The impact of agro-food industry on regional employment and population changes : the case of Denmark and France

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Abstract

In the European rural development policy special emphasis is placed on support of the agro-food industry which is regarded as an important economic development driver in rural areas. This paper analyses and compares the employment and population changes in Denmark and France in the period 1990 – 2006, applying a regional adjustment model. We modify the classical Boarnet model by addressing the employment in the agro-food, manufacturing, and services sectors explicitly. Besides revealing the interactions between employment in the three analysed sectors and between employment and population changes we estimate the impact of exogenous factors, e.g. amenities and public services, on employment and population changes. To account for spatial error autocorrelation the model is estimated, applying a generalized spatial two-stage least squares procedure. The empirical results for both countries do not unambiguously support the export base hypothesis, i.e. growth in the manufacturing sector employment is not driving employment in the service sector. However, considering the agro-food sector there are indications of a positive impact of employment growth in this sector on the service sector employment growth. In Denmark, the agro-food employment growth has also a positive impact on the employment growth in export sector and on the population growth, indicating that the focus on the agro-food sector in rural development policies may be reasonable

1 Introduction

This paper examines determinants of employment and population growth applying a regional adjustment model and spatial disaggregated data for Denmark and France. The focus is on the role of the agro-food sector in regional development, i.e. the interplay of agro-food industry employment, export employment, service employment, and population change. Even though the importance of agro-food industry for income and employment generation is declining, the agro-food industry still plays a significant role for rural economies (Hasler et al. 2002, Diakosavvas 2006, Warren and Isserman 2006). In rural areas the relative employment in the food processing is typically higher than the national employment share in food processing (OECD 2010). For example, in 2006 the average employment share in the food industry was 4.7% in rural municipalities in Denmark whereas 3.1% at the national level. For France, the corresponding figures are in 1999 5.3% in rural areas and 2.7% at the national level. The higher concentration of food industry employment in rural areas can be explained by advantages of being close to farms supplying input to the food industry and by relative low-skilled workers in rural areas (Goetz 1997, Ellison and Glaeser 1999, Kim 1999, Huiban 2000, Cohen and Paul 2005).

In rural development policies, the food industry has traditionally been regarded as an important driver for regional and rural development (Capps et al. 1988, Barkley 1995). Also in the present European Rural Development Program (European Commission 2005) support to the improvement of the competitiveness of the agro-food sector, including primary agriculture and food processing, is one of the three main thematic axes. The objective of the present study is to provide insights into the role of the food industry as rural development driver, using empirical data on municipality and economic functional areas in Denmark and France, respectively.

In many traditional regional economic models the key to regional development is to focus on employment in businesses that sell to urban and foreign markets. For example, the export base hypothesis (North 1955) states that a local economy can be divided into an export, or basic, sector and a residentiary, or non-export, sector supplying goods and services to local residents. The export activities are seen as the economic base because the residentiary activities are derived from the performance of the export sector in selling their products outside the region. Agriculture and manufacturing are typically representing the export sectors. Since agriculture and food processing are important economic activities in rural areas, agro-food sector is, according to the export base idea, an important driver of economic development in rural areas. (Schaffer 1999, Kilkenny and Partridge 2009). Input-output models and regional multipliers are based on the same ideas that external demand drives local economic activity. Based on a review of regional input-output models Léon and Surry (2009) find that the production multipliers of the agro-food sector are, in general, higher than multipliers of other sectors. Especially, an increase in employment in the food industry generates relative many jobs in other sectors. This is because this sector has close to local inter-industry linkages and this supports that the food sector may be an important driver of rural development. However, input-output models need more detailed information and it is therefore often difficult to obtain the necessary statistical data on a regional or finer level for building regional versions of such models with detailed inter-industry linkages.

However, the export base hypothesis and multipliers derived from input-output models are based on rigid and questionable assumptions (Kilkenny and Partridge 2009). For example, it is assumed that factor supplies are perfectly elastic so the only constraint on regional growth is the demand for export. However, increased demand for export sector employment may crowd out other activities, because the supply of labor is not perfectly elastic (Tiebout 1956, Edmiston 2004, Leven 2006).

The export base hypothesis is also contradicted by new trade and economic geography theory (Krugman 1991) where causality between export growth and employment can go both ways (Kilkenny and Partridge 2009). On one hand, specialization in production and exporting the region's comparative advantage products it may enjoy increasing returns to scale which may increase the demand for employment which is supporting the export base hypothesis. On the other hand, a large population can also support the achievement of return to scale by home market effects.

Empirical evidences do not support unambiguously that specialization in export sector enhances local growth. While input-output models, by construction, show increasing local employment as results of increasing export demand, empirical results from econometrical analyses of the relation between basic and non-basic sectors are not consistent. For example, Harris et al. (1999) find a positive co-integration relationship between employment in basic and non-basic employment whereas Lego et al. (2000) find that there may be a negative

relationship between employment in the basic sectors and in non-basic sectors. Goetz and Debertin (1996) find that agricultural dependent areas have experienced a decline in rural populations in the U.S. and that this decline may have been accentuated by the farm program payments. Wagner and Deller (1998) show that industrial diversity rather than specialization in export industries is important for local growth.
The interplay between factor supply and demand on regional economic activity has been analyzed empirically in a computable general equilibrium (CGE) framework (McGregor et al. 1996, Hasler et al. 2002, Cutler and Davies 2007, Daniel and Kilkenny 2009). In this framework it is also possible to distinguish between short- and long-run impacts of supply or demand shocks, applying dynamic CGE (McGregor et al. 1996, Rickman 2010). However, the development and calibration of CGE models on regional data will often be constrained by data availability.

In the present study, we analyze the interplay between regional employment changes and labor supply, applying a simultaneous equation model framework originally introduced by Steinnes and Fisher (1974) and modified by Carlino and Mills (1987) to include adjustment lags toward an equilibrium. This approach permits explicit modeling of population changes which makes it possible to determine whether population growth has a positive impact on employment growth, i.e. whether an increased supply of labor can attract new employment. It is also possible to test whether employment growth has a positive effect on population growth. For policy-making it is important to have insights in the interactions between employment and population growth. Whether incentives for job creation or immigration are the most efficient approach to stimulate growth in lagged regions depends on interdependences between employment and population growth. For example, if employment growth has no impact on population growth, but population growth stimulates employment growth, economic development of an area may depend on policies that make them a desirable place to live (Carruthers and Vias 2005).

This, so-called chicken-egg question of jobs versus people, has long been discussed in the literature (e.g. Muth 1971). Empirically, the question has also been analyzed extensively. Since Carlino and Mills's (1987) model on population and employment growth in 3,000 counties in the US, a large number of studies have addressed the question whether "people follow jobs" or "jobs follow people" (Hoogstra et al 2010). However, there is no consensus about the casual direction. Some studies find that causality goes from population growth to employment growth (e.g. Boarnet 1994, Deitz 1998) whereas other studies find evidence of causality from employment growth to population growth (e.g. Barkley et al. 1998, Duffy-Deno 1997, Mulligan et al. 1999). There are also studies finding dual causality between employment and population growth (e.g. Mills and Lubuele 1995, Carruthers and Vias 2005) as well as studies without significant simultaneous interaction between population and employment (e.g. Henry et al. 1997). The ambiguous results may be a consequence of applying the model in different contexts, e.g. the analyzed time period, geographical area, and the spatial scale, and the specification of the empirical model applied. An important modification of the model was the introduction of spatial lags in the model to account for dependences between communities (Boarnet 1994) and has since been an often used specification of the Carlino-Mills model.

In the present application of the "Carlino-Mills" model framework we take into account that the impact of employment changes on local economic growth and migration may be sector-specific. Therefore, the employment is decomposed into agro-food industry, export sector, and service sector employment. This allows us to investigate interactions between different sectors, e.g. between export and non-export sectors, and to account for the potential sector-specific interaction between employment and population growth. A large number of studies have documented that local economic structure influences economic growth and that this impact of economic structure influence sectors differently (Glaeser et al. 1992, Thurston and Yezer 1994, Henderson et al. 1995, Deitz 1998, Combes 2000, Henderson 2003, Devereux et al. 2007, Carruthers and Mulligan 2008). The local interaction between firms may be between firms in the same industry sector (localisation economies) or between firms in different sectors (urban economies). The level of interaction depends on the vertical linkages between firms, competition for employment and other locally supplied factors as well as local spillovers between firms. For example, Cohen and Paul (2005) find in a study of the food manufacturing sector in the U.S. evidences of cost-savings in firms being located close to other food industry firms as well as close to firms from other sectors.

Then, the Carlino-Mills framework has been modified to address sector-specific employment in other studies. In a study of impact of a rapid rail transit on economic development Bollinger and Ihlanfeldt (1997) decompose employment in 11 sectors and population in whites and blacks. They find sector specific results, however, their main focus was not to investigate the links between sectors and population growth. Schmitt et al. (2006) decompose employment into export and services sectors employment in an analysis of urban growth effects on rural population, export and service employment in eastern France. They argue that demand for service goods comes primarily from households within the subarea where the service establishment is located, implying that service employment depends on size of the local population. On the other hand, export sector employment is only restricted by the distance household are willing to commute which is generally longer than the acceptable service good shopping trip distance. Graaff et al. (2007) model employment in production, distribution, producer service, and consumer services sectors in a model of employment and population growth in the Netherlands. Their results contradict also the export base hypothesis, i.e. increasing production employment has a negative impact on consumer service employment. Duffy-Deno (1997) applies a system with four equations in the analysis of the effect of listing of threatened and endangered species on county employment growth between 1980 and 1990 in the U.S. West. Employment is decomposed in natural resource employment and non-resource employment. To account for the pressure from economic activity on local ecosystems and endemic species habitats and thereby potential endogenous listing of endangered species, the listed species density in a county is modeled as a function of employment growth and population. Arauzo-Carod (2007) divides employees as well as population into subgroups defined by professional groups, and find that location pattern depends on the professional groups of residents and employees. There have, to our knowledge, been no "Calino-Mills" models addressing the food industry explicitly. Hailu and Rosenberger (2004) include an equation for agricultural land use, assuming that changes in agricultural density depend on changes in population and employment, but they do not estimate the impact of agricultural density on employment and population growth.

The empirical model will be applied on Danish and French data. This allows an assessment of how country differences in the local socioeconomic milieu affect linkages between employment and population growth. Henry et al (1999) have estimated a related model on Danish, French and U.S. data which takes urban spread and back wash effects into account (see Henry et al. 1997). This study used rural municipality data from 1985 and 1993 in Denmark and data on commune level in six regions in France for the years 1982 and 1990. Their results indicate that urban spread effects are often significant and tend to dominate urban backwash impacts on rural communities. Similar results are found in Schmitt and Henry (2000) for the French data. Henry et al. (2001) apply different empirical model specification on data from the same six regions in France and compare the results. They conclude that in rural France "people follow jobs". Schmitt et al. (2006) analysis also the impact of urban core and fringe growth in the same six regions, however, applying a modified model where employment is disaggregated into a service sector and a manufacturing sector. They find, among others, that in functional economic regions with declining urban cores, manufacturing employment growth has a significant negative impact on rural service employment which is contradicting the manufacturing base hypothesis. In an application of the Carlino-Mills and Boarnet models on data from France in the period 1990-1999 Blanc et al. (2007) find that changes in employment has a stronger effect on population growth than the impact of population on employment.

As mentioned above, the main objective of this study is to investigate the role of the agro-food sector as employment and population growth driver, applying a sector-specific version of the Boarnet model. If employment in the agro-food sector has a positive impact on employment in other sectors or has a positive impact on population, it confirms that the agro-food sector is an economic development driver in rural areas. On the other hand, if increasing employment in the agro-food sector has a negative impact on employment in other sectors and on population we will question the agro-food sector as an important economic development driver.

The next section describes the model framework and the empirical model is developed. Then, the data used in the study is described and estimation issues are discussed. Then, we present the results and conclude the paper with a discussion of the policy relevance of the results.

2 The empirical model

The empirical model is based on a simultaneous equation model describing the changes in employment and population at local level introduced by Carlino and Mills (1987). The spatial structure of the data is handled explicitly using the spatial formulation in Boarnet (1994). However, we modify this framework and disaggregate employment into agro-food sector, manufacturing industry and services sectors, implying a simultaneous equation system with four endogenous variables. In equilibrium consumer and producer amenities are capitalized into land rents and wages (Roback 1982). Therefore, land rents and wages are not specified explicitly in the model (Schmitt et al. 2006). However, in an analysis of whether people follow newly created jobs into regions or whether jobs follow newly arrived migrants in 48

U.S states Partridge and Rickman (2003) estimate a structural model with wages modeled explicitly, applying a three-dimensional structural vector autoregressive model (SVAR). This specification allows for a more direct identification of the labour-demand and supply-shocks causing changes in employment as well as labor-supply shocks can be decomposed into changes due to the original residents and changes due to migration. However, the results hinge on a correct specification of the underlying economic model which provides restrictions used for identification of the empirical model and the availability of relative long time series data. In this study we use the lagged adjustment model which is compatible with the available data set (cross section and relative short period) and the model is estimated using instrumental variable methods.

The four simultaneous equations can be written

$$
(1)\quad
\begin{aligned}
P_{it}^{*} &= \Psi(A_i, EMP_{Ait}^{*}, EMP_{Xit}^{*}, EMP_{Sit}^{*}) \\
E_{Ait}^{*} &= \Phi(B_i, POP_{it}^{*}, EMP_{Xit}^{*}, EMP_{Sit}^{*}) \\
E_{Xit}^{*} &= \Xi(C_i, POP_{it}^{*}, EMP_{Ait}^{*}, EMP_{Sit}^{*}) \\
E_{Sit}^{*} &= \Theta(D_i, POP_{it}^{*}, EMP_{Ait}^{*}, EMP_{Xit}^{*})
\end{aligned}
$$

where P_{it}^{*}, E_{Ait}^{*}, E_{Xit}^{*} and E_{Sit}^{*} are equilibrium population and employments in agro-food sector, in the manufacturing sector, and in the service sector, respectively, in the *i*th area at time period *t*. POP_{it}^{*}, $EMP_{Ait}^{*}, EMP_{Xit}^{*}$, and EMP_{Sit}^{*} are the equilibrium in local residential and labor market zones, i.e. area *i* and its proximate neighbours, at time period *t*. Not only are people drawn to locations that offer economic opportunity, people are drawn to locations that appeal to personal preferences, and firms are not only drawn to locations that offer labour but also low costs and access to markets. Therefore, we include other drivers of population and employment, respectively, (A_i, B_i, C_i, and D_i). These variables represent characteristics of the municipalities which are influencing the four equilibrium relationships.

A similar model, with three simultaneous equations, is estimated in Schmitt et al. (2006), where employment is divided into rural manufacturing employment and service employment. However, they include also variables for nearby urban and urban fringe and focus on the effect of nearby urban growth on rural changes in population and employment.

It is assumed that changes in population and employment levels at a residential or labour market zone are adjustments towards an equilibrium. Assuming the same adjustment process as in Carlino and Mills (1987) we can the write the changes in population and employment in area i:

$$
(2)\quad
\begin{aligned}
dP_{it} &= P_{it} - P_{it-1} = \lambda_P\left(P^*_{it} - P_{it-1}\right)\\
dE_{Ait} &= E_{Ait} - E_{Ait-1} = \lambda_A\left(E^*_{Ait} - E_{Ait-1}\right)\\
dE_{Xit} &= E_{Xit} - E_{Xit-1} = \lambda_X\left(E^*_{Xit} - E_{Xit-1}\right)\\
dE_{Sit} &= E_{Sit} - E_{Sit-1} = \lambda_S\left(E^*_{Sit} - E_{Sit-1}\right)
\end{aligned}
$$

where dP_{it}, dE_{Ait}, dE_{Xit}, and dE_{Sit} are population and employment changes and where P_{it}, E_{Ait}, E_{Xit}, and E_{Sit}, are the observed level of population and employment. λ_P, λ_A, λ_X, and λ_S are the rates of adjustments to equilibrium levels for population and employment. We assume the same adjustment process for local residential and labor market zones.

It is further assumed that the equilibrium levels in (1) are linear functions. Substituting (1) into (2) and writing in matrix form

$$
\begin{aligned}
\boldsymbol{dP}_t &= \alpha_1\boldsymbol{i} + \boldsymbol{\alpha}_2\boldsymbol{A} - \lambda_P\boldsymbol{P}_{t-1} + \alpha_3(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{At-1} + \alpha_4(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{At} + \alpha_5(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{Xt} + \alpha_6(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{Xt-1}\\
&\quad + \alpha_7(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{St} + \alpha_8(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{St-1} + \boldsymbol{\varepsilon}_{Pt}\\
\boldsymbol{dE}_{At} &= \beta_1\boldsymbol{i} + \boldsymbol{\beta}_2\boldsymbol{B} - \lambda_A\boldsymbol{E}_{At-1} + \beta_3(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{P}_{t-1} + \beta_4(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dP}_t + \beta_5(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{Xt} + \beta_6(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{Xt-1}\\
&\quad + \beta_7(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{St} + \beta_8(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{St-1} + \boldsymbol{\varepsilon}_{At}\\
\boldsymbol{dE}_{Xt} &= \gamma_1\boldsymbol{i} + \boldsymbol{\gamma}_2 C - \lambda_X\boldsymbol{E}_{Xt-1} + \gamma_3(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{P}_{t-1} + \gamma_4(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dP}_t + \gamma_5(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{At} + \gamma_6(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{At-1}\\
&\quad + \gamma_7(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{St} + \gamma_8(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{St-1} + \boldsymbol{\varepsilon}_{Xt}\\
\boldsymbol{dE}_{St} &= \delta_1\boldsymbol{i} + \boldsymbol{\delta}_2 D - \lambda_S\boldsymbol{E}_{St-1} + \delta_3(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{P}_{t-1} + \delta_4(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dP}_t + \delta_5(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{At} + \delta_6(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{At-1}\\
&\quad + \delta_7(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{Xt} + \delta_8(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{Xt-1} + \boldsymbol{\varepsilon}_{St}
\end{aligned}
$$

Where $\boldsymbol{i}$ is a vector of ones, $\boldsymbol{I}$ is the identity matrix, and $\boldsymbol{W}$ a spatial weight matrix with the elements w_{ij} which are nonzero for areas in the local residential or labor market zone and zero for the diagonal elements w_{ii}, i.e. $\boldsymbol{POP}_t = \left(\boldsymbol{W}+\boldsymbol{I}\right)\boldsymbol{P}_t$ where $\boldsymbol{POP}_t$ and $\boldsymbol{P}_t$ are vectors of observations. $\boldsymbol{\varepsilon}_P$, $\boldsymbol{\varepsilon}_A$, $\boldsymbol{\varepsilon}_X$, and $\boldsymbol{\varepsilon}_S$ are vectors of random disturbance terms that are assumed to be normally and independently distributed with zero mean and constant variance. λ_P, λ_A, λ_X, λ_S, α_j, β_j, γ_j, δ_j for j =1, …, 8 are parameters to be estimated. λ_P, λ_A, λ_X, λ_S are adjustment parameters $\in[0,1]$. This model is termed a spatial cross-regressive model in the Rey and Boarnet (2004) terminology.

Schmitt et al. (2006) interpret the regression coefficients on contemporaneous changes, $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dP}_t$, $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{At}$, $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{Xt}$, and $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{dE}_{St}$ as static spatial externalities and the regression coefficients on the base period population or employment size, $(\mathbf{W}+\mathbf{I})\mathbf{P}_{t-1}$, $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{At-1}$, $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{Xt-1}$, and $(\boldsymbol{W}+\boldsymbol{I})\boldsymbol{E}_{St-1}$, as dynamic spatial externalities associated with building up of knowledge across industries in a more diverse (larger) urban area. However, we cannot before hand determine the sign of these parameters. On one hand, an increase in employment in the agro-food sector may have an negative impact on the employment in other sectors due to input competition but on the other hand it may have a positive impact on employment in other sectors due to vertical linkages between firms in the agrofood sector and the manufacturing and service sectors.

3 Data

The study period is 1997-2006 for Denmark and 1990-1999 for France, representing the most recent periods where data is available in both countries. The geographical units used in Denmark are the 265 municipalities and in France the 1,916 functional economic areas (FEA) defined by the French National Statistics Institute (INSEE 2003). The two main data sources for the Danish data are the online databases *Statbank Denmark* and *De Kommunale Nøgletal* provided by Statistics Denmark and by the Ministry of the Interior and Health, respectively. The sources for the French data are INSEE, Meteo France, Ministry of the Interior, and Ministry of Budget.

The dependent variables in the four equations are dP_i, the change in population density (*vdpop*)[1], dE_{Ai}, the change in employment density in the agro-food sector excluding employment in agriculture and fisheries (*vdfood*), dE_{Xi}, the change in employment density in the manufacturing sectors (*vdexp*), and dE_{Si}, change in employment density in the service sectors (*vdserv*). The agro-food, manufacturing, and service sectors are defined in the appendix. Densities are used for the employment and population change variables to control

[1] Variable names in parentheses are the names used in the estimations

for the geographical size of the geographical units. Applying area standardized variables may give more robust results when geographical units are small (Mulligan et al. 1999).

As explanatory variables we use in each equation the beginning period value of the dependent variable undifferenced (*dpop_ini, dfood_ini, dexp_ini, or dserv_ini*) and the spatial weighted undifferenced beginning period densities of the other dependent variables (*widpop_ini*, *widfood_ini*, *widexp_ini*, *widserv_ini*), the spatial weighted changes in densities of the dependent variables in the other equations (*wivdpop*, *wivdfood*, *wivdexp*, *wivdserv*), and exogenous control variables representing local amenities and other characteristics of the local administrative units (see table 1). The **W** matrix for calculating the spatial weighted variables contains the elements $w_{ij}=1/d_{ij}$ where d_{ij} is the distance between geographical unit *i* and *j*. We have included a threshold of 100 km for the impact of one unit on another, i.e. the $w_{ij} = 0$ if d_{ij} larger than this threshold. The distance between geographical units is the road distance between the administrative centres (typically the largest town in the unit). If the transport between two units includes ferry transport or crossing a bridge with toll, the implied costs are converted to distance. The weight matrix ***W*** is standardized so that the elements in each row sum to 1.

The estimations for Denmark and France have the same dependent variables but can have alternatives control variables. The controls variables are evaluated at the beginning of the period (1997 for Denmark, 1990 for France).

We include control variables for the access to amenities which is expected to have impact on the changes in population (Deller et al. 2001, Duffy-Deno 1997, Mathur and Sheldon 2005) as well as on the employment. Generally, the empirical studies confirm that the presence of amenities attracts firms (Gottlieb 1995). However, it is less clear whether the presence of amenities attract firms directly or firms are attracted indirectly by the workers' residential preferences. The firm takes into account the workers' preferences because in amenity-poor regions they must offer higher wages to retain workers. However, the impact may also be direct due to amenities having impact on firm productivity (Roback 1982). For example, amenities serve as latent primary factor inputs to the production process of tourism (Marcouiller 1998) and therefore the employment in the service sector. Amenity-related migration can change over time because of aging of the population and amenity demand shifts associated with change in real income (Mueser and Graves 1995). Since income is increasing over time and the demand for amenities increases with income, we will expect that the presence of local amenities implies a positive change in population over time (Mathur and Sheldon 2005). Natural amenities are represented by a variable for location at the coast, i.e. if a municipality has a coastline *coast*=1. We expect that proximity to the sea will attract population. For France we have also included a climate zone variable. For the five climatic areas defined by Meteo France, we have introduced a dummy variable: oceanic climate (*clim_sea*), oceanic climate of transition (reference), continental climate (*clim_contin*), Mediterranean climate (*clim_medit*), and mountain climate (*clim_mount*). In Denmark the climate is rather homogeneous and is not expected to influence migration choices.

In the service sector employment equation we have included the number of tourist accommodations per inhabitants (*tourist*), represented by the sum of hotels and restaurants in the Danish data and the number of beds in 1988 in the French data. Deller et al. (2008) find that the existence of natural amenities as such does not facilitate economic growth. There need to be facilities in addition to the natural amenities to have an impact on employment.

Also man made amenities, e.g. schools and hospitals, may influence the attractiveness of a region (see e.g. Schmitt and Henry 2000). Variables representing the access to intermediate schools and high schools have been included for France and Denmark, respectively, and the distance to the nearest school is used as a proxy for the access (*dist_highscho*). The distance to the nearest hospital was included initially but due to its collinearity with the other explanatory variables it was excluded in the final model.

Variations in local tax rates and the supply of public provided services may be important determinants of residents' location choice (Tiebout 1956, Wilson 1999). Therefore, the population equation includes the local tax rate and an indicator of the supply of public services (*acc_servp*). The tax rate is also included in the employment equations to account for the impact of local tax on the firm location decision (see e.g. Papke 1991). For France, we have used the residential tax in 1993 (*th93*) for the population equation and the business tax in 1993 (*tp93*) for the employment equations. In Denmark the same local tax rates (*tax97*) applies to households and businesses and therefore the same tax rate is included in both population and employment equations. The accessibility to proximity services (*acc_servp*) are in the French data in terms of time and defined using the methodology described in appendix 4 in INSEE (2003) to data in 1988. We retain three types of services: trade services (supermarket, …), public services (post office, …) and health services (general practitioner, …). In the Danish data the access to proximity services is calculated as the relative level of expenditure by a municipality on public services (schools, kindergartens, old people care, local infrastructure etc.) in 1997 adjusted for demographic factors and thereby indicating the level and quality of services in the municipality.

The beginning period annual income (*inc*), measured in DDK and EUROS for Denmark and France respectively, has been included in the population equation representing the economic potential of a location (endowment, productivity).

The employment equations include variables characterising the labour force evaluated at the beginning period value: the share of unemployed (*rchom*), the ratio between the number of executive and intermediate occupations and the number of manual and clerical workers (*noblu*), the share of self-employed workers in the active population (*self*), and the ratio between skilled manual workers by unskilled manual workers (*skiwo*). In the case of Denmark, this ratio is between skilled and unskilled workers in general. The population equation was also added a variable representing labour force skills (Denmark *skiwo,* France *noblu*) to account for potential spatial sorting of the labour force (Combes et al. 2008).

In agro-food employment equation we have included a proxy variable for the access to input to the agro-food industry (*widagr*). This variable is calculated as the employment in agriculture and fisheries at the beginning period value weighted with the matrix ($\boldsymbol{I}$ + $\boldsymbol{W}$) based on the distance matrix $\boldsymbol{W}$ defined above.

Many studies show that growth in a municipality may depend on the location in urban-rural hierarchy (e.g. Schmitt et al. 2006, Partridge et al. 2008). Whether a municipality is located in an urban or rural neighbourhood and the distance to nearest urban growth centre may be determinant for changes in population and employment growth. In the Danish data set we include a variable for distance to the nearest of the five largest cities in Denmark. In the French model we include, in addition to the distance to the nearest urban center more than 100,000 workers, a dummy variable for areas located in Ile de France (*idf*, region of Paris), periurban areas (*periurb*) and rural areas (*rural*). The INSEE delineation called *Urban and Rural Area Zoning* divides French municipalities into urban centers, periurban fringes and predominantly rural areas. The center of each FEA is a municipality which has a position in the *Urban and Rural Area Zoning*. *periurb*=1 when the centre of the FEA is in periurban fringes, *rural*=1 when the centre of the FEA is in predominantly rural areas and not in a rural centre of employment with more than 1,500 jobs.

Table 1. Variables and descriptive statistics

	Denmark		France	
Variable	Mean	Std Dev	Mean	Std Dev
vdpop	7.19	25.14	5.58	17.53
vdfood	-0.91	3.72	0.03	0.93
vdexp	0.65	15.56	0.38	5.60
vdserv	4.15	20.48	2.42	5.70
dpop_ini	263.65	801.60	97.98	151.32
dfood_ini	3.02	6.55	1.18	2.34
dexp_ini	40.46	116.19	10.47	25.15
dserv_ini	72.98	263.20	13.92	32.38
widpop_ini	193.83	271.60	119.62	128.28
widfood_ini	2.56	2.48	1.35	1.17
widexp_ini	28.84	43.97	15.61	22.21
widserv_ini	55.46	94.52	21.50	27.94
wivdpop	6.11	9.15	4.46	6.31
wivdfood	-0.65	1.12	-0.01	0.31
wivdexp	1.45	4.85	0.03	1.60
wivdserv	3.68	7.13	2.66	2.54
coast	0.62	0.49	0.11	0.32
clim_sea			0.34	0.47
clim_contin			0.16	0.37
clim_medit			0.07	0.26
clim_mount			0.17	0.37
tourist	2.10	0.95	0.83	1.84
dist_highscho	9.61	8.55	4.43	2.91
acc_servp	0.98	0.06	7.09	2.98
th93/tax97	31.08	1.09	10.03	3.08
tp93			11.57	3.88
inc	141588	16461	10847	2240
noblu	0.45	0.24	0.37	0.15
skiwo	1.23	0.41	1.17	0.46
self	0.13	0.04	0.09	0.03
rchom	7.40	2.14	10.25	3.25
widagr	2.77	0.71	2.60	1.19
dist_urb	59.19	37.71	54.66	34.99
idf			0.03	0.18
periurb			0.17	0.38
rural			0.36	0.48

4 Estimation issues

The empirical results are obtained in a two-stage process using an instrumental variable method to account for endogenous explanatory variables implied by potential simultaneity between the changes in population density, dP_i, and changes in employment density, dE_{Ai},

dE_{Xi}, and dE_{Si}. The predicted values of the endogenous variables used in the second stage of the estimation are obtained by regression of the spatially lagged dependent variables (*wivdpop*, *wivdfood* etc.) on instruments, as recommended by Rey and Boarnet (2004).

The instruments used for the estimation in the first stage are all the exogenous variables introduced in the population and the three employment equations and, when possible, their spatial lag values. We modified the set of instruments according to the results of the Sargan test for instrument validity. In a simultaneous system, we need to use the same set of instruments for all equations. This condition could not be met without treating the adjustment parameters as endogenous variables. When adjustment parameters are treated as endogenous, the Sargan statistics are always sufficient low, i.e. the probability of the χ^2 is much higher than 0.10 (see table A.2 in the appendix).

Following Bound et al. (1995), we report the partial R^2 of the excluded instruments in the first-stage regression. For each equation, the set $\mathbf{Z}$ of instruments can be subdivided into $\mathbf{Z}_1$, the exogenous variables, and $\mathbf{Z}_2$, the additional instruments or excluded instruments. For example, in the agro-food employment equation, *noblu* is in $\mathbf{Z}_1$ whereas *coast* is in $\mathbf{Z}_2$. The partial R^2 measures the correlation between the endogenous variable and the additional instruments, $\mathbf{Z}_2$, after taking into account the exogenous variables $\mathbf{Z}_1$. In the case of weak instruments, the partial R^2 is close to 0. In our case, the partial R^2 is above 0.10 except for the spatial weighted change in manufacturing employment (0.073) in the Danish agro-food employment equation and for the spatial weighted change in agro-food employment (0.077) in the Danish manufacturing employment equation.

We also perform influence diagnostics on the second stage of the estimation (Belsley et al. 1980). We consider six statistics: leverage, standardized residuals, studentized residuals, Cook's distance, precision, and influence on the adjusted value. We find that the share of influent observations is between 2.5% and 5% in the Danish model whereas in the French model, between 2% and 3% of the observations are influent. Table A.3 in the appendix gives the number of influent observations in each equation.

For each equation and each influent observation, we introduce a dummy variable in the model taking 1 for the observation and 0 elsewhere. The sign of the estimated parameter of the dummy variable was then used to define two groups for each equation: those with a positive value and those with a negative value. Thus we obtain 8 variables (*pop_gr1*, *pop_gr2*, *food_gr1*, *food_gr2*, *exp_gr1*, *exp_gr2*, *serv_gr1*, *serv_gr2*) that we add in the four equations to control these influent observations. For the Danish population equation, *pop_gr1* takes the value 1 for the 4 influent observations having a negative effect whereas *pop_gr2* defines the 6 influent observations having a positive impact. The number of observations in each group and equation is reported in Table A.3 in the appendix.

These group variables are introduced as exogenous variables, i.e. they enter the initial set of instruments. Then, the validity of instruments was checked in the Danish model and consequently we excluded the spatial lag of *coast*, *tourist* and *inc* in the Danish model and ended up with a set of 33 instruments. In the French model, we excluded the spatial lag of *clim_sea*, *clim_medit*, *dist_highscho*, *inc*, *rchom,* and *rural,* implying a set of 46 instruments.

The tests for exogeneity of the instrumented variables included on the right side of the four equations are made with the 'added' regression method. In all equations, the values of the corresponding F are high enough to reject the exogeneity of those variables.

We also test for spatial autocorrelation in the errors, applying the I-Moran test suggested by Anselin and Kelejian (1997) for models with endogenous regressors. Tests for spatial error autocorrelation were made with different spatial weight matrices: the row-standardized matrix of contiguity between local administrative units (W_C); the row-standardized matrix of contiguity in a radius of 100 km around the local administrative unit ; the row-standardized matrix of distance inverse in a radius of 100 km around the local administrative unit (W); and, the row-standardized matrix of distance inverse. As the I-Moran takes the most often the highest value for the contiguity matrix (W_C), we only report the I-Moran test for W_C[2].

When the I-Moran test detects spatial autocorrelation, we correct for it using the generalized spatial two-stage squares procedure described by Kelejian and Prucha (1998). A generalized moments estimation is performed on the two-stage least squares residuals in order to estimate the spatial autocorrelation coefficient ρ. Then ρ is used to perform a Cochrane-Orcutt transformation. Finally, the transformed model is estimated by two-stage least squares.

[2] The results for the other matrices are available upon request.

5 Empirical results

Figure 1. Static externalities (W+I).ΔX_t

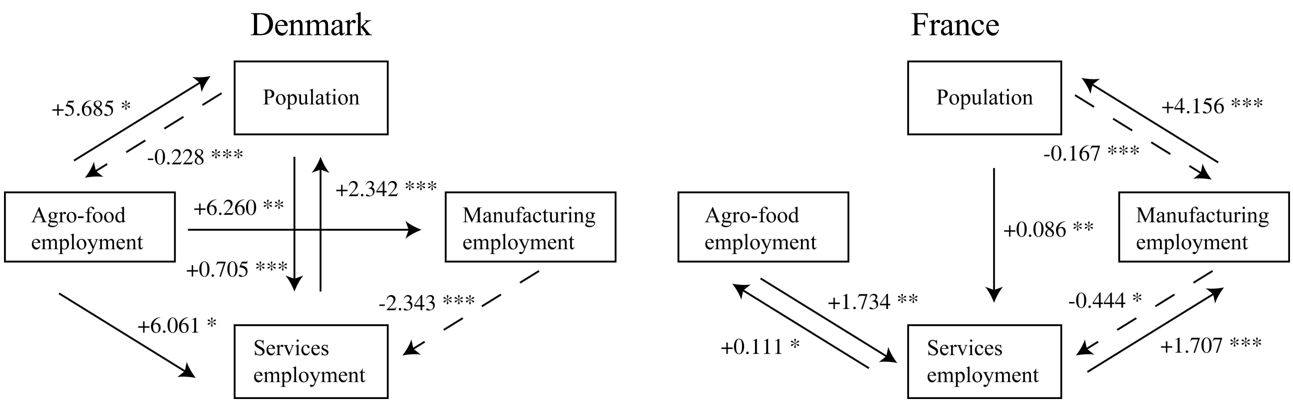

Figure 2. Dynamic externalities (W+I).X_{t-1}

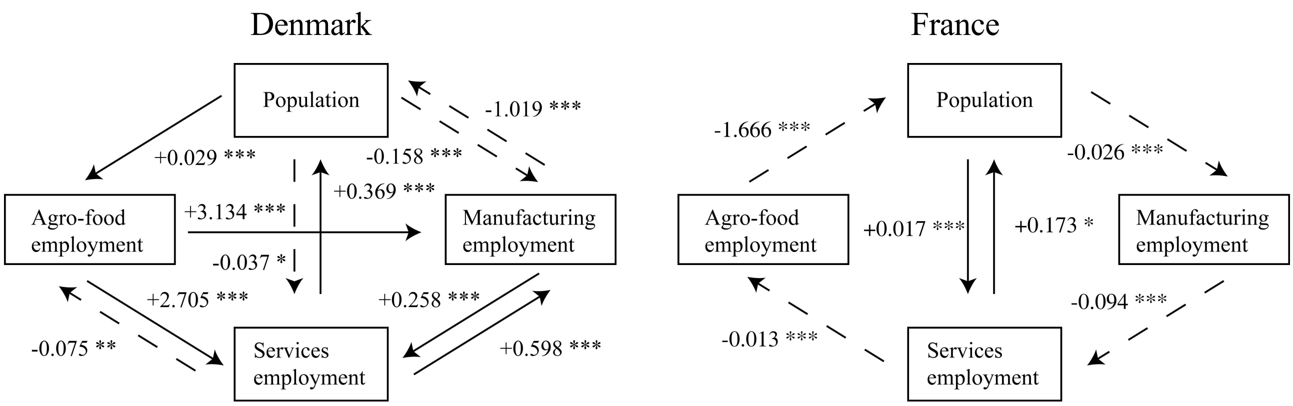

Figure 1 and 2 present the main results of estimating the model for Denmark and France. The parameter estimates are reported in the Appendix 2. Both in France and in Denmark the results indicate that employment growth has a simultaneous positive effect on population growth, or in other words, people follow jobs. However, in France it is only the manufacturing sector which has a significant impact on population whereas in Denmark it is both the service and agro-food sectors. One reason for these differences may be that the Danish dataset is from a later time period, i.e. the transformation of the economy from manufacturing-based to a service-based economy is more advanced in Denmark.

The beginning period service sector employment density has a positive impact on population growth in both countries whereas the beginning period employment density in agro-food sector has a significant negative impact in France and the manufacturing sector employment density has a significant negative impact in Denmark. This indicates that regions where the starting point is a high employment in the traditional manufacturing sectors, have been weak in attracting new inhabitants while regions which have had a high density of employment in service sector have been able to attract population.

Jobs in the agro-food sector do not follow people. In fact, we find a significant negative impact of population density growth on employment growth in this sector in Denmark. This may seem surprising that an increase in population and thereby an increase in supply of employment has a negative impact on employment in this sector. One could interpret this as an effect of excluding land rents in the model. A strong residential demand for land may crowd out agro-food industries. In France there is a significant positive impact of employment growth in the service sector on the agro-food sector employment, indicating positive externalities from the service sector on the agro-food sector. While the simultaneous impact of population growth on the agro-food sector in Denmark was negative, the dynamic effects, i.e. the beginning period population, has a positive impact. This indicates that the employment in agro-food firms located in less dense populated (rural) areas have lost relative most employment. In both countries, there are negative dynamic externalities of the service sector on the agro-food sector. This implies that employment in regions with a high initial service sector employment have the lowest growth in agro-food employment. Therefore, the results provide no unambiguous answer on the question whether service sector has a positive effect on the agro-food sector employment, i.e. positive static externalities (France) and negative dynamic externalities. The agro-food employment does not seem to be influenced by other manufacturing firms, i.e. the coefficients on initial manufacturing employment and growth are insignificant.

The results do not support of that the manufacturing sector employment follows population. In fact, we find a negative impact of population growth on the manufacturing employment in France. This may be explained by particular demographical trends in France where people on retirement often chose to migrate to the Mediterranean areas to enjoy the climatic amenities. This is reflected in strongly significant positive coefficient of the control variable representing areas in the southern France (*clim_medit)*. Basically, in attractive regions for settlement (Southern France) in-migration of pensioners crowd out labour supply for manufacturing industry. The agro-food employment (in Denmark) and the service sector employment (France) have a significant positive impact on employment in manufacturing sector, indicating positive spillovers from these sectors to the manufacturing sector. That is, positive urban externalities (technical spillovers, labour market pooling, and/or vertical linkages between firms in these sectors) dominate over the potential negative effect of competition about local labor supply and consequently crowding out effects. The beginning period population density has a negative impact on manufacturing sector employment growth, indicating that the manufacturing sector, contrary to the agro-food sector, has the highest relative growth in low population density regions. In Denmark, there are significant positive coefficients on the beginning period employment density in both the agro-food and service sectors. This is consistent with the positive simultaneous effects, i.e. the manufacturing sector is influenced positively from spillovers from both other sectors.

In the service sector equation the impacts of population changes on employment are positive, i.e. jobs in service sector follows people, in both countries. There may in fact be two explanations for this result. The firms may be attracted by the increased supply of labour in the regions where the population density increases or the firms supplying consumer services may be attracted by an increased consumer demand in regions with increasing population. The latter explanation applies when they are retirees who dominate the population growth (Vollet et al. 2005). We also find in both countries that the agro-food sector employment has a positive impact on the service sector whereas the manufacturing sector has a negative impact, implying that an increase in the manufacturing sector crowds out employment in the service sector while positive externalities are dominating the impact of the agro-food sector on the service sector. In Denmark, we also observe a positive impact of beginning period agro-food and manufacturing sector employment density whereas in France there is a negative impact of the manufacturing sector employment density. Beginning period population density has a positive impact in France but a negative impact in Denmark. This may imply that the growth in the service sector in Denmark has been dominated by relative more firms providing business services whereas the growth in France has been dominated by firms supplying consumer services.

The coefficients of the control variables are reported in table A.2. in the appendix. The variables representing natural amenities in the population equation, i.e. proximity to the costs (*coast*) and climatic variables (*clim_medit, clim_sea*), shows that population is attracted by coastal areas and Mediterranean climate. As also discussed above on explanation of this result may be that people move to the south of France after they retire on pension. The positive effect of amenities on population growth is also reflected by the positive sign of the coefficient on the variable *tourist* as tourist accommodations typically will be associated with amenities. The impact of the local tax rate (*th97*) has a positive significant effect in the French data as expected whereas the variable representing the access to local consumer services (*acc_servp*) had a negative effect. Income (*inc*) had a significant positive effect on population density growth in Denmark. This effect may reflect that relative high beginning period wages in a region have attracted in-migration, contradicting (in the short run) our initial assumption that regional differences in wages and land prices are reflecting differences in local amenities and endowments. In Denmark the variable *skiwo* and in France the variable *noblu* were significant in the population equation indicating that regions with a high share of skilled workers and employees with executive and intermediate positions, respectively, have a positive impact on population density growth. The variables representing the urban-rural hierarchy indicates that in population is density is growing less far from an urban centre (cf. a negative sign on *dist_urb*) and periurban areas (*periurb*) have a relative high growth.

The coefficient on the beginning period employment in the primary agricultural sector was used as indicator of the access to input to the agro-food sector. In France, this variable has a positive impact on the employment in the agro-food sector whereas the impact is negative in Denmark. Furthermore, in the French data we see that the distance to an urban centre (*dist_urb*) has a positive impact on the employment in the agro-food sector. This indicates that the agro-food industry in France is more closely related to the primary agricultural sector than in Denmark where the focus is more related to the consumers. An explanation of these differences may be found in the more strong tradition of locale produced foods and origin certified products in France (Renting et al. 2003).[3]

Interestingly, we see that the share of the labour force with executive or intermediate positions (*noblu*) have a negative effect whereas the share of skilled workers (*skiwo*) have a positive impact on employment in the agro-food sector. This is unlike the manufacturing equation where *noblu* has a positive impact on employment and *skiwo* is insignificant. This indicates that food processing is different from other types of manufacturing. The employment in the manufacturing sector is influenced positively by the number of self-employed (*self*) in

[3] According to the EU Commission (2008) in France 160 products are with the geographical labels "Protected Designation of Origin" and the "Protected Geographical Indications". In Denmark this number is only three.

Denmark. In France, a location in a periurban area has a positive impact on employment growth in the manufacturing sector.

In the service sector, the labour market variables have similar effects on employment as in the manufacturing equation for both countries. The tax rate has a negative effect on employment growth in the service sector, however, not significant in Denmark. In periurban areas in France the growth in service employment is also higher. The variable representing *Ile de France* has a negative sign.

Based on the theoretical model, the equilibrium relationship in equation (1) and adjustment mechanism in (2), we would expect that the sign of the regression coefficient on the beginning period level of the left hand size variable should be negative. Nevertheless, in the service sector we find significant positive coefficients in both countries and it is also the case for France in the population equation. This indicates that the equilibrium relationship is not stable which may be explained by agglomeration externalities (Blanc et al. 2007).

As described in the section *Estimation issues*, a several diagnostic tests have been applied and in the table A.2. in the appendix the main results of these tests are reported. Often diagnostic tests, e.g. of the validity of the instrumental variables, have not been reported in the applications of the regional adjustment model and one may fear that deviating results between different studies may be due to model misspecification (Rickman 2010). Due to the results of our rather rigorous diagnostic tests we are rather confident with our results. Only with respect to the partial R^2 for the two variables *wivdfood* and *wivdexp* in the Danish manufacturing sector and agro-food sector, respectively, the diagnostics indicated relative weak instruments.

The I-Moran test of spatial autocorrelation in the residuals was on significant for the population and the manufacturing sector equation. In these two cases the results presented are based on the application of the generalized spatial two-stage squares procedure. In both case the spatial autocorrelation coefficient was positive.

6 Discussion and concluding remarks

In both countries, the results are not unambiguously supporting the export base hypothesis, i.e. the manufacturing sector employment is not driving employment in the service sector. This is consistent with the results in, e.g., de Graaff et al. (2007) and in Kilkenny and Partridge (2009). However, when we look at the agro-food sector there are indications of a positive impact of this sector on the service sector, i.e. confirming the export base hypothesis. This shows that the aggregation of employment in, typically, two sectors, the export and the non-export sector, in empirical analysis of the export base hypothesis may be too simplistic.

Is the agro-food sector an important driver of economic development which could justify the focus on this sector in rural development programs? This study does not answer this question definitively. However, we find that especially in Denmark the employment growth and beginning period density in the agro-food sector has positive impacts on the other two sectors, implying that increasing the employment in this sector does not crowd out employment in other sectors. The impact on population growth is less clear. In Denmark, the agro-food employment growth had a positive simultaneous impact on population growth whereas in France the initial period employment density had a negative impact.

While Chevassus-Lozza and Galliano (2003) find that the export of agro-food firms is positively influenced by urban economies, our results show that employment growth in the agro-food sector is only influenced positively by employment growth in the service sector in France and that the initial employment in the service sector has a negative impact on the agro-food sector employment in both countries. In other words, we do not find strong evidences of urban economies in the agro-food sector.

Even though there are many similarities in the results from both countries, there are also some particularities for each country. In both countries, we find that the service sector employment is influenced positively by the employment growth and beginning period employment in the agro-food sector and by population density growth but negatively by the manufacturing employment growth. We also see in both countries that the population density has a negative impact on employment growth in manufacturing sector. This may reflect a general trend where relative low-waged manufacturing firms are being crowded out in urban agglomerations. On the other hand, a higher initial employment density in the service sector has in both countries a positive impact on population growth.

The growth in agro-food employment seems to be more important for local economic development in Denmark where population density growth as well as employment growth in the two other sectors are affected positively by the agro-food sector. In France, agro-food employment growth has only a positive effect on service sector employment. Another particularity in the French results is that it is only the manufacturing sector employment growth which has a positive impact on population density growth whereas it is the two other sectors considered which is important for the population growth in Denmark. In the results for Denmark the population density growth has negative impact on employment in the agro-food sector while we find a negative impact of population density growth on manufacturing in France. As mentioned in the previous section, this apparently contradicting results according to the theoretical model, may be due to not including land values in the model (Boarnet et al 2005) or due to some particular migration trends (pensioners moving to the southern France).

Rickman (2010) has recently criticized the use of regional adjustment models because of instability of results due to misspecification of models or that the model parameters do not reflect underlying behavioral relations. We have in our study performed a rigorous diagnostic test of the applied adjustment model and by decomposing the employment into three sectors we believe that our results are not artifacts of potential variations in composition of the employment among regions. It also have to be noted that alternative methods like structural VAR models or computable general equilibrium models are not possible due to limitations in access to data.

Our finding that manufacturing employment has a negative impact on service sector employment contradicts the basic assumptions in the input-output models and models based on the export base hypothesis that does not take factor competition into account. Therefore, compared to such traditional models we believe the model presented in this paper provides a more flexible approach for modeling sectoral interaction at a local level.

7 References

Anselin, L., Kelejian, H. 1997. Testing for spatial error autocorrelation in the presence of endogenous regressors. *International Regional Science Review* 20: 153-182.

Arauzo-Carod, J.-M. 2007. Determinants of population and jobs at a local level. *Annals of Regional Science* 41: 87-104.

Barkley, D. L. 1995. The economics of ehange in rural America. *American Journal of Agricultural Economics* 77(5): 1252-1258.

Barkley, D. L., Henry, M. S., Bao, S. 1998. The role of local school quality in rural employment and population growth. *The Review of Regional Studies* 28(1): 81-102.

Belsley, D.A., Kuh, E., Welsh, R. E. 1980. Regression diagnostics. Wiley

Blanc, M., Schmitt, B., Ambiaud, E. 2007. Orientation économique et croissance locale de l'emploi dans les bassins de vie des bourgs et petites villes. *Économie et Statistique* 402 : 57-74.

Boarnet, M. G. 1994. An empirical model of intrametropolitan population and employment growth. *Papers in regional Science* 73(2): 135-152.

Boarnet, M. G., Chalermpong, S., Geho, E. 2005. Specification issues in models of population and employment growth. *Papers in Regional Science* 84: 21-46.

Bollinger, C. R., Ihlanfeldt, K. R. 1997. The impact of rapid rail transit on economic development: the case of Atlanta's MARTA. *Journal of Urban Economics* 42: 179-204.

Bound, J., Jaeger, D. A., Baker, R. M. 1995. Problems with instrumental variables estimation when the correlation between the instruments and the endogeneous explanatory variable is weak. *Journal of the American Statistical Association* 90(430): 443-450.

Capps, O, Fuller, S. W., Nichols, J. P. 1988. Assessing opportunities in food and fibre processing and distribution. *American Journal of Agricultural Economics* 70(2): 362-368.

Carlino, G. A., Mills, E. S. 1987. The determinants of county growth. *Journal of Regional Science* 27(1): 39-54.

Carruthers, J. I., Mulligan, G. F., 2008. A locational analysis of growth and change in American metropolitan areas. *Papers in Regional Science* 87(2) : 155-171.

Carruthers, J. I., Vias, A. C. 2005. Urban suburban and exurban sprawl in the Rocky Mountain West: Evidence from regional adjustment models. *Journal of Regional Science* 45(1): 21-48.

Chevassus-Lozza, E., Galliano, D. 2003. Local Spillovers, Firm organization and export behaviour: evidence from the French food industry. *Regional Studies* 37(2): 147-158.

Cohen, J. P., Paul, C. J. M. 2005. Agglomeration economies and industry location decisions: the impacts of spatial and industrial spillovers. *Regional Science and Urban Economics* 35: 215-237.

Combes, P.-P., 2000. Economic structure and local growth: France, 1984–1993. *Journal of Urban Economics* 47: 329-355.

Combes, P.-P., Duranton, G., Gobillon, L. 2008. Spatial wage disparities: Sorting matters! *Journal of Urban Economics* 63: 723-742.

Cutler, H., Davies, S. 2007. The impact of specific-sector changes in employment on economic growth, labor market performance and migration. *Journal of Regional Science* 47(5): 935-963.

Daniel, K, Kilkenny, M. 2009. Agricultural Subsidies and Rural Development. *Journal of Agricultural Economics* 60(3): 504-529.

Deitz, R. 1998. A joint model of residential and employment location in urban areas. *Journal of Urban Economics* 44: 197-215.

Deller, S. C., Lledo, V., Marcouiller, D. W. 2008. Modeling regional economic growth with a focus on amenities. *Review of Urban and Regional Development Studies* 20(1): 1-21.

Deller, S. C., Tsai, S. T. H., Marcouiller, D., English, D. B. K. 2001. The role of amenities and quality of life in rural economic growth. *American Journal of Agricultural Economics* 83(2): 352-365.

Devereux, M. P., Griffith, R., Simpson, H. 2007. Firm location decisions, regional grants and agglomeration externalities. *Journal of Public Economics* 91: 413-435.

Diakosavvas, D. 2006 (Ed.). Coherence of agricultural and rural development policies. The development dimension. Organisation for Economic Co-Operation and Development, pp 419.

Duffy-Deno, K. T. 1997. Economic effect of endangered species preservation in the Non-metropolitan West. *Growth and Change* 28: 263-288.

Edmiston, K. D. 2004. The Net Effects of Large Plant Locations and Expansions of County Employment. *Journal of Regional Science* 44: 289-319.

Ellison, G., Glaeser, E. L., 1999. The geographic concentration of industry : Does natural advantage explain agglomeration. *American Economic Review* 89(2): 311-316.

European Commision 2005. Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD). *Official Journal of the European Union L 277* Volume 48.

European Commision 2008. Green paper on agricultural product quality: product standards, farming requirements and quality schemes. COM(2008) 641 final.

Glaeser, E. L., Kallal, H., Scheinkman, J., Schleifer, A. 1992. Growth in cities. *Journal of Political Economy* 100: 1126-1152.

Goetz, S. J. 1997. State- and county-level determinants of food manufacturing establishment growth. *American Journal of Agricultural Economics* 79: 838-850.

Goetz, S. J., Debertin, D. L. 1996. Rural population decline in the 1980s: Impacts of farm structure and federal farm programs. *American Journal of Agricultural Economics* 78(3): 517–29.

Gottlieb, P. D. 1995. Residential amenities, firm location and economic development. *Urban Studies* 32(9): 1413-1436.

de Graaff, T., Florax, R. J. G. F., van Oort, F. G. 2007. About the validity of the monocentric model: A sectoral decomposition of population-employment dynamics in the Netherlands. Department of Spatial Economics, Faculty of Economics, Faculty of Economics and Business Administration, Vrije Universiteit Amsterdam. Working paper.

Hailu, Y. G., Rosenberger, R. S. 2004. Modeling migration effects on agricultural lands: A growth equilibrium model. *Agricultural and Resource Economics Review* 33(1): 50-60.

Harris, T., Shonkwiler, S., Ebai, G. 1999. Dynamic Nonmetropolitan Export-Base Modeling. *Review of Regional Studies* 29(2): 115-38.

Hasler, B., Jensen, J. D., Madsen, B., Andersen, M., Huusom, H., Jacobsen, L. B. 2002. Scenarios for rural areas' development – an integrated modelling approach. AKF-forlaget. Copenhagen, pp 142.

Henderson, J. V. 2003. Marshall's scale economies. *Journal of Urban Economics* 53(1): 1-28.

Henderson, J. V., Kuncoro, A., Turner, M. 1995. Industrial development in cities. *Journal of Political Economy* 103: 1067-1090.

Henry, M. S., Barkley, D. L., Bao, S. 1997. The hinterland's stake in metropolitan growth: Evidence from selected southern regions. *Journal of Regional Science* 37 (3): 479-501.

Henry, M. S., Schmitt, B., Kristensen, K., Barkley, D. L., Bao, S. 1999. Extending Carlino-Mills models to examine urban size and growth impacts on proximate areas. *Growth and Change* 30: 526-548.

Henry, M. S., Schmitt, B., Piguet, V. 2001. Spatial conometric models for simultaneous systems: Application to rural community growth in France. *International Regional Science Review* 24(2): 171-193.

Hoogstra, G. J., Dijk, J. van, Florax, R. J. G. M. 2010. Determinants of variation in population-employment interaction findings: A quasi-experimental meta-analysis. *Geographical Analysis* forthcoming.

Huiban, J.-P. 2000. Localisation spatiale et efficacité de la firme agro-alimentaire. *Revue d'Économie Régionale et Urbanine* 3: 443-456.

INSEE 2003. Structuration de l'espace rural: une approche par les bassins de vie. Report for DATAR: 1-170

Kelejian, H. H., Prucha, I. R. 1998. A generalized spatial two stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances. *Journal of Real Estate Finance and Economics* 17(1): 99-121

Kilkenny, M., Partridge, M. 2009. Export sectors and rural development. *American Journal of Agricultural Economics* 91(4): 910-929

Kim, S. 1999. Regions, resources, and economic geography: Sources of U.S. regional comparative advantage, 1880-1987. *Regional Science and Urban Economics* 29: 1-32.

Krugman, P. 1991. Increasing Returns and Economic Geography. *Journal of Political Economy* 99(3): 483-499.

Lego, B., Gebremedhin, T., Cushing, B. 2000. A multi-sector export base model of long-run regional employment growth. *Agricultural and Resource Economics Review* 29(2): 192-197.

Léon, Y., Surry, Y. 2009. Les effects d'entrainement du complexe agro-alimentaire au niveau local. Evaluation par le modèle de Léontief. In: Aubert, Piveteau, Schmitt (eds). Politiques agricoles et territoires, Quae, Versailles: 21-48

Leven, C. 2006. Distortions in estimating net benefit of regional development projects. *Annals of regional Science* 40: 191-201.

Marcouiller, D. W. 1998. Environmental resources as latent primary factros of production in tourism: the case of forest-based commercial recreation. *Tourism Economics* 4(2): 131-145.

Mathur, V. K., Sheldon, S. H. 2005. Do amenities matter in attracting knowledge workers for regional economic development? *Papers in Regional Science* 84(2): 251-269.

McGregor, P. G, Swales, J. K., Yin, Y. P. 1996.A long-run interpretation of regional input-output analysis *Journal of Regional Science* 36(3): 479-500

Mills, E. S. Lubuele, L. S. 1995. Projecting growth of metropolitan areas. *Journal of Urban Economics* 37: 344-360.

Mueser, P. R., Graves, P. E. 1995. Examining the role of economic opportunity and amenities in explaining population redistribution. *Journal of Urban Economics* 37(2): 176-200.

Mulligan, C. F., Vias, A. C., Glavac, S. M. 1999. Initial diagnostics of a regional adjustment model. *Environment and Planning A* 31: 855-876.

Muth, R. F. 1971. Migration: Chicken and egg. *Southern Economic Journal* 37 (3): 295-306.

North, D. C. 1955. Location theory and regional economic growth. Journal of Political Economy 63(3): 243-258.

OECD 2010. The role of agriculture and farm household diversification in the rural economy of France. OECD, Trade and Agriculture Directorate, www.oecd.org/dataoecd/35/31/ 43245372.pdf, 28 pp

Papke, L. E. 1991. Interstate business new firm location tax differentials and new firm location Evidence from panel data. *Journal of Public Economics* 52: 47-68.

Partridge, M., Rickman, D., 2003. The waxing and waning of regional economies: the chicken-egg question of jobs versus people. *Journal of Urban Economics* 53: 76-97.

Partridge, M., Rickman, D., Ali, K., Olfert, M. R. 2008. Lost in space: Population dynamics in American hinterland and small cities. *Journal of Economic Geography* 8(6): 727-757

Renting, H., Marsden, T. K., Banks, J. 2003. Understanding alternative food networks: exploring the role of short food supply chains in rural development. *Environment and Planning A*. 35(3): 393-411.

Rey, S. J., Boarnet, M. G. 2004. A taxonomy of spatial econometric models for simultaneous equations systems. In: Anselin, L., Florax, R., J. g. M., Rey, S. J. (Eds.): *Advances in spatial econometrics*. Springer, Berlin: 99-119.

Rickman, D. S. 2010. Modern macroeconomics and regional economic modeling. *Journal of Regional Science* 50(1): 23-41.

Roback, J., 1982. Wages, rents, and the quality of life. *The Journal of Political Economy* 90(6): 1257-1278.

Schaffer, W. A. 1999. Regional impact models. http://www.rri.wvu.edu/WebBook/Schaffer/

Schmitt, B., Henry, M. S. 2000. Size and growth of urban centers in French labor market areas: consequences for rural population and employment. *Regional Science and Urban Economics* 30: 1-21.

Schmitt, B., Henry, M. S., Piguet, V., Hilal, M. 2006. Urban growth effects on rural population, export and service employment: evidence from eastern France. *Annals of Regional Science* 40(4): 779-801.

Steinnes, D. N., Fisher, W. D. 1974. An econometric model of intraurban location. *Journal of Regional Science* 14(3): 65-80.

Thurston, L., Yezer, A. M. J. 1994. Causality in the suburbanization of population and employment. *Journal of Urban Economics* 35: 105-118.

Tiebout, C. H. 1956. Exports and Regional Growth. *Journal of Political Economy* 64: 160-164.

Vollet, D., Callois, J.-M., and Roussel, V. 2005. Impact of Retirees on Rural Development : Some Observations from the South of France. *The Journal of Regional Analysis and Policy* 35(2): 54-68.

Wagner, J., Deller, S. 1998. Measuring the Effects of Economic Diversity on Growth and Stability. *Land Economics* 74 (4): 541-556.

Warren, D., Isserman, A. M. 2006. Industrialization of U.S. agriculture: The new geography of animal production and slaughter. A report to USDA Rural Development. University of Illinois at Urbana-Campaign.

Wilson, J. D. 1999. Theories of tax competition. *National Tax Journal* 52(2): 269-304.

Appendix

Table A.1. Sector definitions

The french economic summary classification NES, taken up by INSEE in 1994, is an aggregated double entry classification - economic activities and products - and is structured through three levels including respectively 16, 36 and 114 items. In 1990, the data is only available at the level 2 with 36 items. They are given in parenthesis in the table.

	Denmark	France
Agro-food sector	Manufacturing of food, beverages and tobacco	Manufacture of food products, beverages and tobacco (B0)
Manufacturing sector	Manufacturing of textiles and leather Manufacturing of wood products, printing and publishing Manufacturing of chemicals and plastic products Manufacturing of other non-metallic mineral products Manufacturing of basic metals and fabrication of metal products Manufacturing of furniture and other manufacturing Electricity, gas and water supply Wholesale except of motor vehicles Business activities (Business service)	Manufacture of consumers goods (C1, C2, C3, C4)) Manufacture of motor vehicles (D0) Manufacture of capital goods (E1, E2, E3) Manufacture of intermediate goods (F1, F2, F3, F4, F5, F6) Energy (G1, G2) Wholesale trade and commission trade (J2) Services to businesses (N1, N2, N3, N4)
Service sector	Sale and repair of motor vehicles sale of fuel Retail trade and repair work except of motor vehicles Hotels and restaurants Post and telecommunications Finance and insurance Letting and sale of real estate Public administration Education Human health activities Social institutions etc. Associations, culture and refuse disposal	Sale, maintenance and repair of motor vehicles and motorcycles (J1) Retail trade, repair of personal and household goods (J3) Financial activities (L0) Real estate activities (M0) Personal and domestic services (P1, P2, P3) Education, health and social work (Q1, Q2) Administration (R1, R2)

Table A.2. Estimation results

	Population				Agro-food employment				Manufacturing employment				Services employment			
	Denmark		France		Denmark		France		Denmark		France		Denmark		France	
	IV		GMM W_C		IV		IV		IV		GMM W_C		IV		IV	
N	265		1 916		265		1 916		265		1 916		265		1 916	
Adj R²	0.925		0.708		0.862		0.610		0.886		0.617		0.891		0.726	
									Adjustment parameters							
dpop_ini	0.013	***	0.005	ns												
dfood_ini					-0.305	***	-0.168	***								
dexp_ini									-0.080	***	-0.127	***				
dserv_ini													0.062	***	0.085	***
									Dynamic externalities							
widpop_ini					0.029	***	0.000	ns	-0.158	***	-0.026	***	-0.037	*	0.017	***
widfood_ini	0.615	ns	-1.666	***					3.134	***	0.212	ns	2.705	***	-0.045	ns
widexp_ini	-1.019	***	0.231	ns	0.002	ns	0.008	ns					0.258	***	-0.094	***
widserv_ini	0.369	***	0.173	*	-0.075	**	-0.013	***	0.598	***	0.032	ns				
									Static externalities							
wivdpop					-0.228	***	-0.005	ns	0.096	ns	-0.167	***	0.705	***	0.086	**
wivdfood	5.685	*	2.598	ns					6.260	**	-0.271	ns	6.061	*	1.734	**
wivdexp	-0.350	ns	4.156	***	0.276	ns	0.076	ns					-2.343	***	-0.444	*
wivdserv	2.342	***	-0.943	ns	0.041	ns	0.111	*	-0.515	ns	1.707	***				
									Control variables							
intercept	-0.986	ns	8.211	***	3.004	***	0.007	ns	0.680	ns	-2.364	***	-4.877	ns	-0.021	ns
coast	-1.369	ns	2.065	*												
clim_sea			-2.192	***												
clim_contin			0.128	ns												
clim_medit			8.092	***												
clim_mount			-0.817	ns												
tourist			0.668	***									-363.282	ns	0.028	ns
dist_highscho	0.021	ns	0.003	ns												
acc_servp	-15.017	ns	-0.309	***												
th93/tax97	0.222	ns	-24.970	***												
tp93/tax97					0.133	ns	0.138	ns	-0.315	ns	-1.505	ns	-0.038	ns	-3.635	*
inc	0.000	**	0.159	ns												
noblu			7.304	***	-6.166	***	-0.497	***	13.642	**	1.479	*	4.054	ns	4.853	***

skiwo	11.658	***			2.496	***	0.037	ns	0.406	ns	-0.064	ns	0.288	ns	-0.423	**
self					-4.363	ns	-0.288	ns	53.271	***	-2.834	ns	57.116	***	-1.852	ns
rchom					-0.065	ns	-0.680	ns	0.307	ns	-1.031	ns	0.159	ns	0.126	ns
widagr					-0.316	**	0.033	**								
dist_urb	0.002	ns	-0.031	***	0.000	ns	0.001	*	-0.008	ns	0.000	ns	-0.005	ns	-0.002	ns
idf			-1.258	ns			0.162	ns			-1.111	ns			-1.314	**
periurb			5.183	***			0.035	ns			0.521	*			0.464	*
rural			0.558	ns			-0.048	ns			-0.176	ns			-0.013	ns
pop_gr1	-41.905	***	-37.184	***	-7.657	***	0.102	ns	6.211	ns	-1.263	ns	17.994	***	2.737	**
pop_gr2	35.439	***	72.582	***	0.595	ns	-0.381	**	7.451	*	4.175	***	28.601	***	2.607	***
food_gr1	-3.896	ns	5.783	*	-9.392	***	-3.034	***	15.452	***	-1.942	**	-19.614	***	0.955	ns
food_gr2	-5.057	ns	-2.601	ns	8.011	***	3.056	***	-10.958	*	0.964	ns	-15.697	**	-1.440	*
exp_gr1	36.718	***	0.380	ns	-2.197	ns	-0.280	ns	-74.112	***	-23.707	***	-61.067	***	1.444	ns
exp_gr2	18.733	***	8.517	ns	-2.213	ns	0.328	ns	41.076	***	23.567	***	-2.944	ns	1.441	ns
serv_gr1	12.883	**	13.318	ns	1.802	ns	0.831	***	-13.233	*	14.359	***	-47.712	***	-24.955	***
serv_gr2	-15.428	*	10.912	***	-5.355	***	0.270	*	12.634	ns	1.833	*	106.166	***	20.029	***
Sargan statistic	10.967	ns	16.236	ns	12.776	ns	14.130	ns	15.616	ns	24.469	ns	9.660	ns	23.294	ns
	$\chi^2(10)$		$\chi^2(15)$		$\chi^2(10)$		$\chi^2(20)$		$\chi^2(11)$		$\chi^2(21)$		$\chi^2(10)$		$\chi^2(20)$	
							first-stage partial adj. R^2									
wivdpop					0.485		0.391		0.502		0.402		0.494		0.441	
wivdfood	0.123		0.148						0.077		0.217		0.106		0.224	
wivdexp	0.276		0.138		0.073		0.144						0.456		0.189	
wivdserv	0.181		0.127		0.180		0.163		0.193		0.189					
dpop_ini	0.191		0.207													
dfood_ini					0.661		0.398									
dexp_ini									0.371		0.271					
dserv_ini													0.350		0.201	
Exogeneity test	8.06	***	21.37	***	2.69	**	23.29	***	4.56	***	3.81	***	5.18	***	3.83	***
	F(4,238)		F(4,1881)		F(4,238)		F(4,1886)		F(4,239)		F(4,1887)		F(4,238)		F(4,1886)	
I-Moran test W_C	0.030	ns	0.059	**	-0.026	ns	-0.002	ns	0.007	ns	0.039	**	-0.007	ns	-0.009	ns
ρ			0.020								0.003					

ns $p \geq 0.1$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.3

	Denmark	France
Number of influent observations in the population equation	10	42
with a negative parameter (*pop_gr1*)	4	10
with a positive parameter (*pop_gr2*)	6	32
Number of influent observations in the agro-food employment equation	9	61
with a negative parameter (*food_gr1*)	5	21
with a positive parameter (*food_gr2*)	4	40
Number of influent observations in the manufacturing employment equation	7	37
with a negative parameter (*exp_gr1*)	3	11
with a positive parameter (*exp_gr2*)	4	26
Number of influent observations in the services employment equation	13	36
with a negative parameter (*serv_gr1*)	8	9
with a positive parameter (*serv_gr2*)	5	27