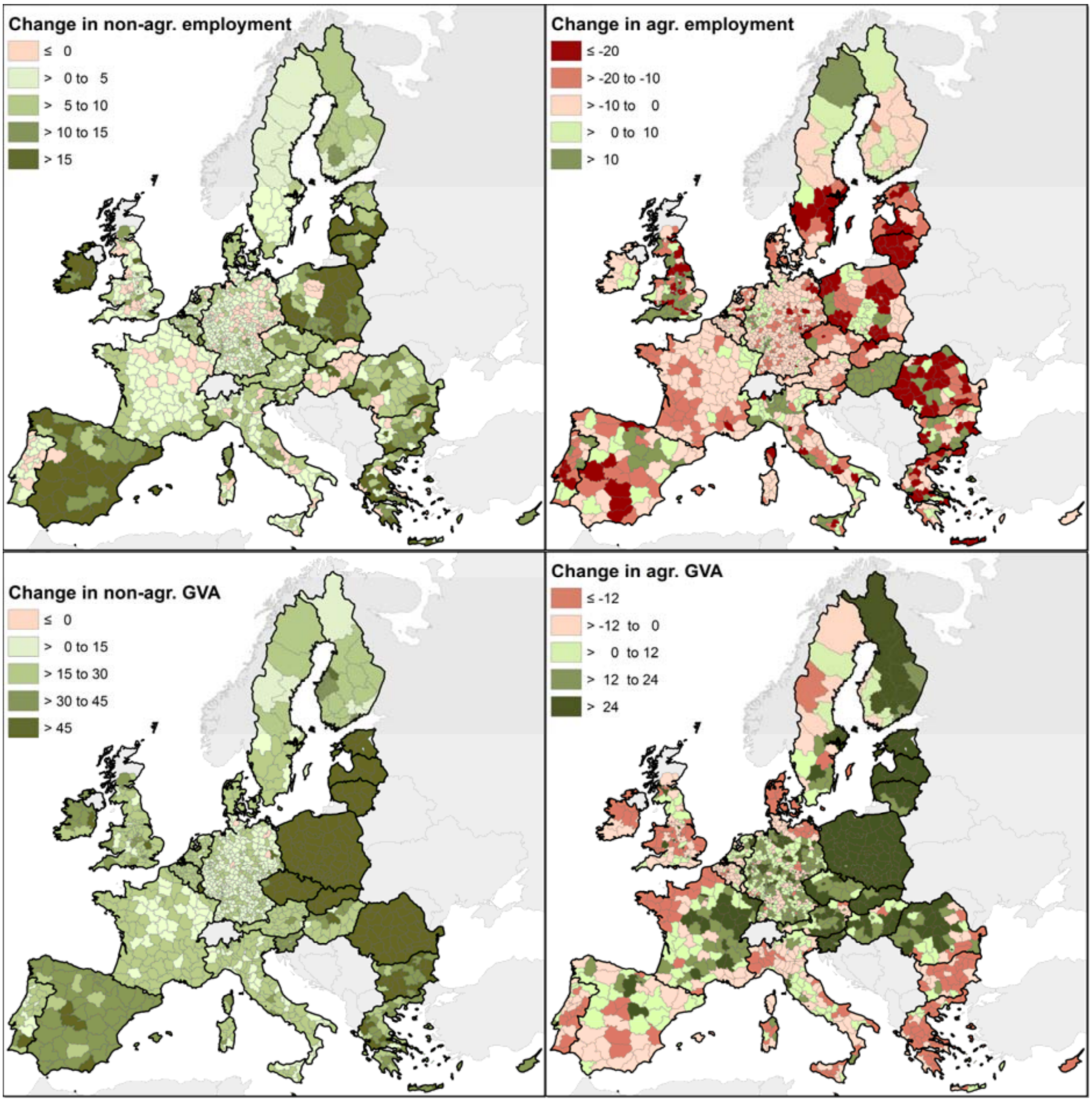


Note: Grey areas within regions of the EU27 denote missing values.
Source: Own map based on regional economic accounts (EUROSTAT). NUTS Level 3 (Geodan IT, 2004).

Map 1 shows the actual economic relevance of the agricultural sector in terms of the share of employment and labour-productivity for the Nuts 3 level of Europe's regions. It also shows the general economic productivity in terms of GVA per inhabitant. Agricultural and general productivity is markedly higher in Europe's northwestern regions than in the east. Considering the apparent heterogeneity, the relative strength of the possible relations between agriculture and other sectors is expected to differ between regions as well. As

Map 2 shows, there is no obvious, linear relationship between the general development of employment or GVA and the development of agricultural employment or GVA.

Map 2: Percentage change in employment and GVA in 2003 to 2007



Note: Grey areas within regions of the EU27 denote missing values.
Source: Own map based on calculated values (source see Map 1). NUTS Level 3 by Geodan IT, 2004.

The relation between the share of agricultural employment and agricultural productivity on the one hand, and of the development of agricultural and general employment on the other, is not clear-cut either.

The detailed analysis needs to differentiate different effects in order to interpret the observed gross relation between agricultural development and the development of other sectors. For the estimation, regions were classified based on quintiles from the indicators ‘agricultural productivity’ and ‘share of agricultural employees’. Combinations of these five x five classes permitted a finer classification of 25 classes (Table 2).

Table 2: Classification of regions by quintiles of agricultural productivity and share of agricultural employment

Quintiles of share of agric. employees	Quintiles of agricultural productivity					
	1	2	3	4	5	**Total**
1	**33** 12.6	**61** 23.28	**50** 19.08	**50** 19.08	**68** 25.95	**262** **100**
2	**10** 3.89	**44** 17.12	**64** 24.9	**63** 24.51	**76** 29.57	**257** **100**
3	**12** 4.65	**52** 20.16	**59** 22.87	**78** 30.23	**57** 22.09	**258** **100**
4	**27** 10.51	**56** 21.79	**63** 24.51	**58** 22.57	**53** 20.62	**257** **100**
5	**178** 67.94	**46** 17.56	**23** 8.78	**10** 3.82	**5** 1.91	**262** **100**
Total	**260** 20.06	**259** 19.98	**259** 19.98	**259** 19.98	**259** 19.98	**1,296** **100**

Source: Own table

The following table shows the distribution of regions within countries among these 25 classes.

Table 3: Distribution of regions among classes by country (in percent)

	Class 'Share of agricultural employment'																										
	1					2					3					4					5						
	Class 'Agricultural productivity'																										
Country	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Sum	**N**
Austria			3			3	6				6	6				9	17	6			20	23	3			100	**35**
Belgium				9	2		2	7	27	14				11	7			5	7	7					2	100	**44**
Bulgaria											4										96					100	**28**
Cyprus																	100									100	**1**
Czech Republic	7					21	14					21				21	14									100	**14**
Germany	2	10	8	7	3		6	11	6	1		8	10	9	1		5	7	4	2						100	**429**
Denmark	9				9			18		9				9	27				9	9						100	**11**
Estonia						40										20					40					100	**5**
Spain			7			2	3	7	3	3			7	10	2		6	17	3	2		3	12	12	2	100	**59**
Finland					5									10	15			5	40	15			10			100	**20**
France	3			3	2		2		5	16		1	1	8	19			2	15	19			2		2	100	**100**
Greece			2									2	2				4				37	39	12	2		100	**51**
Hungary		5					5				5	30				10	30				15					100	**20**
Ireland			13														25	63								100	**8**
Italy			1	3	4		1	2	6	12		3	8	7	7		9	8	7	8		11	3			100	**107**
Lithuania																10					90					100	**10**
Luxembourg										100																100	**1**
Latvia	17																				83					100	**6**
Malta									50										50							100	**2**
Netherlands				5	8			3	5	20		3	3	13	18				3	20					3	100	**40**
Poland	12					3					7					14					65					100	**66**
Portugal		3					7				3					10		3			53	10	3	7		100	**30**
Romania	2																				98					100	**42**
Sweden			5						14	39				10	19			5	5	5						100	**21**
Slovenia											8					33					50	8				100	**12**
Slovakia							13				25	13				13	38									100	**8**
United Kingdom	9	12	6	6	36	1	2	2	4	13		1		4	2			2	1	1						100	**126**
Total	**3**	**5**	**4**	**4**	**5**	**1**	**3**	**5**	**5**	**6**	**1**	**4**	**5**	**6**	**4**	**2**	**4**	**5**	**4**	**4**	**14**	**4**	**2**	**1**	**0**	**100**	**1,296**

Source: Own table.

Only few additional variables were employed for the estimation because each indicator shows missing values for some regions and thereby implies a loss of observations for the estimation. The variables employed in the two models estimated are constructed from only four indicators: agricultural employment, non-agricultural employment, GVA of agriculture and non-agricultural GVA. The derived variables are:

a) for the model that analyses the relation between the development of agricultural and non-agricultural employment:

- annual scaled change in non-agricultural employment (endogenous variable),
- annual scaled change in agricultural employment between 2002 and 2008,
- lagged and lead-version of this variable,
- quadratic terms of these variables,
- mean scaled change in agricultural employment between 2002 and 2008,
- classes constructed from quintiles on agricultural productivity and share of agricultural employees (table 2),
- interactions of the annual scaled changes (incl. lagged and lead version) with the 25 classes.

b) for the model that analyses the relation between the development of agricultural and non-agricultural GVA:

- annual scaled change in non-agricultural GVA (endogenous variable),
- annual scaled change in agricultural GVA between 2002 and 2008,
- lagged and lead-version of this variable,
- quadratic terms of these variables,
- mean scaled change in agricultural GVA between 2002 and 2008,
- agricultural GVA per agricultural employee (agricultural productivity),
- share of agricultural employees in all employees,
- interaction between agricultural productivity and share of agricultural employees and
- interactions of the annual scaled changes (incl. lagged and lead version) with the agricultural productivity and share of agricultural employees.

5 Methodology

The analysis takes advantage of the panel structure of the data available and exploits the cross-sectional distribution as well as the distribution in time. The broad geographical coverage of the data allows for the estimation of heterogeneous effects in space and the time-series character of the data allows for a partial separation of the observed gross effect into effects directed from agriculture towards other sectors on the one hand and effects directed from other sectors towards agriculture on the other.

5.1 The spatially differentiated effect in a geographically weighted regression (GWR)

The existence of spatially heterogeneous effects between the development within agriculture and outside agriculture has been tested in advance based on the observed gross effects within a geographically weighted regression (GWR) model. A cross-sectional model that did not exploit the panel character of the data at hand, explains the relative change of non-agricultural employment [GVA] in the years between 2003 and 2007 in relation to the level of employment [GVA] in 2002 by the same relative change in agricultural employment [GVA]. Spatial weights were calculated with a bi-square spatial weighting function, while the distances are calculated with respect to the geographical coordinates of the NUTS 3-areas' midpoints. Table 4 presents results of spatially un-weighted OLS regressions and the GWR.

The table shows that the OLS- and the GWR estimation both identify a significant negative gross-relation between the relative changes of agricultural and non-agricultural employment, and likewise a significant positive gross-relation between the relative changes of the agricultural and the non-agricultural GVA. The results show also that the explanatory power of this simple model has been raised considerably by allowing for spatial variations in the estimated coefficients: R-square has been raised from 0.12 to 0.69 respectively from 0.04 to 0.38, and the Akaike Information Criterium (AIC) diminishes from 620 to -653 respectively from -2622 to -3130.

Table 4: Results of cross-sectional OLS- and GWR-regressions

	OLS estimator	GWR estimator		
		Minimum	Median	Maximum
Explanation of change in scaled non-agricultural **GVA** 2002 to 2007				
Constant	0.30 *** *(0.01)*	0.16	0.20	1.25
Change in scaled agricultural GVA	4.11 *** *(0.32)*	-5.38	2.91	11.14
R-square	0.12	0.69		
AIC	620	-653		
Explanation of change in scaled non-agricultural **employment** 2002 to 2007				
Constant	0.06 *** *(0.00)*	0.02	0.04	0.29
Change scaled agricultural employment	-0.24 *** *(0.04)*	-1.89	-0.34	27.00
R-square	0.04	0.38		
AIC	-2,622	-3,130		

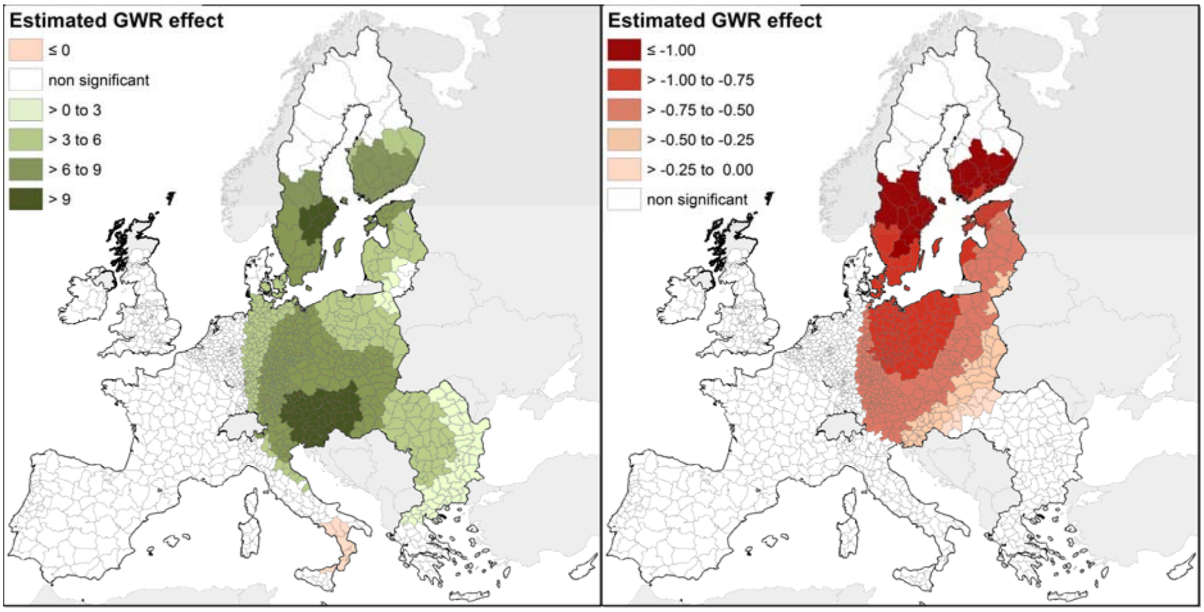
Note: Standard errors in parentheses; Significance: °: 10%, *: 5%, **: 1%, ***: 0.1%
Source: Own table; calculated with SAM v4.0 (RANGEL et al., 2010)

Map 3 presents the spatial distribution of the significant coefficients estimated within the GWR-regression. Obviously, positive correlations dominate the observed gross relation between agricultural and non-agricultural changes in GVA and negative correlations dominate the relation in the developments of employment. Obviously, the positive estimated coefficient of the GVA model mainly reflects the existing coincidence between a generally positive development of agricultural GVA on the one hand and of non-agricultural GVA on the other hand. This coincidence is not due to a causal relationship but rather to the generally rising technical efficiency of production (compare Map 2). A similar non-causal coincidence underlies the negative estimated coefficients in the employment model, as in structural change agricultural employment generally declines, while non-agricultural employment more often grows (compare Map 2).

The maps show that there are significant gross relations between the developments within and outside of agriculture in the central-eastern regions of Europe. There is a gravity centre in the north for the negative relation between the developments of agricultural and non-agricultural employment, and one northern and one southern gravity centre each for the positive relation between the developments of agricultural and non-agricultural GVA.

Map 3: Spatial distribution of significant coefficients from the GWR estimation

GVA Employment



Note: Values are presented for those coefficients with a significance level of 10% or lower.
Source: Own maps. NUTS Level 3 by Geodan IT, 2004.

Given the general correlations discussed above, the insignificance of coefficients in large parts of western Europe is remarkable.

Nevertheless, GWR-models do not provide explanations for the heterogeneous effects they provide. Therefore, we relied on panel models that were set up in order to estimate the regionally differentiated relations between the agricultural and non-agricultural developments with the help of interaction effects.

5.2 Control of endogeneity and unobserved variable biases

As outlined in the data section, the availability of data for the analysis of the relation between non-agricultural and agricultural development is restricted at the European level. Therefore, many important influences that relate to the regional development of the agricultural and non-agricultural sector cannot be controlled directly. A naïve estimation that relates the observed absolute change in the agricultural sector to the observed absolute change in the non-agricultural sector (see Section 5.1) would inevitably lead to the unobserved variable bias with biased estimators. Usually, with panel data, this problem is approached by fixed effect estimation. The fixed effect approach relies on the inclusion of dummy variables for each single observational unit, in our case regions, and for each single unit in time – years in our case. Alternatively, differences are taken from all endogenous and exogenous variables in t+1 with respect to t. Both approaches eliminate all time constant influences. The annual dummies control all annual changes in unobservables that are common to all observational units.

While the fixed effect model is a workhorse of modern statistical policy analyses, it nevertheless suffers from some disadvantages. Two important aspects from our point of view are that dynamic unobservables, which relate to the developments under scrutiny, are not controlled for and, even more important, that heterogeneous effects may not be identified. This second problem implies that if the effect is positive in some regions and negative in some others, the fixed effect model might only identify a non-significant overall effect. The inability of fixed effect model to identify heterogeneous effects stems from its constituent characteristics, as it does not allow for the consideration of constant differences in regional characteristics. An apparent advantage thereby turns into a potential disadvantage. A simple introduction of interactions with time-constant effects in the fixed effects model re-introduces the unobserved time-constant influences through the back door and thereby destroys the immunisation of the model from biases of time-constant unobservables. Because such interaction effects are necessary in order to identify heterogeneous estimators, the fixed effects approach was dismissed for the problem at hand.

Instead, time-constant variables that characterise the different regions were introduced into the panel model in their raw form and in their interacted form. This proceeding controls for the time-constants' own influence, such that it does not confound the estimated heterogeneous effect. In order to minimise the non-observed variable bias, the time varying, explanatory variables, i.e. the annual change in agricultural employment respectively GVA, were transformed such that the probability for a correlation with influential unobservables was minimised. Table 5 gives an overview of the related values of endogenous and exogenous variables on different steps of transformation.

Table 5: Transformed values of the time-varying variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Scaled non-agricultural employment	8,912	0.9405	0.1318	0.2259	4.2667
Scaled agricultural employment	8,912	0.0808	0.1040	0.0000	0.7787
Annual change in scaled non-agric. employment	7,615	0.0111	0.0785	-3.2578	3.2733
Annual change in scaled agric. employment	7,615	-0.0016	0.0182	-0.2822	0.2604
Mean regional change in scaled agric. employment	7,615	-0.0016	0.0065	-0.0615	0.0451
Annual deviation from mean regional change in scaled agricultural employment	**7,615**	**0.0000**	**0.0170**	**-0.2207**	**0.2176**
Regional deviation from mean change in scaled agricultural employment	7,615	0.0000	0.0065	-0.0599	0.0467
Variable	Obs	Mean	Std. Dev.	Min	Max
Scaled non-agricultural GVA	8,937	1.0995	0.2111	0.6126	4.0161
Scaled agricultural GVA	8,937	0.0460	0.0606	-0.0546	0.7578
Annual change in scaled non-agricultural GVA	7,645	0.0549	0.0839	-0.3380	1.0374
Annual change in scaled agricultural GVA	7,645	0.0009	0.0177	-0.2598	0.4746
Mean regional change in scaled agric. GVA	7,645	0.0009	0.0057	-0.0199	0.0667
Annual deviation from mean regional change in scaled agricultural GVA	**7,645**	**0.0000**	**0.0167**	**-0.3265**	**0.4079**
Regional deviation from mean change in scaled agricultural GVA	7,645	0.0000	0.0057	-0.0208	0.0658

Source: Own calculation

Firstly, scaling was used in order to eliminate spurious effects that result from the different sizes of regions and their correlation with changes in agricultural developments. Therefore, division by the same all-sector values within the non-agricultural sector in the base period (2002) in the same region scales the absolute regional values on sectoral employment and GVA. In other words, the left- and right-hand side variables were both related to the same common base value in the base year in the region. With the scaling of exogenous and endogenous variables by a common value, a one-to-one relation between the scaled changes in agriculture and in other sectors is realised. The first two lines for employment and GVA in table 5 illustrate the character of the scaled size of employment and GVA. Obviously, the scaled value may be larger than one, as the original non-transformed value grows in the course of time. The scaled values may therefore not be interpreted as shares. The scaled values of employment and GVA are calculated as

$$sNonAgric_{it} = NonAgric_{it} / Total_{it0} \quad (1)$$

$$sAgric_{it} = Agric_{it} / Total_{it0} \quad (2)$$

with the prefix *s* indicating the scaled variables, $Agric_{it}$ as the size in agricultural employment or GVA in region *i* at time *t*, $NonAgric_{it}$ as the size of non-agricultural employment or GVA in region *i* at time *t* and $Total_{it0}$ as the size of overall employment or GVA in the region in the base year.

Secondly, first differences were taken in order to eliminate the trend in the scaled change. This implies that changes directly explain changes in the model. The trend in regional developments probably has a strong correlation with unobserved regional characteristics. By detrending, this possible source of an omitted variable bias is eliminated. The third and fourth lines in Table 5 illustrate the differenced scaled values of the sizes of employment and GVA. With the values created in equations (1) and (2) the changes are calculated as

$$ChangeNonAgric_{it} = sNonAgric_{it} - sNonAgric_{it-1} \tag{3}$$

$$ChangeAgric_{it} = sAgric_{it} - sAgric_{it-1} \tag{4}$$

with the index *t-1* indicating the previous period.

Additional to the original trend, there may also be a trend in the change itself. This possible non-stationarity causes cross-sectional differences in the level of change between different regions in the panel-model. These differences would possibly relate to non-observed regional characteristics as well. Therefore, the changes calculated in equations (3) and (4) have been centred to their regional mean. This group mean centring (ENDERS and TOFIGHI, 2007) removes the second non-stationarity and has the desired effect that, like in the fixed effects model, changes in a region's endogenous variables are explained by changes of the region's exogenous variable and not by cross-sectional differences in changes. Accordingly, group-mean centring seems appropriate, because we are mainly interested in the impact of the annual agricultural change within a region on the annual non-agricultural change within the same region (see ENDERS and TOFIGHI, 2007). The values of the annual deviations from the regional mean level of change that are calculated by group mean centring are presented in the sixth lines in Table 5:

$$cChangeAgric_{it} = ChangeAgric_{it} - \overline{ChangeAgric_i} \tag{5}$$

with $\overline{ChangeAgric_i} = \sum_t ChangeAgric_{it} \big/ t$.

The regional mean-values are additionally re-introduced as time-constant explanatory variables into the model. These regional mean values are centred on the overall mean of the level of changes in all regions (grand mean centring, ENDERS and TOFIGHI, 2007).

$$\overline{cChangeAgric_i} = \overline{ChangeAgric_i} - \overline{\overline{ChangeAgric}} \tag{6}$$

with $\overline{\overline{ChangeAgric}} = \sum_i \overline{ChangeAgric_i} \big/ i$.

Grand mean centring is also applied to all other time-constant non-dummy explanatory variables, i.e. to agricultural productivity and the share of agricultural employment. It does not affect the significance or the values of the estimated coefficients but it facilitates the interpretation of the non-linear model.

Centring of the time-varying exogenous variables had to be conducted before multiplication for the creation of quadratic and interaction terms. This order enables the calculation of common derivatives and thereby allows for the calculation of the correct standard errors and significances after the estimation (AIKEN and WEST, 1991). On the other hand, it should be noted that centring is far from innocuous in multi-level models (like panel models) (PACCAGNELLA, 2006), and centring before the multiplication might re-introduce the cross sectional effect that stems from differences between rather than from differences within regions. The regional mean-values in the model therefore also serve as controls for this cross sectional effect.

The last transformation of the time-varying explanatory variables, i.e., of the annual change of agricultural employment and GVA in the regions, for the prevention of spurious correlation was the introduction of the variables' lagged and leading forms. Accordingly, the agricultural development is related to the non-agricultural development in each the previous period t-1 (lagged version of the explanatory variable), in the contemporaneous period t and in the following period t+1 (leading version of the explanatory variable). Additionally, as in most fixed effects models, a dummy variable for each year was introduced into the model in order to control for those unobserved time-varying effects that affect all regions likewise.

Additionally to the linear effect, a quadratic effect is allowed for all explanatory variables. Equation (7) illustrates a simplified model with time-varying effects only and without interaction effects:

$$\begin{aligned} ChangeNonAgric_{it} &= \beta_{00} + \beta_{01} cChangeAgric_{it-1} + \beta_{02} cChangeAgric_{it-1}^{2} \\ &+ \beta_{03} cChangeAgric_{it} + \beta_{04} cChangeAgric_{it}^{2} \\ &+ \beta_{05} cChangeAgric_{it+1} + \beta_{06} cChangeAgric_{it+1}^{2} + u_{i0} + e_{it} \end{aligned} \tag{7}$$

The indices denote region (i) and time (t). Estimated coefficients are denoted by β_{it}. The two zeros in the first coefficient indicate the over-all intercept that is not affected by time or region. The zeros in the indices' first position of the other coefficients indicate that the estimators in this model are not related to cross-sectional differences but only measure the time-varying effects.

The model includes two error terms: u_{i0} as the clustered regional-level error term and e_{it} as the residual. These error terms were estimated in a pooled OLS-regression with cluster-robust standard errors in STATA. The alternative was a specification as a random effects panel model, which is slightly less robust against violations of the standard assumptions concerning the distribution of the residuals. A comparison of both model types showed that results are very similar. The cluster option in STATA takes into account the dependence of observations within regions in that it calculates the standard errors based on the differences between regions; in contrast to observations within regions, observations between regions are assumed to be independent. With the cluster specification, STATA estimates the standard errors using the Huber-White sandwich estimators. It corrects for minor violations of standard assumptions concerning the distribution of residuals (UCLA, 2012).

Interaction effects are introduced in order to capture the expected heterogeneous relation between the main explanatory variables and the endogenous variable. In the following presentation of the model equation, the main explanatory variable on the annual development in agriculture is not differentiated into its lagged, current and leading version in order to keep the model presentation clear and concise. Actually, all terms in the equations that refer to the agricultural change need to be added two more times, first with the lagged version of the variable and the second time with the leading version of the variable. The model equations in the simplified form are the following:

a) Explanation of changes in GVA

$$\begin{aligned} ChangeNonAgric_{it} = {} & \beta_{00} + \beta_{10}\overline{cChangeAgric}_{i0} \\ & + \beta_{20} cShareAgric_{i0} + \beta_{30} cAgric\Pr od_{i0} \\ & + \beta_{40} cShareAgric_{i0} cAgric\Pr od_{i0} \\ & + \beta_{01} cChangeAgric_{it} + \beta_{02} cChangeAgric_{it}^2 \\ & + \beta_{11} cChangeAgric_{it} cShareAgric_i \\ & + \beta_{21} cChangeAgric_{it} cAgric\Pr od_i + u_{i0} + e_{it} \end{aligned} \tag{8}$$

b) Explanation of changes in employment

$$\begin{aligned} ChangeNonAgric_{it} = {} & \beta_{00} + \beta_{10}\overline{cChangeAgric}_{i0} + \beta_{20}\operatorname{Re} gClass_{i0} \\ & + \beta_{01} cChangeAgric_{it} + \beta_{02} cChangeAgric_{it}^2 \\ & + \beta_{11} cChangeAgric_{it}\operatorname{Re} gClass_j \\ & + \beta_{12} cChangeAgric_{it}^2\operatorname{Re} gClass_j + u_{i0} + e_{it} \end{aligned} \tag{9}$$

with the prefix c denoting centred variables and

$cShareAgric_i = ShareAgric_i - \overline{ShareAgric}$ and

$cAgric\Pr od_i = Agric\Pr od_i - \overline{Agric\Pr od}$

with $\overline{ShareAgric} = \sum_i ShareAgric_i \Big/ i$ and $\overline{Agric\Pr od} = \sum_i Agric\Pr od_i \Big/ i$.

The indices show that all indicators describe the regional level. $ShareAgric_i$ is the regional share of agricultural employees from all employees, $AgricProd_i$ is the agricultural productivity (GVA per employee) and $RegClass_i$ is the classificatory variable with those 25 classes that were constructed from the five quintiles each of agricultural productivity and share of agricultural employment (see Table 2). The terms u_{i0} and e_{it} describe the residuals, whereby the clustering of observations within regions is taken into account by the introduction of the region-level residuum u_{i0}.

The first model for the explanation of the development of GVA characterises the regions by agriculture's productivity, the share of agricultural employment and the interaction of these two. This simple characterisation did not deliver similar satisfactory results for the explanation of the development of employment in the second model. Instead, in the second model, regions are characterised by those 25 classes that were constructed based on the quintiles from the indicators 'agricultural productivity' and 'share of agricultural employment' (see Tables 2 and 3). This classification allows for a much more detailed characterisation in terms of the interplay of the two indicators. Both indicators, the share of agricultural employment as well as agricultural productivity, correlate strongly with other regional characteristics that remain unobserved in the model. They are therefore employed in order to characterise the regions but the estimated coefficients that relates them to the non-agricultural changes need to be interpreted with care. In the following, these time-constant variables are usually treated as moderator variables in interaction terms (PREACHER et al., 2006), which allow for the estimation of differentiated effects of the time-varying variables but are not interpreted themselves.

Working with interaction effects introduces some specific difficulties in the interpretation of coefficients as the different coefficients need to be combined, and the effect and its significance often depend on the level of the intervening variable itself (Table 6). Standard errors, too, need to be corrected taking into account the correlation of variables with the interacted terms. In the calculation of the significance of estimated overall effects, the covariance between distinct estimators has been taken into account as outlined in Table 6. We present marginal all-up effects, the combined significance of which is evaluated separately for each observation.

Table 6: Calculation of marginal effects and variances for various interaction models

Case	Equation	Marginal Effect	Variance
1a	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 XZ$	$\frac{\partial Y}{\partial X} = \beta_1 + \beta_3 Z$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + Z^2 var(\hat{\beta}_3) + 2Z cov(\hat{\beta}_1 \hat{\beta}_3)$
1b	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 XZ$	$\frac{\partial Y}{\partial Z} = \beta_2 + \beta_3 X$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_2) + X^2 var(\hat{\beta}_3) + 2X cov(\hat{\beta}_2 \hat{\beta}_3)$
2	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 W + \beta_4 XZ + \beta_6 ZW$	$\frac{\partial Y}{\partial X} = \beta_1 + \beta_4 Z$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + Z^2 var(\hat{\beta}_4) + 2Z cov(\hat{\beta}_1 \hat{\beta}_4)$
3	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 W + \beta_4 XZ + \beta_5 XW + \beta_6 ZW$	$\frac{\partial Y}{\partial X} = \beta_1 + \beta_4 Z + \beta_5 W$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + Z^2 var(\hat{\beta}_4) + W^2 var(\hat{\beta}_5) + 2Z cov(\hat{\beta}_1 \hat{\beta}_4) + 2W cov(\hat{\beta}_1 \hat{\beta}_5) + 2ZW cov(\hat{\beta}_4 \hat{\beta}_5)$
4	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 W + \beta_4 XZ + \beta_5 XW + \beta_6 ZW + \beta_7 XZW$	$\frac{\partial Y}{\partial X} = \beta_1 + \beta_4 Z + \beta_5 W + \beta_7 ZW$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + Z^2 var(\hat{\beta}_4) + W^2 var(\hat{\beta}_5) + Z^2 W^2 var(\hat{\beta}_7) + 2Z cov(\hat{\beta}_1 \hat{\beta}_4) + 2W cov(\hat{\beta}_1 \hat{\beta}_5) + 2ZW cov(\hat{\beta}_1 \hat{\beta}_7) + 2ZW cov(\hat{\beta}_4 \hat{\beta}_5) + 2WZ^2 cov(\hat{\beta}_4 \hat{\beta}_7) + 2ZW^2 cov(\hat{\beta}_5 \hat{\beta}_7)$

Case	Equation	Marginal Effect	Variance
1	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2$	$\frac{\partial Y}{\partial X} = \beta_1 + 2\beta_2 X$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + 4X^2 var(\hat{\beta}_2) + 4X cov(\hat{\beta}_1 \hat{\beta}_2)$
2	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 Z$	$\frac{\partial Y}{\partial X} = \beta_1 + 2\beta_2 X$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + 4X^2 var(\hat{\beta}_2) + 4X cov(\hat{\beta}_1 \hat{\beta}_2)$
3a	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 Z + \beta_4 XZ$	$\frac{\partial Y}{\partial X} = \beta_1 + 2\beta_2 X + \beta_4 Z$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + 4X^2 var(\hat{\beta}_2) + Z^2 var(\hat{\beta}_4) + 4X cov(\hat{\beta}_1 \hat{\beta}_2) + 2Z cov(\hat{\beta}_1 \hat{\beta}_4) + 4XZ cov(\hat{\beta}_2 \hat{\beta}_4)$
3b	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 Z + \beta_4 XZ$	$\frac{\partial Y}{\partial Z} = \beta_3 + \beta_4 X$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial Z}} = var(\hat{\beta}_3) + X^2 var(\hat{\beta}_4) + 2X cov(\hat{\beta}_3 \hat{\beta}_4)$
4a	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 Z + \beta_4 XZ + \beta_5 X^2 Z$	$\frac{\partial Y}{\partial X} = \beta_1 + 2\beta_2 X + \beta_4 Z + 2\beta_5 XZ$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial X}} = var(\hat{\beta}_1) + 4X^2 var(\hat{\beta}_2) + Z^2 var(\hat{\beta}_4) + 4X^2 Z^2 var(\hat{\beta}_5) + 4X cov(\hat{\beta}_1 \hat{\beta}_2) + 2Z cov(\hat{\beta}_1 \hat{\beta}_4) + 4XZ cov(\hat{\beta}_2 \hat{\beta}_4) + 4XZ cov(\hat{\beta}_1 \hat{\beta}_5) + 8X^2 Z cov(\hat{\beta}_2 \hat{\beta}_5) + 4XZ^2 cov(\hat{\beta}_4 \hat{\beta}_5)$
4b	$\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 Z + \beta_4 XZ + \beta_5 X^2 Z$	$\frac{\partial Y}{\partial Z} = \beta_3 + \beta_4 X + \beta_5 X^2$	$\hat{\sigma}^2_{\frac{\partial Y}{\partial Z}} = var(\hat{\beta}_3) + X^2 var(\hat{\beta}_4) + X^4 var(\hat{\beta}_5) + 2X cov(\hat{\beta}_3 \hat{\beta}_4) + 2X^2 cov(\hat{\beta}_3 \hat{\beta}_5) + 2X^3 cov(\hat{\beta}_4 \hat{\beta}_5)$

Source: AIKEN and WEST (1991) and https://files.nyu.edu/mrg217/public/interaction.html#code

Accordingly, the significance and the level of the relations between the agricultural and non-agricultural development of employment were calculated differentiatedly for each of the 25 classes in the second model. Region-specific effects are further calculated by accounting for the region-specific level of agricultural development. In the explanation of the development of GVA, region-specific effects were calculated taking into account the region-specific values of the share of agricultural employment, the region-specific agricultural productivity and the region-specific development of agricultural GVA.

6 Results and interpretation

The differentiation that results from the additional introduction of the lagged and the leading form of the exogenous time-varying variables allows for the separation of different kinds of relation between changes in agriculture and in other sectors. The effect of the lagged variable is cautiously interpreted as the effect of the agricultural development upon the non-agricultural development (push effect), and the effect of the leading variable after appropriate transformation is interpreted as the effect from the non-agricultural upon the agricultural development (pull effect). The terms push- and pull effect are adopted from the older discussion of structural change in agriculture, where the pull effect is usually meant to describe the phenomenon that good outside options attract labour from the agricultural sector. The push effect in contrast describes that agricultural labour is set free due to disadvantageous developments within the agricultural sector. Both effects thereby apply to negative developments within agriculture. We are also concerned with the case of positive developments within agriculture. The following list (Table 7) gives a summary of possibly existing relations between developments in and outside agriculture and their potential interpretation.

Table 7: Classification of potential relations between agricultural and non-agricultural developments

Coefficient		**Positive coefficient**		**Negative coefficient**	
General effect		Transmission effect		Competition effect	
		Agricultural development			
Differentiated effect		**positive**	**negative**	**positive**	**negative**
lagged	effect	Induction effect	Dependence effect	Immobility effect	Mobility effect
	impact	Growth in other sectors induced	Development in other sectors inhibited	Development in other sectors inhibited	Growth in other sectors induced
current	effect	Spurious correlation, induction or stabilisation effect	Spurious correlation, dependence or destabilisation effect	Immobility or detraction effect	Mobility or attraction effect
lead	effect	Stabilisation effect	Destabilisation effect	Detraction effect	Attraction effect
	impact	Agricultural development stabilised	Agricultural sector destabilised	Agricultural development stabilised	Agricultural sector destabilised

Source: Own table.

Principally, positive coefficients concerning the relation of changes within and outside agriculture indicate transmission effects, i.e. the development in one sector disseminates into other sectors. In most cases, transmission results from the pecuniary impetus that results from a changed amount of money in circulation. Therefore, transmission effects can be explained similarly for changes in employment and in GVA, as more employment immediately translates into additional sources of income. Additional income can either be saved or be spent within the region or be spent outside the region. Consequently, a positive relation will usually be expected if not all additional income is saved or spent at other places. Nevertheless, the transmission effect competes against the competition effect in the estimated relation.

The competition effect implies a negative relation between the developments of different sectors. The development in one sector may be inversely affected by the development in another sector because the production in different sectors is partially based on the application of the same scarce factors of production. While capital might be a scarce factor in some cases, its mobility and non-specificity usually alleviates its scarceness on the regional level. Therefore, labour, or more precisely specific human capital more often plays a key role in the competition effect. Observed changes in money flow relate to the distribution of labour only indirectly. Therefore, the competition effects may be more easily interpreted in the employment model. In the GVA model, negative coefficients may result from the fact that a rising GVA in one year could partially result from higher investments or additional employment in previous years. Competition in capital for different investments may become relevant if local farmers exhibit entrepreneurial activities in other sectors as well because farmers' capital might be immobile. In this case, a positive agricultural development may attract their investments towards agriculture and inhibit activities in non-agricultural investments. Additionally, competition for land may cause negative relations. The conduct of large infrastructure projects, for example, as in the building of highways, may affect agricultural GVA negatively due to the loss of land, while other sectors receive positive stimuli.

Table 7 differentiates further with respect to the direction of developments (positive vs. negative) and with respect to the different versions of the time-varying variables that were employed (lagged, current and leading form). The inclusion of quadratic terms in the estimation models potentially allows for the estimation of differentiated effects for different ranges of values. If there is **a positive effect from positive agricultural on non-agricultural development** (lagged exogenous variable), we may speak of an **induction effect**. Multipliers, income effects or the induction of new jobs contribute positively to the development within other sectors. This induction effect may be interpreted as an indication of the local economy's dependence on agriculture if it is a negative agricultural development that affects the other sectors. If there is **a positive effect from negative agricultural on non-agricultural development** (lagged exogenous variable), we may speak of a **dependence effect**.

If the same effects are **negative**, this may be interpreted as a **mobility effect, respectively as an immobility effect**. Due to the competition for scarce resources, a positive [negative] development in agriculture, that implies immobility [mobility] of agricultural factors, induces a negative [positive] development of non-agricultural sectors, which benefit from freed factors from agriculture.

If there is a **positive effect from non-agricultural on agricultural development** (leading exogenous variable), we can interpret this as a **(de-)stabilisation effect**. If agriculture relies on part-time farms, for example, a positive development of incomes from the non-agricultural sector could stabilise these farms. The reverse holds true for negative developments in non-agricultural sectors. If the same effect is **negative**, this indicates an **attraction effect, respectively a detraction effect**, i.e. the attraction [detraction] of agricultural factors by a positive [negative] development in non-agricultural sectors.

The current or contemporaneous effect is difficult to interpret because it embraces all of the other effects and additionally the spurious relation between agricultural and non-agricultural developments within a region, i.e. those relations that are due to unobserved regional influences, which affect both developments simultaneously. Spurious correlation is largely controlled by the contemporaneous effect. In conclusion, positive relations ascribe a supporting role to agriculture in economic dynamics, while negative relations are a sign of other sectors playing a leading role, also for agricultural dynamics.

Estimated raw coefficients are uninformative due to the difficulties in the interpretation of the interaction effects. The following tables, with estimated coefficients and standard errors, therefore need to be assessed with caution. The final models were selected from a variety of possible models based on the Bayesian Information Criterion (BIC) that allows for the assessment of the superiority of more complex models as compared with simpler models. In this assessment, the BIC penalizes the introduction of additional parameters. The Criterion is only valid for nested model, i.e., for models that rely on identical observations and identical parameters besides those that are in question.

6.1 Employment model

In the employment model (Tables 8a and 8b), Class 5-1, i.e., the class characterised by a high share of agricultural employees and a low agricultural productivity, was chosen as reference class in the estimation because it is occupied by the largest share of observations (see Table 2).

Table 8a: Model for the explanation of change in non-agricultural employment

Intercept	0.024 *** *(0.002)*	R-square	0.76
Mean annual change in scaled agricultural employment	-0.053 *(0.098)*	Number of observations	5,041
Mean annual change in scaled agricultural employment square	0.331 *(2.697)*	Number of Regions	1,287
Dummy year 2004	-0.008 *** *(0.001)*		
Dummy year 2005	-0.009 *** *(0.001)*		
Dummy year 2006	*Reference*		
Dummy year 2007	0.002 * *(0.001)*		

Note: Standard errors in brackets below coefficients. Significance: °: 10%, *: 5%, **: 1%, ***: 0.1%
Source: Own calculation

The dummies for the years show that by explaining changes rather than absolute numbers, and by the construction of lagged and leading variables, we lose three of the eight points in time that were originally available (2002 to 2008). 2002 is lost, because it does not relate to an earlier year for the calculation of a change. 2003 is lost, because it does not possess a lagged change (since no change is observed for 2002). 2008 is lost, because it does not possess a leading change, since no observations exist for 2009. Therefore, effectively we calculate with 2004 to 2007. 2006 serves as the reference year.

The model reaches an R-square of 0.76, the random effects model (very similar results not reported) shows in more detail that the R-square is 0.78 for the explanation of the variation within regions and 0.68 for the explanation of the variation between regions. This seems to be surprisingly high on the first sight. Nevertheless, the high explanatory power for between regions differences is due to the relatively large number of regional types employed (the 25 classes). The high explanatory power for the variation within regions is mainly due to the relatively low remaining variance after detrending and group-mean centring (see Section 5.2). A similar phenomenon is known from fixed effects estimations.

Table 8b: Continuation of Table 8a

Regional class (quintiles)			Annual change in scaled agricultural employment					
Share of agricultural employment	Agri-cultural produc-tivity		lagged		current		leading	
			linear	squared	linear	squared	linear	squared
			0.088 **	-0.214	-0.060 °	-0.129	-0.049	-0.343
			(0.030)	*(0.221)*	*(0.034)*	*(0.271)*	*(0.032)*	*(0.249)*
			Interactions with classes:					
1	1	-0.003	3.315 *	409.360	-0.384	-223.460 *	0.772	20.070
		(0.005)	*(1.549)*	*(356.882)*	*(1.108)*	*(98.718)*	*(0.585)*	*(121.128)*
	2	-0.015 ***	0.933	-319.984	-0.077	206.522 **	2.131 *	-151.409 *
		(0.002)	*(1.673)*	*(449.090)*	*(1.283)*	*(69.873)*	*(1.017)*	*(66.541)*
	3	-0.005	-6.658	277.653	2.604	-219.879	0.230	72.553
		(0.004)	*(4.838)*	*(376.957)*	*(3.795)*	*(181.255)*	*(2.039)*	*(88.211)*
	4	-0.015 ***	2.021 *	-311.217	2.289	-269.043 **	-1.029	98.260
		(0.002)	*(0.991)*	*(220.667)*	*(1.508)*	*(106.958)*	*(2.502)*	*(138.523)*
	5	-0.002	-3.060 ***	-20.370	-2.976 **	-870.026 ***	-1.691 **	47.578
		(0.003)	*(0.697)*	*(22.106)*	*(1.215)*	*(53.626)*	*(0.626)*	*(62.889)*
2	1	-0.003	2.895 **	-134.033 °	1.055	107.960	1.318	177.128
		(0.007)	*(1.004)*	*(73.396)*	*(0.679)*	*(83.035)*	*(1.340)*	*(146.206)*
	2	-0.010 ***	-0.626	2.865	-0.480	-55.957 **	-1.480 *	45.503 °
		(0.002)	*(0.514)*	*(8.890)*	*(0.517)*	*(19.844)*	*(0.614)*	*(24.859)*
	3	-0.010 ***	0.892	-117.950 **	-0.801	-363.643 *	-0.900 °	347.640 ***
		(0.002)	*(0.925)*	*(47.284)*	*(0.976)*	*(153.741)*	*(0.551)*	*(79.312)*
	4	-0.009 ***	-0.613	-202.849 *	0.250	42.505	0.089	80.697 **
		(0.002)	*(1.142)*	*(97.403)*	*(0.701)*	*(62.134)*	*(0.530)*	*(29.595)*
	5	-0.011 ***	-0.393	45.852 **	0.043	-15.293	0.452	-17.856 **
		(0.002)	*(0.259)*	*(18.110)*	*(0.328)*	*(13.964)*	*(0.295)*	*(7.178)*
3	1	-0.003	1.179 °	-26.176	1.008	113.448 **	-1.695 °	90.702
		(0.006)	*(0.680)*	*(17.031)*	*(1.170)*	*(35.683)*	*(0.911)*	*(61.421)*
	2	-0.012 ***	0.015	-4.693	-0.516 °	11.988 ***	-0.227	-36.368 *
		(0.003)	*(0.240)*	*(5.133)*	*(0.286)*	*(3.338)*	*(0.454)*	*(15.924)*
	3	-0.012 ***	-1.243	-244.425 **	-0.086	396.005 °	1.243 *	3.229
		(0.002)	*(1.006)*	*(90.474)*	*(0.548)*	*(233.373)*	*(0.603)*	*(194.747)*
	4	-0.009 ***	1.179 *	21.657	-0.111	-88.326 *	-0.300	39.758
		(0.002)	*(0.580)*	*(57.649)*	*(0.529)*	*(37.689)*	*(0.752)*	*(32.911)*
	5	-0.012 ***	0.660	-58.265 **	0.018	23.747	0.559 *	-7.689 *
		(0.002)	*(0.431)*	*(20.998)*	*(0.668)*	*(25.724)*	*(0.232)*	*(3.882)*
4	1	0.003	-0.083	-2.881	-0.178	-1.831	0.249	11.819
		(0.005)	*(0.214)*	*(5.404)*	*(0.353)*	*(11.102)*	*(0.258)*	*(28.457)*
	2	-0.008 **	0.023	-5.148	-0.207	2.521	0.161	-0.962
		(0.003)	*(0.331)*	*(5.680)*	*(0.571)*	*(6.995)*	*(0.433)*	*(5.212)*
	3	-0.006 *	-0.670 *	18.033 ***	-0.769 *	10.229 **	0.029	14.116 ***
		(0.003)	*(0.350)*	*(4.834)*	*(0.326)*	*(4.102)*	*(0.222)*	*(3.216)*
	4	-0.009 ***	1.430	78.720	1.861 °	-591.129 ***	-2.083	607.026 ***
		(0.002)	*(1.097)*	*(50.855)*	*(1.136)*	*(152.864)*	*(1.376)*	*(145.838)*
	5	-0.011 ***	0.823 ***	-29.178	-0.075	-46.409 *	0.421	37.089 **
		(0.002)	*(0.242)*	*(20.361)*	*(0.407)*	*(20.680)*	*(0.267)*	*(12.999)*
5	2	-0.006	-0.022	0.820	-0.204	-1.401	0.157	4.896 **
		(0.005)	*(0.158)*	*(2.049)*	*(0.204)*	*(2.526)*	*(0.155)*	*(1.817)*
	3	-0.001	-0.073	34.616 ***	0.266	-35.882 °	-0.312	23.129 *
		(0.005)	*(0.290)*	*(5.570)*	*(0.368)*	*(19.028)*	*(0.274)*	*(10.513)*
	4	0.000	-0.771 *	-22.179	-1.143 *	4.085	-1.278 °	26.150 ***
		(0.008)	*(0.393)*	*(21.008)*	*(0.575)*	*(10.967)*	*(0.700)*	*(7.029)*
	5	-0.016 ***	0.575 ***	20.800	-0.134	13.906	0.366	134.183 *
		(0.004)	*(0.071)*	*(14.156)*	*(0.253)*	*(16.957)*	*(0.581)*	*(65.370)*

Note: Standard errors in brackets below coefficients. Significance: °: 10%, *: 5%, **: 1%, ***: 0.1%
Source: Own results

The first column of coefficients in Table 8b describes the existing cross-sectional differences in the development of non-agricultural employment in the different classes of regions. Class 5-1, i.e. the class with a very high share of agricultural employment and a very low productivity, which embraces the highest number of regions (compare Table 2), is the reference class, which is covered by the intercept. The first column in Table 8b indicates deviations from this intercept in the other classes. Accordingly, the annual change in the scaled non-agricultural employment in regions of class 5-1 is 0.024 (intercept in Table 8a) and the annual change is lower or not significantly different in the regions of all other classes. The following columns in Table 8b indicate the differentiated effects of the change in agricultural employment upon the change in non-agricultural employment. The top line shows that there is a significantly positive linear lag-effect in class 5-1. It describes the effect of the development of agricultural employment in the previous period upon the development of non-agricultural employment in the current period. The lines below indicate the deviations of the estimated effects in regions that belong to the other classes. The following column indicates the same for the squared lagged effect, followed by the current and leading linear and squared effects. The linear and squared effects need to be accumulated for interpretation.

Table 9 gives a summary of the calculated marginal effects of all regions differentiated by the 25 classes. Within a region, the effect varies with the level of change in agricultural employment due to the quadratic terms (see Table 8b). The effect of the leading version of ‘Annual change in scaled agricultural employment’ (lead effect) has been transformed to its reciprocal in order to acknowledge that it has to be interpreted as the effect of the non-agricultural development in the current period upon the agricultural change in the following period. Therefore, the equation has to be reversed and is divided by the estimated marginal effect. The reciprocal of the original coefficient therefore captures the desired relation.

The marginal effects presented in Table 9 are interpreted based on the previous discussion of the implications of the different positive and negative effects in the introduction of this Chapter. Accordingly, the significant negative contemporaneous relations between the agricultural and non-agricultural development (current effect) imply that the competition effects dominate the short-term relation between agriculture and other sectors in many regions.

The estimated relation between the leading variable (t+1) of the agricultural change and current (t+0) non-agricultural change (lead effect) is negative in many classes. This result supports the interpretation of the lead effect as a pull effect that captures the attraction of agricultural factors by positive developments outside of agriculture. Mainly in regions with a medium share of agricultural employment (Class 3), a positive stabilisation effect of non-agricultural development on agricultural development is predicted in some cases.

The effect of the lagged change in agricultural employment upon non-agricultural employment (lag effect) is, in contrast, rather positive in many classes. This supports the existence of induction or dependence effects. According to table 9, a positive lag effect is mainly observed, where agricultural productivity is high or the share of agricultural employment is low. A negative lag effect is of high relevance for regions with a very low share of agricultural employment and a very high agricultural productivity (Class 1-5). Here the competition for scarce resources leads to the effect, that restricted mobility of agricultural factors restricts non-agricultural development.

Class 5-1 is the class with the most significant all-up relation. The overall effect is calculated by the common calculation of a single marginal effect, i.e., by the summation of the lead, the current and the lag effect and the calculation of their common variance. It is strongly negative and clearly dominated by the competition effect. A positive all-up relation that attributes agriculture a positive role in the dynamics of regional economies only dominates in regions with a low share of agricultural employment and a very low agricultural productivity (Class 2-1) and in regions with a high share of agricultural employment and a very high agricultural productivity (Class 4-5).

Table 9: Summary of the marginal effects of the employment model by types of regions

Quintiles: Share of agric. employment	Quintiles: Agric. productivity	Frequency	All up relation: Mean	Std. dev.	Median	Min	Max	Lag effect: Mean	Std. dev.	Median	Min	Max	Current effect: Mean	Std. dev.	Median	Min	Max	Lead effect: Mean	Std. dev.	Median	Min	Max	Reversed lead effect: Mean	Std. dev.	Median	Min	Max
1	1	33	0.00	0.00	**0.00**	0.00	0.00	1.92	1.80	**3.08**	0.00	4.17	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	2	60	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	1.71	0.82	**2.08**	0.00	2.54	0.39	0.19	**0.48**	0.00	0.53
	3	50	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	4	50	0.00	0.00	**0.00**	0.00	0.00	1.76	0.84	**2.11**	0.00	2.46	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	5	67	-6.91	4.75	**-7.75**	-15.71	25.83	-2.97	0.07	**-2.97**	-3.18	-2.68	-1.75	4.92	**-3.04**	-11.02	30.80	-1.53	0.61	**-1.74**	-1.98	0.00	-0.49	0.20	**-0.57**	-0.60	0.00
2	1	10	3.31	2.93	**4.67**	0.00	6.82	3.04	0.32	**3.04**	2.59	3.65	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	2	44	-2.49	0.55	**-2.61**	-2.85	0.00	0.00	0.00	**0.00**	0.00	0.00	-0.04	0.17	**0.00**	-0.88	0.00	-1.51	0.28	**-1.53**	-2.45	0.00	-0.64	0.11	**-0.65**	-0.72	0.00
	3	64	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	-0.07	0.31	**0.00**	-1.54	0.00	-0.04	0.22	**0.00**	-1.27	0.00	-0.02	0.14	**0.00**	-0.79	0.00
	4	63	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	5	76	0.00	0.00	**0.00**	0.00	0.00	-0.02	0.16	**0.00**	-1.38	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
3	1	12	0.00	0.00	**0.00**	0.00	0.00	0.09	0.30	**0.00**	0.00	1.03	0.39	0.62	**0.00**	0.00	1.43	-1.47	1.23	**-1.75**	-3.91	0.00	-0.32	0.25	**-0.46**	-0.59	0.00
	2	51	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	-0.46	0.23	**-0.57**	-0.61	0.00	0.02	0.14	**0.00**	0.00	1.02	0.02	0.14	**0.00**	0.00	0.98
	3	58	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0.16	**0.00**	0.00	1.19	0.01	0.11	**0.00**	0.00	0.84
	4	75	0.00	0.00	**0.00**	0.00	0.00	1.14	0.37	**1.25**	0.00	1.37	-0.02	0.21	**0.00**	-1.86	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	5	57	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.51	0.03	**0.51**	0.47	0.68	1.96	0.08	**1.95**	1.47	2.13
4	1	27	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	2	56	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	3	62	-1.39	0.26	**-1.44**	-1.58	0.00	0.00	0.00	**0.00**	0.00	0.00	-0.81	0.11	**-0.83**	-0.92	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	4	57	0.37	0.99	**0.00**	0.00	4.16	0.00	0.00	**0.00**	0.00	0.00	0.60	1.23	**0.00**	0.00	4.20	-0.89	1.63	**0.00**	-5.17	0.00	-0.07	0.14	**0.00**	-0.68	0.00
	5	53	0.88	0.49	**1.11**	0.00	1.31	0.89	0.14	**0.90**	0.00	1.10	-0.03	0.15	**0.00**	-0.84	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
5	1	178	0.00	0.00	**0.00**	0.00	0.00	0.09	0.01	**0.09**	0.00	0.11	0.00	0.00	**0.00**	0.00	0.00	0.00	0.01	**0.00**	-0.07	0.00	-0.17	1.60	**0.00**	-15.30	0.00
	2	46	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00
	3	23	0.00	0.00	**0.00**	0.00	0.00	-0.03	0.15	**0.00**	-0.73	0.00	0.00	0.00	**0.00**	0.00	0.00	-0.04	0.18	**0.00**	-0.87	0.00	-0.05	0.24	**0.00**	-1.15	0.00
	4	10	-1.99	1.72	**-3.03**	-3.55	0.00	0.00	0.00	**0.00**	0.00	0.00	-0.72	0.62	**-1.19**	-1.21	0.00	-0.46	0.74	**0.00**	-1.59	0.00	-0.20	0.32	**0.00**	-0.70	0.00
	5	5	0.00	0.00	**0.00**	0.00	0.00	0.73	0.06	**0.71**	0.68	0.82	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00

Source: Own calculation

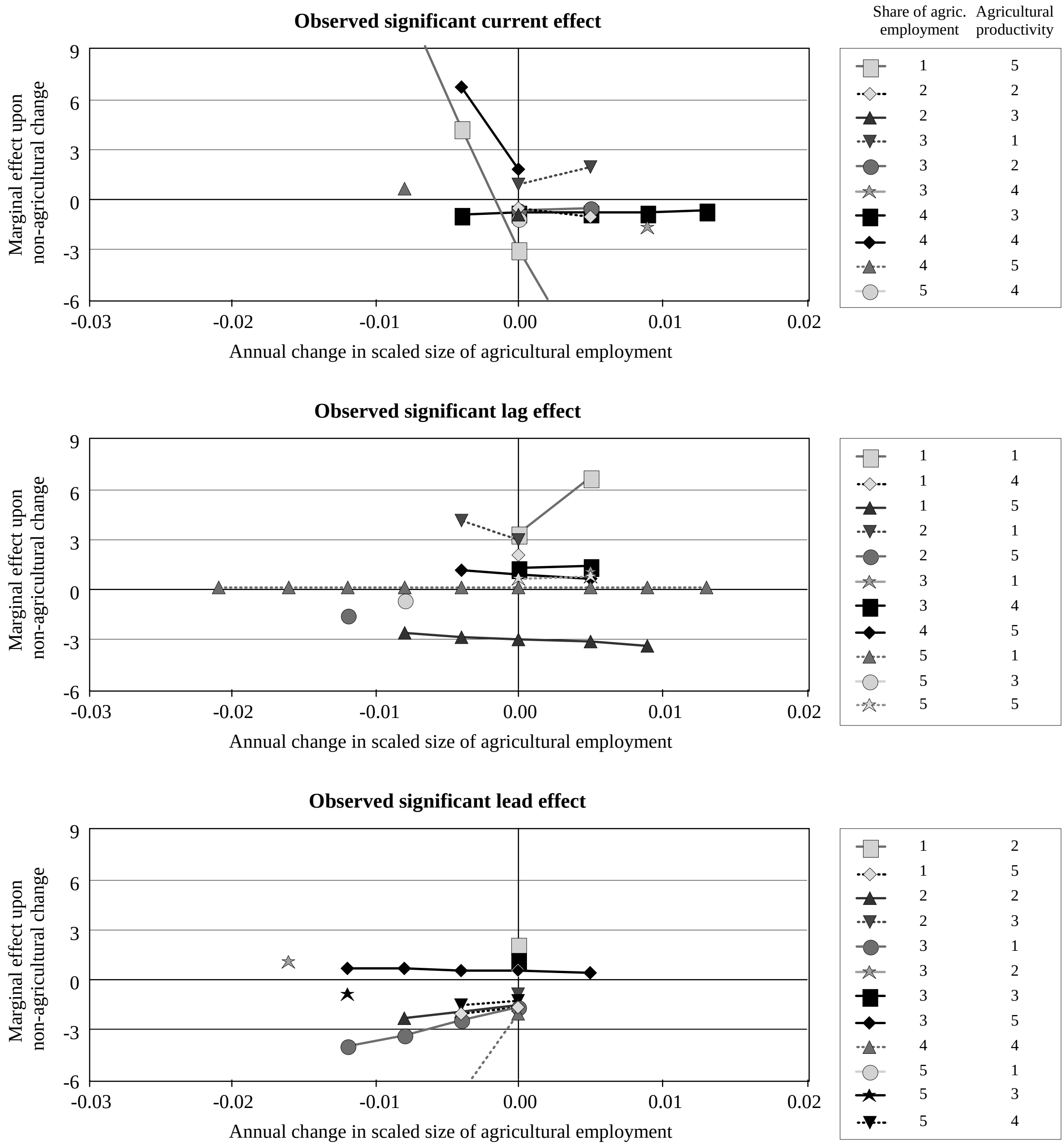
As has been lined out in the introduction of this chapter, the interpretation of the effects also depends on their area of significance. Specifically, it needs to be considered whether the estimated effects are significant for negative or positive values of the agricultural development. This observed area of significance is illustrated in Figure 1 for the five-percent level of significance.

The figure illustrates that the estimated effects are usually either negative or positive for the regions of specific classes. One important exception is the current or contemporaneous effect in class 1-5, which is strongly positive for negative developments of agricultural employment, indicating a dependence or destabilisation effect (compare Table 7), and strongly negative for positive developments of agriculture, indicating an immobility or detraction effect. This implies that the role of agriculture in this class does not have a constructive role for the regional economic development as was also indicated by the strongly negative all-up effect.

In other cases, the picture is not as clear. The lag-effect is often positive for positive agricultural developments. The relation of a negative non-agricultural development to a negative agricultural development (dependence effect) is only significant for Classes 2-1, 4-5 and 5-1. The positive lag-effect is significant but very low for all changes within agriculture in Class 5-1.

The negative lead-effect is in all cases only significant for negative changes in agricultural employment. This is a clear indication of the high relevance of the attraction effect (see Table 7).

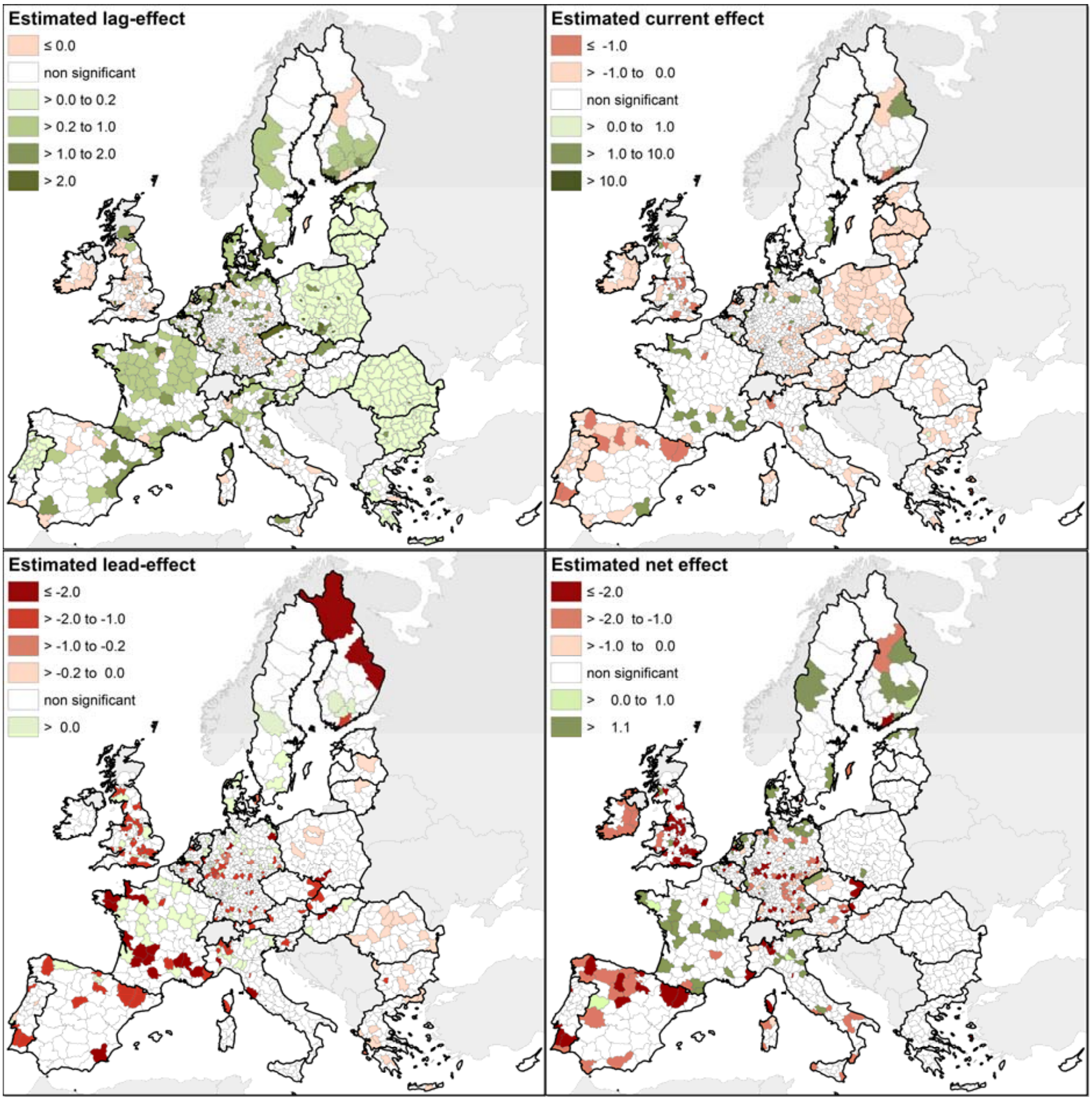
Figure 1: Relationship between the change in scaled agricultural employment and the change in scaled non-agricultural employment



Source: Own figure

Map 4 demonstrates the spatial distribution of the significant effects. Obviously, there are only few regions with a positive and significant all-up relation. The differentiated analysis does show, however, that there are underlying relations between the two sectors in most regions. On the one hand, there is a significant mutual dependence and/or common affectedness of both sectors in many regions, especially in Eastern Europe, according to the lag-effect. The low but significant positive lag effect in eastern Europe is due to the significant positive lag effect across the whole range of values in regional class 5-1, as illustrated in Figure 1. Especially for France a more positive lag effect is estimated. Nevertheless, for years with a negative employment dynamic in agriculture the positive relation implies a vulnerability of these regions (dependence effect). In other western European regions, the lag effect is ambiguous. Sometimes it is even negative, which implies the existence of a competition effect, i.e. a positive annual deviation in agricultural employment in the previous period inhibits, and a negative annual deviation promotes non-agricultural employment development in the current period.

Map 4: Marginal relationship between the development of agricultural and non-agricultural employment development (significant at the 10-percent-level)



Source: Own map. NUTS Level 3 by Geodan IT, 2004.

In most regions, the competition effect dominates the lead effect and the current effect. This implies that restructuring of agriculture towards a more labour-efficient situation supports the development in other sectors, while the development in other sectors raises the mobility of agricultural factors and supports agricultural restructuring. Obviously, the non-agricultural sector attracts and absorbs labour from the agricultural sector. This implies that structural change in agriculture is accompanied by growth in other sectors while immobility of agricultural factors potentially inhibits the economic development of a region. Thereby, the predominantly positive lag effect is counteracted by the predominantly negative current and lead effect.

The all up, or net, effect is insignificant in eastern European regions. A positive all up effect characterises France, northern Italy and some regions in Scandinavia. Other western European regions, especially in Spain, Great Britain and Germany are characterised by a negative all-up effect. In these regions, the development of employment in non-agricultural sectors determines the development of the agricultural sectors rather than the other way around.

A summary of the spatial patterns disclosed by Map 4 may be given in terms of the different regimes they indicate:

(1) There are regions with a positive lag- and a positive lead effect as in France, Scandinavia and northern Italy. In these regions, a mutually reinforcing relation exists between agricultural and non-agricultural employment dynamics. A reason for political support of structural change does not exist.

(2) There are some regions with a negative lag- and a negative lead effect as in Germany, Great Britain and Ireland. In these regions, the non-agricultural sector clearly drives regional employment dynamics because competition for labour determines the relation between sectors. A stabilisation of agricultural structures is rather harmful than supportive.

(3) Many eastern European regions are ascribed a negative current (contemporaneous) and/or lead effect and a positive lag effect. While agricultural employment stability contributes to the stabilisation of general employment, other sectors simultaneously attract agricultural labour. In the consequence, a sustainable structural development needs to rest on the development of non-agricultural employment opportunities in these regions. While a stabilisation of agricultural employment may be beneficiary in the short-term, its medium- and long-term effects may be detrimental.

In conclusion, a positive effect of a stable agricultural sector upon other sectors exists according to the lag effect. Nevertheless, it is only small in regions with a high share of agricultural employment and a low agricultural productivity and larger in a more diversified and productive economic environment. Moreover, a positive non-agricultural development promotes agricultural restructuring. Especially in regions with a low agricultural productivity, agricultural stability thereby indicates a lack of a general economic dynamic. Support of agricultural employment stabilises the agricultural sector and has short-term positive impacts upon the regional economy. Nevertheless, it does not promote the development of a more diversified economy, which is a necessary precondition for the inevitable restructuring of the agricultural sector. Thereby, support of agriculture does not seem to be the most effective instrument in order to support a positive rural employment dynamic.

6.2 GVA model

In the GVA model, the development of agricultural GVA explains the development of non-agricultural GVA. The regional characterisation of regions in terms of agricultural productivity and share of agricultural employment was easier for the GVA model than for the employment model (Section 6.1). In the GVA model, regions were characterised by agricultural productivity, the share of agricultural employment and the interaction thereof instead of those 25 classes employed in the employment model. The explanatory power of the GVA model, with an R-square of 0.38, is considerable lower than that of the employment model. Nevertheless, a comparison of its estimated coefficients (Table 10) with the coefficients of the employment model (Tables 8a and 8b) reveals that the former exploits substantially fewer degrees of freedom than the latter. Consequently, the GVA model is much more efficient. The detailed treatment of variances in the random effects model (very similar results not reported) shows that the GVA model has a higher explanatory power with respect to the within-region variance (R-square of 0.49) than with respect to the between-regions variance (R-square of 0.25). Estimation results are presented in Table 10.

As with the employment model, a direct interpretation of the coefficients presented in Table 10 is difficult due to the many non-linear relations and the necessity to calculate variances that consider the resulting interdependencies. Nevertheless, from the coefficients presented in the bottom part of Table 10, which is concerned with the time-varying effects, it becomes evident, that the positive relation between agricultural and non-agricultural developments in GVA dominates for mean values of agricultural productivity and the share of agricultural employment. Nevertheless, the coefficients also imply that the positive relation declines and finally turns negative with a growing share of agricultural employment and with a growing agricultural productivity. Accordingly, both indicators are correlated with a rising relevance of the competition effect in the relation of the sectors.

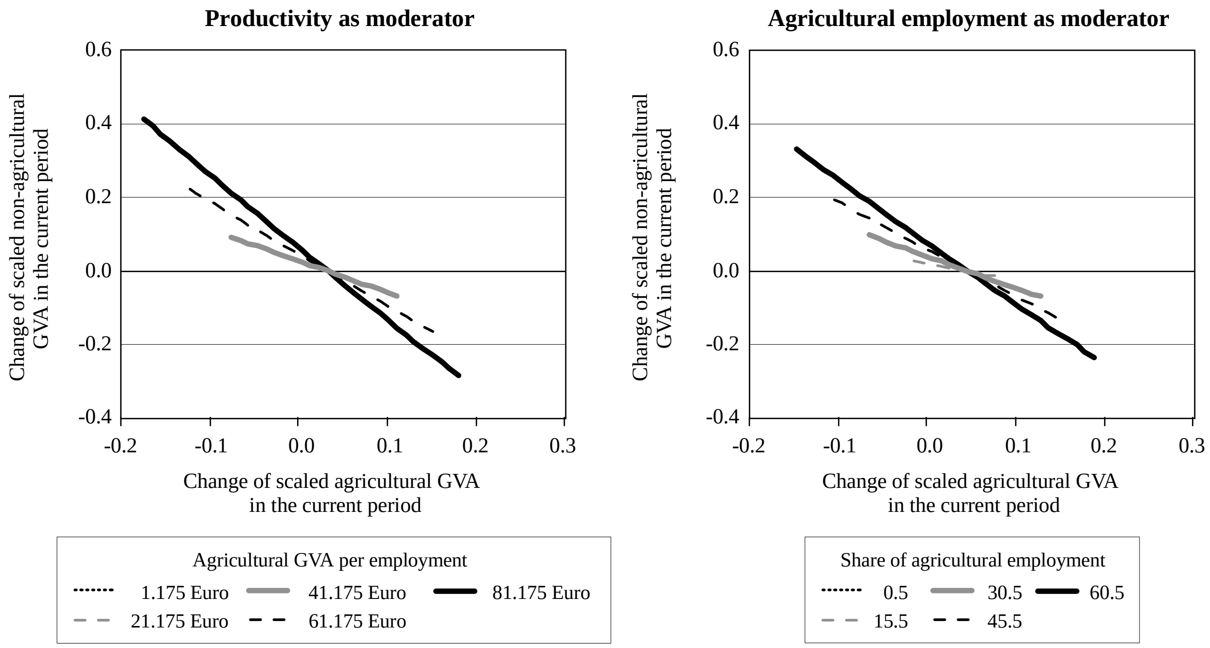
Table 10: Model for the explanation of change in non-agricultural GVA

	Estimated coefficients					
Intercept	0.09 *** *(0.003)*		N	5,061		
Dummy year 2004	-0.04 *** *(0.003)*		Regions	1,292		
Dummy year 2005	-0.03 *** *(0.002)*		R-squared	0.38		
Dummy year 2006	-0.01 *** *(0.002)*					
Dummy year 2007	*Reference*					
	linear	quadratic				
Mean regional change in scaled agricultural GVA	6.32 *** *(0.76)*	-67.84 ** *(27.36)*				
Agricultural productivity	-0.00106 *** *(0.00015)*	0.000003 * *(0.000001)*				
Share of agricultural employment	0.00180 *** *(0.00026)*	-0.00007 *** *(0.00002)*				
Interaction of agricultural productivity and share of agriculture employment	-0.00008 *** *(0.00002)*					
	lag		current		lead	
	linear	quadratic	linear	quadratic	linear	quadratic
Annual change in scaled agricultural GVA	0.34 * *(0.17)*	0.94 *(1.54)*	0.03 *(0.22)*	0.11 *(1.53)*	-0.04 *(0.18)*	1.13 *(1.04)*
Interaction with agricultural productivity	-0.04 *** *(0.01)*		-0.03 * *(0.01)*		-0.05 *** *(0.01)*	
Interaction with share of agricultural employment	-0.03 ** *(0.01)*		-0.02 ° *(0.01)*		-0.01 ° *(0.01)*	

Note: Standard errors in brackets below coefficients. Significance: °: 10%, *: 5%, **: 1%, ***: 0.1%
Source: Own calculation.

The following figures present graphically the calculated marginal effects and their dependence on the different variables in the model. Therefore, they show the relation between the values of agricultural change (exogenous variable) and the estimated effect upon non-agricultural change (endogenous variable) for the whole range of observed values. The current or contemporaneous effect is analysed in Figure 2.

Figure 2: Current relationship between change in scaled agricultural GVA and relative change in non-agricultural GVA

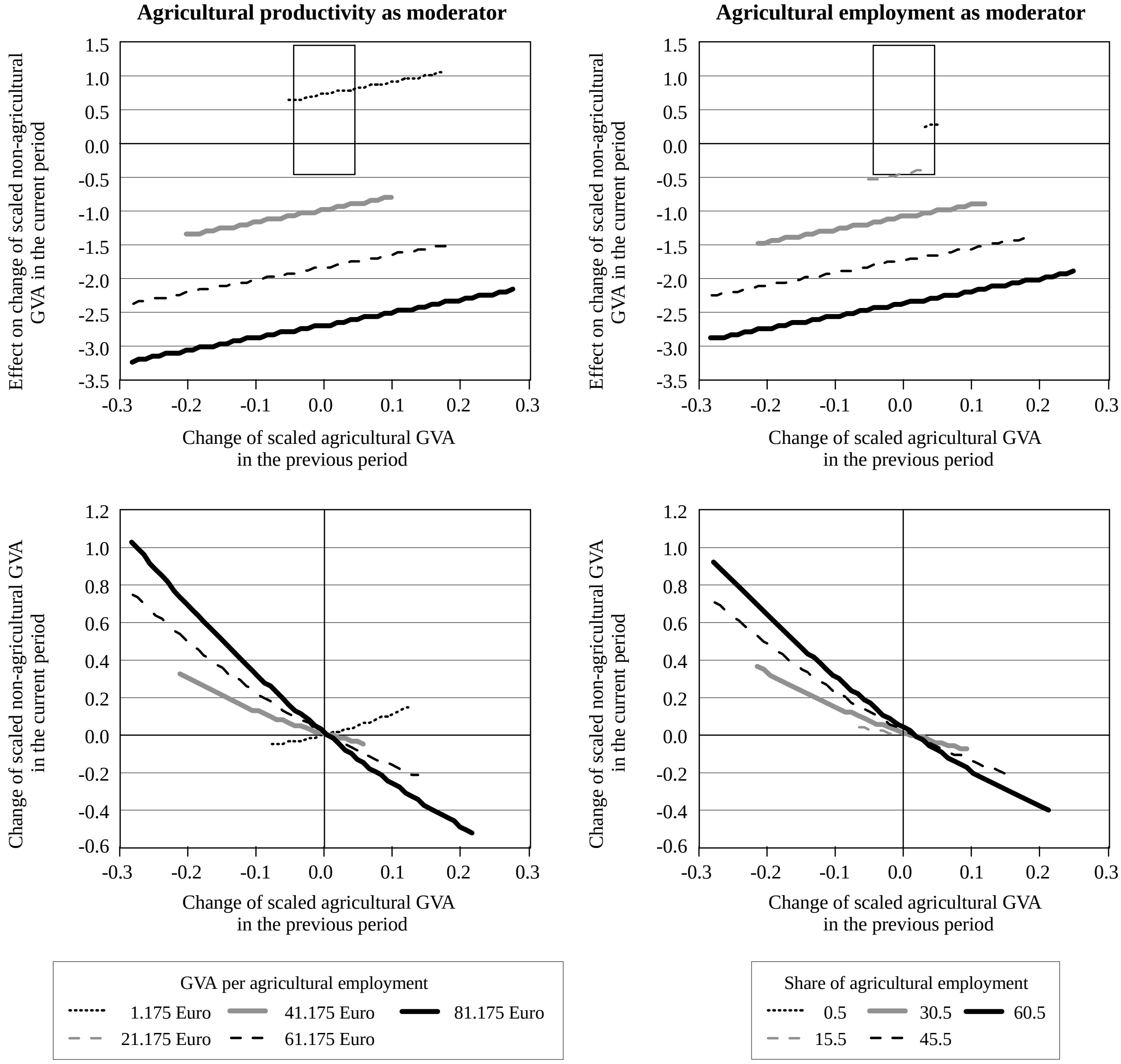


Source: Own figure

The figure shows a clear negative contemporaneous relation between the development of agricultural GVA and the development of non-agricultural GVA. This competition effect (see table 7) is significant for regions with a relatively high share of agricultural employment and for regions with a high agricultural productivity. In such regions, it is significant for negative and for positive developments of agricultural GVA. The observed effect therefore results from the supply or immobility of agricultural factors on the one hand or from the detraction or attraction of agricultural factors by other sectors on the other hand (see table 7).

The top line figures of figure 3 show the marginal effect of the development in agricultural GVA in the previous period upon non-agricultural development in the current period (lag effect). The bottom line figures show the derived relation between the development in agricultural and in non-agricultural GVA. With those values applied, the lag effect is usually negative, i.e. the competition effect dominates. The area of significance of this negative lag effect is considerably larger for negative than for positive agricultural developments in regions with low agricultural productivity or a low share of agricultural employees. Here, a negative development of the agricultural production in the previous period causes higher non-agricultural production in the current period. This effect is probably due to the related rising mobility of agricultural factors.

Figure 3: Relation between lagged relative change in scaled agricultural GVA and relative change in non-agricultural GVA



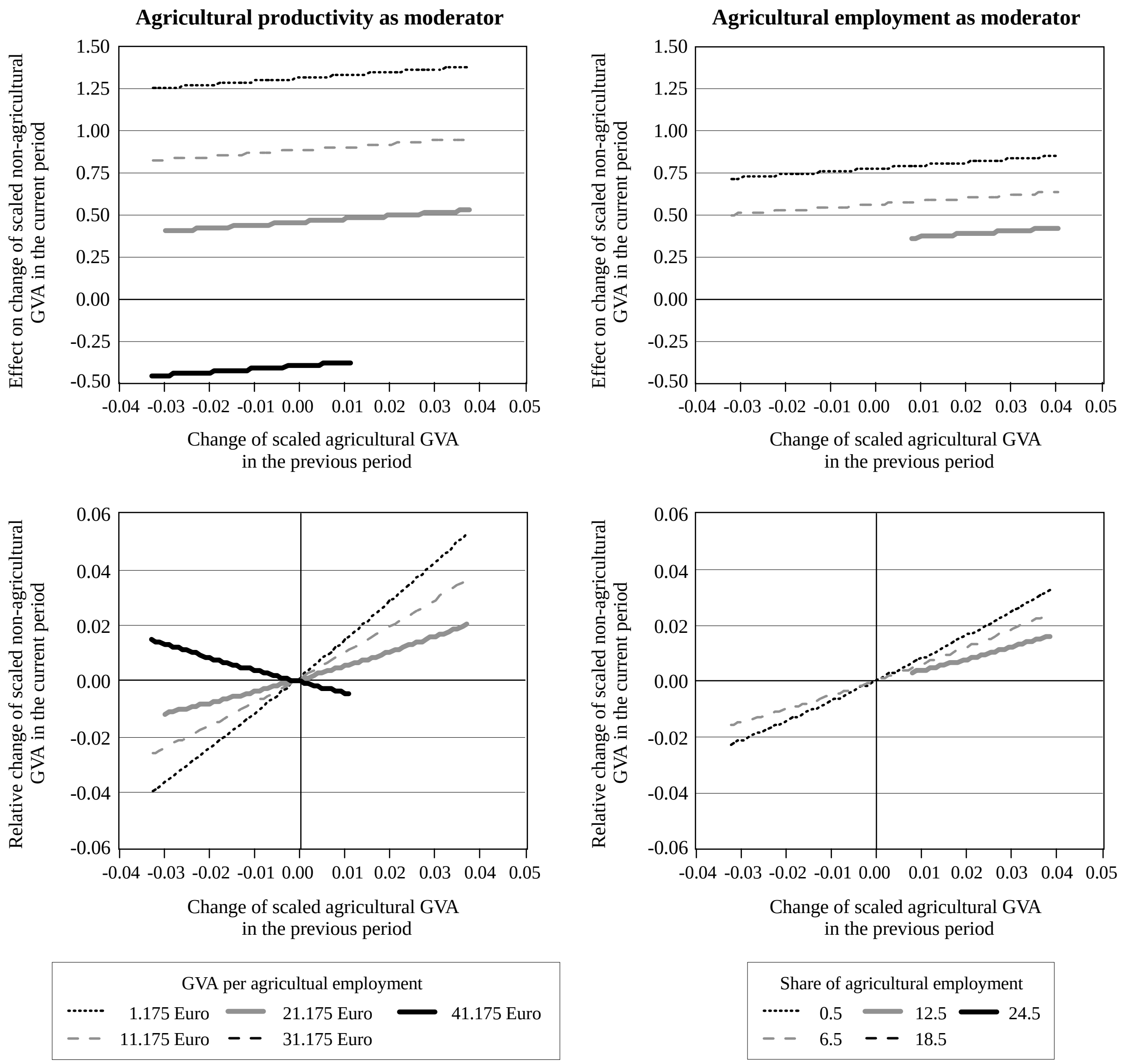
Note: The small squares in the top line indicate the selected area that is analysed separately graphically in Figure 4.

Source: Own figure.

Nevertheless, if agricultural productivity is very low, the lag effect is positive, i.e. the transmission effect dominates. This holds true for negative as well as for positive developments of agricultural GVA. The situation may be understandable if one acknowledges, that general economic productivity is usually low, too, in regions with a very low agriculturally productivity. Given this situation, the competition effect is low, because efficient technologies that employ resources competitively need to be introduced in the first place. The positive lag effect thereby implies a general economic weakness rather than a strongly positive role for agricultural development in economic development.

Under these circumstances, the negative effects of a decline of agricultural production on the general economy are not compensated for by a growth of other sectors. In this case, the positive relation needs to be interpreted as an unfavourable dependence of the regional economy on agriculture. The small squares in the top line of Figure 3 mark a selected area with the most frequent values of exogenous and endogenous variables that is analysed separately graphically in Figure 4.

Figure 4: Graphical analysis of the marked detail square in Figure 3

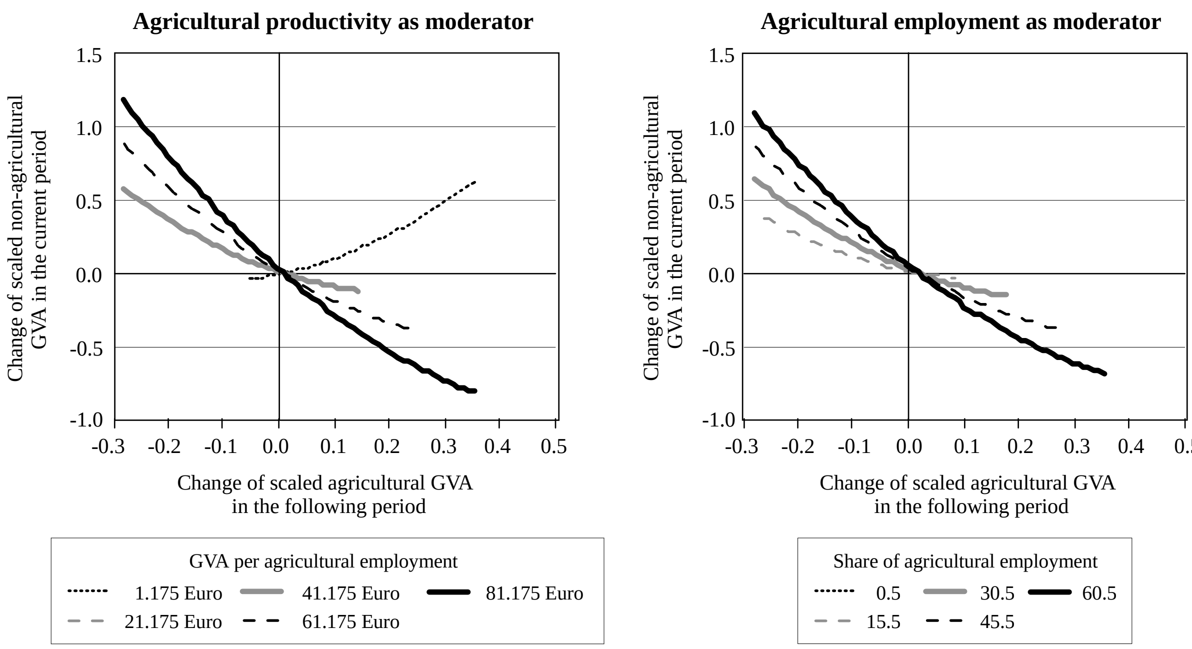


Source: Own figure

The comparison with Figure 3 shows the high relevance that needs to be attributed to the range of values considered for the interpretation of these non-linear models. The estimated effect seems to be negative for most cases according to Figure 3 that covers the whole range of observed values. Nevertheless, a concentration of the most frequent observation, under exclusion especially of the extreme values in the share of agricultural employment and in agricultural productivity, as in Figure 4, illustrates that the estimated effect is actually positive for most observed cases.

Figure 5 shows that the relation between the non-agricultural development in the previous period and the agricultural development in the current period (lead effect) is very similar to the lag effect. This similarity illustrates that the attraction of agricultural factors by the non-agricultural sector just like the mobility effect mirrors the scarcity of factors (see table 7).

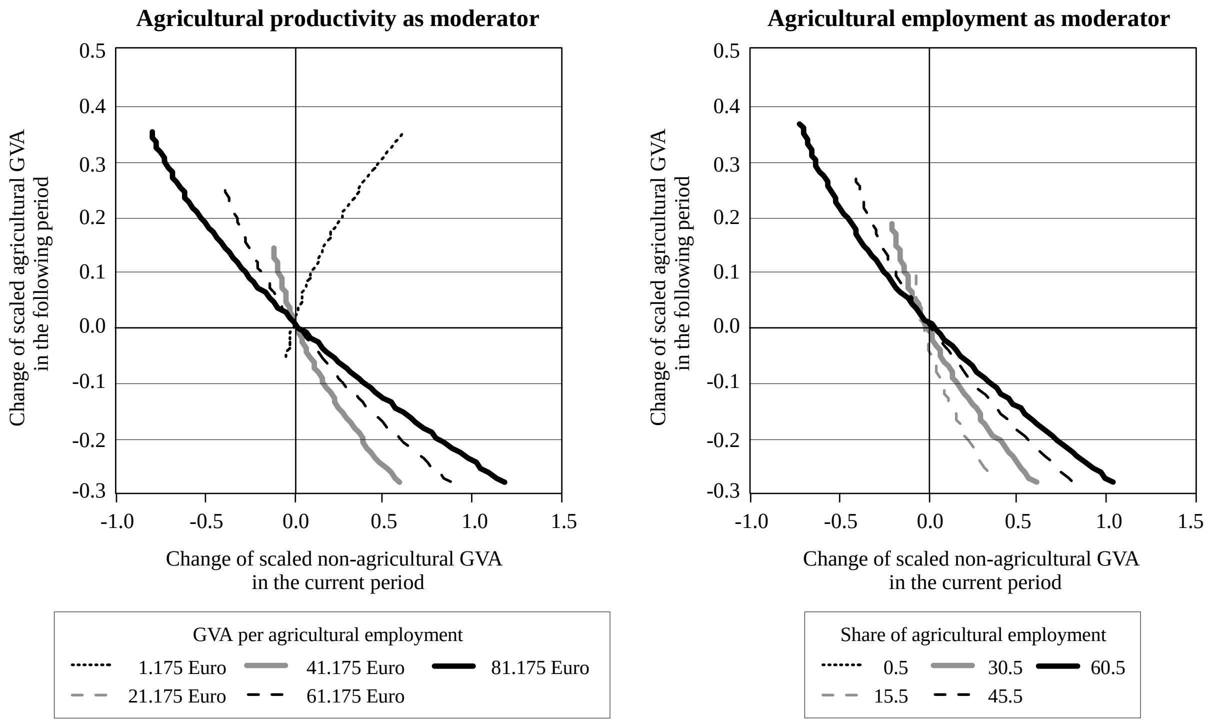
Figure 5: Relation between the agricultural development in the following period and the non-agricultural development in the current period



Source: Own figure.

Unfortunately, in the case of the lead effect a high marginal effect does not necessarily reflect a strong effect of the non-agricultural development upon the agricultural development. Figure 6 clarifies the reversed effect that corresponds to our interpretation.

Figure 6: (Reversed) Relation between the non-agricultural development in the current period and the agricultural development in the following period



Source: Own figure.

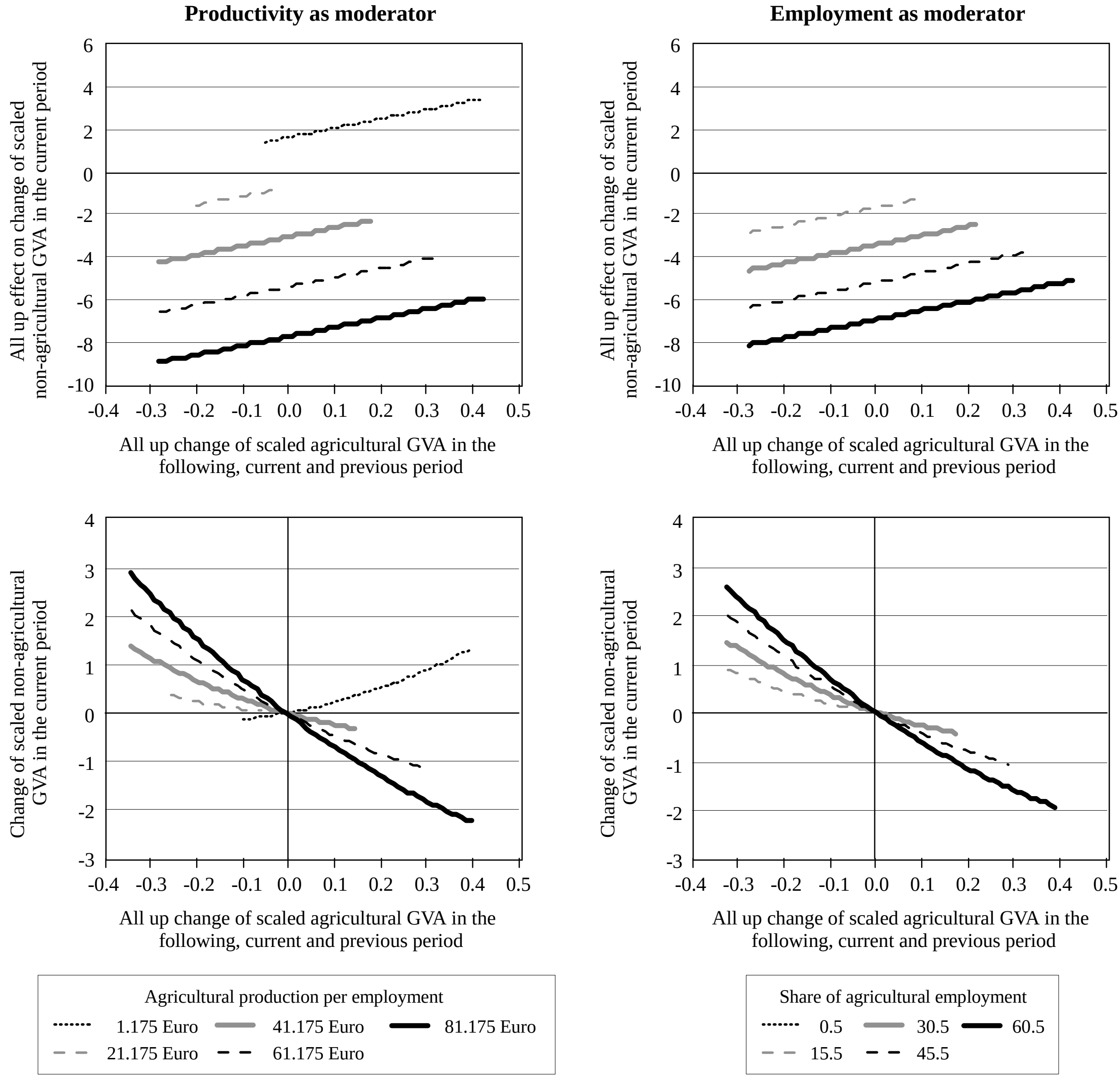
The illustration clarifies that the development of agricultural GVA is positive with a negative development in non-agricultural GVA and negative with positive developments of non-agricultural GVA. While the reversed effect is stronger (steeper curve) for regions with a low agricultural productivity and for regions with a low share of agricultural employment, the range of significance with respect to changes in non-agricultural GVA is larger for regions with a high share of agricultural employment and a high agricultural productivity. This implies that the absolute effect might be larger in the latter.

These observations support intuition. A low share of agricultural employment implies that there are many outside options for agricultural production factors and low agricultural productivity causes a higher mobility of agricultural factors. The results therefore mirror the idea of push- and pull-effects. Only in regions with a very low agricultural productivity we observe a positive lead effect. Here a positive development of non-agricultural production stabilises agricultural production in the low-productivity type of agriculture. The positive lead effect is only significant for positive non-agricultural developments.

Therefore, economic development even in the most agrarian regions depends on non-agricultural developments, while the positive relation to agricultural developments is mainly an expression of an unconsolidated structure of the economy and its vulnerability to inevitable structural change in agriculture. The all-up effect is analysed graphically in

Figure 7. Since most relations were negative, the overall effect is negative in most cases as well. Again, only regions with a very low agricultural productivity show a positive all-up relation between the developments of agricultural and non-agricultural GVA. While the negative all-up effect in low-productivity regions is significant only for negative changes in agricultural production, the positive all-up effect is only significant for positive changes in agricultural production. This implies that despite of the competition effect, a stabilisation of agricultural production not necessarily harms the non-agricultural development. However, it also implies that prevention of dependence effects (negative transmission effects, see Table 7) should not be used as an argument for the support of agricultural production.

Figure 7: Relationship between the non-agricultural development in the previous, current and following period and the agricultural development in the current period



Source: Own figure.

The negative relation indicates competition or absorption effects. According to the result, a decline in agricultural activity contributes positively to non-agricultural development in regions with a very low share of agricultural employees and in regions with a low agricultural productivity. This implies that in these regions factors of production with a more productive or diversified non-agricultural sector find a more productive application outside agriculture. The positive relation, on the other side, indicates income, multiplier and induction effects (it also includes spurious correlation). Overall, the dominance of negative relations in all non-low productivity regions clearly indicates that economic development cannot rest on agriculture alone.

In the light of these interpretations, the spatial distribution of the estimated effect in the GVA model may be interpreted further (Map 5). The all up relation pictured in the first of the four maps in Map 5 gives a clear idea of the strongly heterogeneous relation between the developments in agricultural and non-agricultural GVA in western and eastern Europe. In eastern European region the positive transmission effect dominates the lead and lag effect while the contemporaneous or current effect remains insignificant. In western European regions, the negative competition effect dominates the current and the lead effect, while the sign of the lag effect is rather ambiguous here. The non-existence of significant positive contemporaneous relations in the regions indicates that spurious correlation has been controlled effectively in the estimation.

As in the case of the employment model (Section 6.1), the results may be summarised in terms of different regional development regimes:

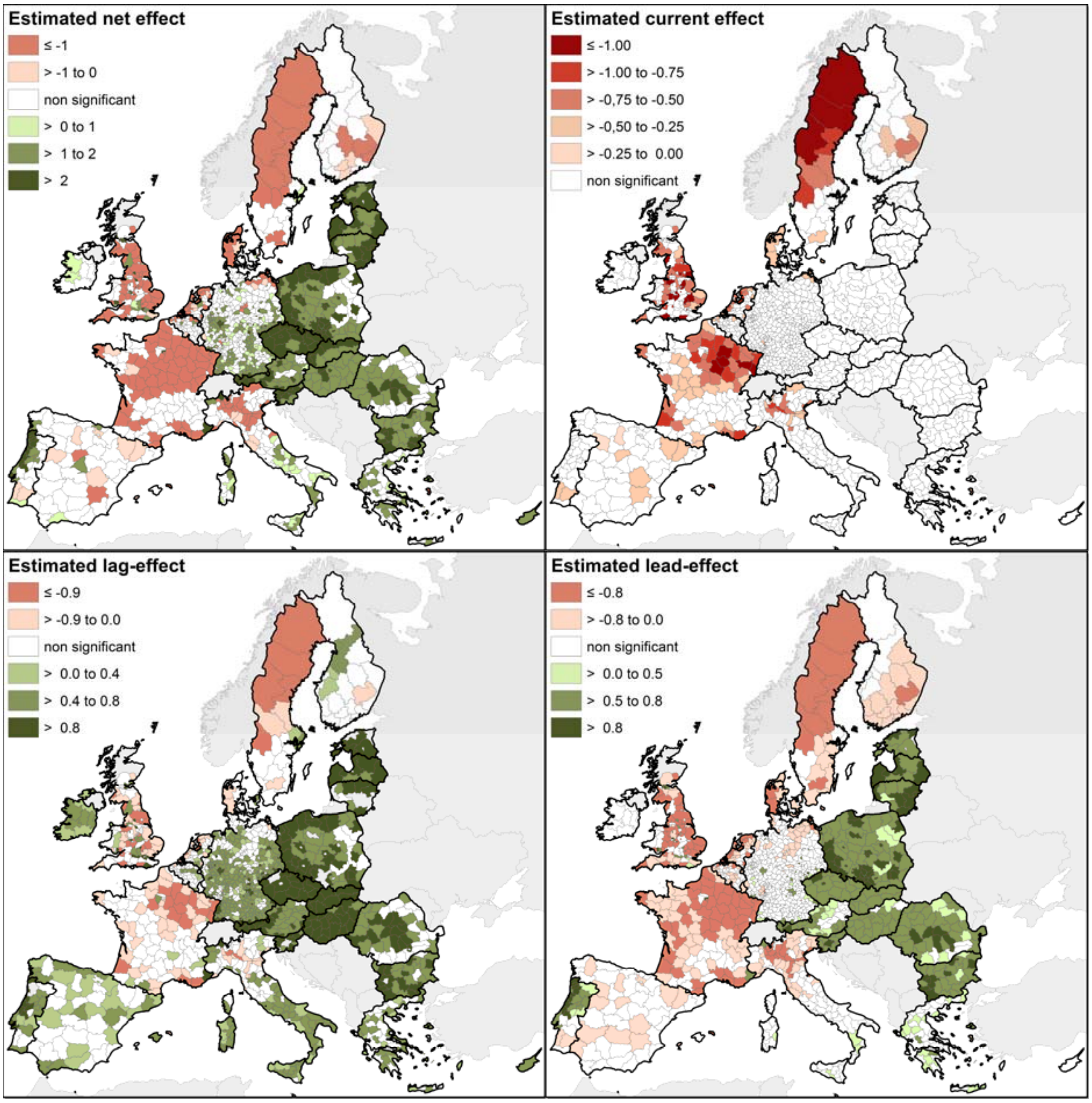
(1) There are regions that are characterised by a significantly positive lag- and a non-significant lead-effect. This pattern mainly applies to regions in Germany, on the Iberian Peninsula, in Southern Italy, Austria and Ireland. In these regions, agricultural production is relatively unaffected by the ongoing structural change. Nevertheless, it does play a constructive role in regional economic development.

(2) Other western European regions are characterised by the only existence of a significantly negative lead-effect. Thereby, agriculture is ascribed a predominantly passive role in the regional economic development.

(3) Regions in northern Italy, France, Scandinavia and Great Britain are often characterised by significantly negative lead- and lag-effects. Here, the competition effect dominates, as resources are scarce, and agricultural production is sensitive with respect to structural change.

(4) The eastern European regions are characterised by a positive lag- and a positive lead-effect. This implies a mutual dependence of the different sectors on each other, as agriculture stabilises production in other sectors and production in other sectors stabilises agriculture. Here, the necessary structural change in the regions may cause disruptions in regional economic development.

Map 5: Marginal relationship between the development of agricultural and non-agricultural GVA (significant at the 10-percent-level)



Source: Own map. NUTS Level 3 by Geodan IT, 2004.

In this last, agricultural, regime, development depends on the situation in the agricultural sector and at the same time, the absorption capacity of the remaining economy for factors from agriculture is low. Therefore, restructuring of agriculture occurs very slowly and per capita income is low. In the third regime, in contrast, development depends on the non-agricultural sector. The pull effect complements the push-effect and freed agricultural factors are absorbed by the remaining economy. Production factors are relatively mobile and agricultural production is rather efficient. Under these circumstances, support of agricultural production might even be harmful to regional economic development, as it restricts the mobility of agricultural factors and hinders their transfer to more productive sectors. In the first regime, on the contrary, efficiency-reserves seem to exist in the agricultural sector, as the level of production is rather unaffected by structural change.

Two conditions need to hold in order to substantiate the existence of a competition effect in the developments of GVA of different sectors: first, the observed growth needs to be based on an extension of the production capacities, i.e. on the factors employed for production; second, sectors need to compete for the same factors. The latter could apply particularly, if investors from one sector are potential investors in other sectors as well. Unfortunately, we know little in quantitative terms about the role of farmers in non-agricultural investments. Considering the all up relation pictured in Map 5, our results imply that the competition between farm- and non farm-investments is especially strong for farmers in Great Britain, Scandinavia, the Netherlands, France and Northern Italy.

In contrast, it is rather a lacking relation between growth in GVA and an extension of production capacities that explains the dominance of positive transmission effects in eastern Europe than the inactivity of farmers in the non-agricultural regional economy. Actually, in the eastern regions characterised by very low agricultural productivity, a growth in agricultural GVA often accompanies the decline in agricultural employment due to a restructuring of the sector towards a more efficient organisation. Either a high relevance of local demand for agricultural products in this region or the stabilisation of small-scale agricultural production by a general positive regional economic development may explain the positive lead effect in eastern European regions.

7 Conclusions

The previous sections discussed results from two panel models that relate the development of employment and GVA in other sectors to the development of agricultural employment and GVA in the past (lagged variable), current and following period (lead variable). The main result of the statistical analysis is the non-linear relation between the development in agriculture and in other sectors, i.e., the spatial differences in the marginal effects. The models show that these relations depend on the economic characteristics of the regions and that the overall effects consist of different underlying mechanisms that constitute the relation between agriculture and other sectors. The potential mechanisms discussed in the paper are

- the transmission effect (positive coefficient) that includes the
  - induction effect (agriculture => other sectors) as well as the
  - stabilisation effect (other sectors => agriculture).
- the competition effect (negative coefficient) that includes the
  - mobility effect (agriculture => other sectors) as well as the
  - attraction effect (other sectors => agriculture).

Several important implications stem from the empirical results. With regard to content, the regionally differing relative strength of the competition effect as compared to the transmission effect helped to identify different regimes of developments of agriculture in the regional economic surrounding:

(1) Regions in France, Scandinavia and northern Italy are characterised by positive transmission effects in employment and negative competition effects in GVA.

(2) Regions in Germany and Ireland, for example, are characterised by negative competition effects in employment and a positive induction effect in GVA.

(3) Many eastern European regions are ascribed a negative attraction and a positive induction effect in employment and positive transmission effects in GVA.

From these differentiated results, different political implications evolve. In the first group of regions (1), there is no indication for a political stabilisation of agricultural employment in the process of structural change as a positive development in non-agricultural employment affects agricultural employment positively. This diagnosis is underlined by the negative competition effect in GVA that implies a possibly negative allocation effect if the stabilisation of employment affects investment decisions and agricultural production. In the second group of regions (2), the reverse argument applies. While a stable agricultural production contributes positively to non-agricultural regional development, politically induced allocation affects need to be avoided in the light of the negative competition effects in employment. With respect to the eastern European regions (3), the situation is more ambiguous. While, on the one hand, agricultural stability supports the general economy, a positive development of non-agricultural employment on the other hand, disturbs agricultural stability. Therefore, in order to overcome the existing low-productivity trap in eastern Europe, the necessary restructuring of agriculture should be supported such that the existing level of production is kept up. Evidently, the creation of outside options for agricultural labour best supports restructuring of agriculture. Support of organisational and institutional restructuring as well as knowledge transfers should be preferred measures for the support of productivity development.

In conclusion, support that tends to preserve existing structures needs to be avoided. Support of agriculture in regions with mature economies does not have a regional economic indication at all and is suspicious for the creation of distortions in entrepreneurs' decisions. The same holds true for all regions, where the pull-effect of the non-agricultural sector determines a dynamic agricultural development. Under the circumstances described, simple subsidies of agricultural production would imply a treatment of symptoms rather than of fundamental causes of the economic hardship in peripheral regions. The unfavourable situation of regions that depend on an unproductive agricultural sector cannot be overcome by the support of the agricultural sector itself. Instead, structural change in the regional economies must be encouraged by the support of non-agricultural investments and by investments that help to create more efficient structures of agricultural production. Social hardships should be overcome by social measures that are unrelated to agricultural production and directed to the needy rural population.

The identification of the complex relation between agricultural and non-agricultural development and of the different mechanisms that constitute this relationship also carries with it methodological consequences. Firstly, it has been demonstrated that the differentiation of effects along the time-scale allows for the (partial) analytical separation of different types of relations. Moreover, it was demonstrated that a careful inspection of areas of significance allows for an even more detailed interpretation of the differentiated effects. Secondly, the spatial differentiation of effects with interactions successfully demonstrated that as long as one is not able to construct complete statistical models, heterogeneous effects cannot be ignored. This also implies that an insignificant all up relation does not automatically mean that no measurable relation exists. The results thereby caution against uncritical applications of fixed effects models, which cannot identify heterogeneous effects and could instead lead to the false conclusion of a general insignificance of effects. Finally, the results caution against an uncritical application of methods from regional input-output analysis. In regions that are characterised by inefficient factor use and a retarded structural change, and in the presence of non-linear phenomena such as lock-ins, regional multipliers obviously have little to say about impacts of observed sectoral changes on overall economic development.

Nevertheless, at the same time, the present study, too, suffers from methodological problems. Firstly, the reliability of the applied data for the question at hand is not clear, due to possible national differences and inexactness in the creation of values in the regional economic account system. Secondly, a perfect separation of the different potential effects is not possible. Specifically, the interpretation of the lead-effect as a reversed causal relation and the assessment of its significance and strength in this interpretation are problematic. The third and final point relates to the second problem: The period under observation was very short if one considers the application of lag- and lead effects. This short period and the neglect of trends imply that only short-term effects were measured. An empirical assessment of structural long-term relations seems virtually impossibly given the current data-situation.

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