Forecasting Regional Employment with Shift–Share and ARIMA Modelling

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Abstract

The analysis of different economic situations and risk factors is necessary in order to properly define forecasting scenarios. In this paper we focus on the shift-share model as a useful tool in the definition of scenarios, based on the different components contributing to the change of a given economic variable (national, sectoral and competitive effects).

Although the most commonly used methodology is based on the "constant shift" and "constant share" hypotheses, additional options can be considered leading to more realistic scenarios. More specifically we propose a dynamic shift-share formulation, allowing time changes in both the sectoral structure and the level of the considered variable.

Once this new option has been developed, this approach is applied to define scenarios and forecast the regional employment in Asturias using the information provided by the Spanish Economically Active Population Survey (Encuesta de Población Activa, EPA).

Key words: forecasting, shift-share, scenarios, Economically Active Population Survey(EPA).

JEL Classification: C53, J21, R11.

1. Introduction

Prospective analyses based on statistical and econometric models must be understood as conditioned forecasts. These latter are based on some hypothetical future values of exogenous variables whose determination requires an great effort and has a great impact on the final results. Therefore, it is essential to guarantee coherence among the hypotheses assumed for different variables.

As HUSS, 1988 points out, the development of scenarios can play an important role as a link between the planning and forecasting processes. The definition of these scenarios requires a sound knowledge of the economic variable to be forecasted, including its historical trend and also its relationship with some other variables.

According to the *Encyclopaedia Britannica* a scenario can be defined as “an account or synopsis of a possible course of action or events”. Nevertheless, as RATCLIFFE, 2000 points out, in the field of future studies this term has gained a more specialised connotation since the main aim of scenario building is to enable decision makers to explore different alternative futures and their subsequent consequences.

From a historical perspective, the use of scenarios as an organizational tool goes back to the decade of the 1950´s. From its first military uses this technique progressively increased its popularity, becoming a key element for strategic planning in business, energy and government. Some of the most outstanding empirical contributions took place during the 1970´s, when General Electric and Royal Dutch Shell became interested in developing energy scenarios in order to face the crises of 1973-74 and 1979.

Although different methodological options can be considered in the definition of scenarios, including intuitive logic, cross-section analysis and trend analysis, the present work is focused on this last category. More specifically, in this paper we propose the consideration of scenarios based on the shift-share models, assuming hypotheses related to their components.

With this purpose in mind, in the next section we briefly describe the shift-share model and its components. In section three we focus on the advantages of dynamic shift-share formulation and the empirical application of these methods is set out in section four, which summarizes the scenarios of Asturian regional employment based on the information provided by the Spanish Economically Active Population Survey. Finally, we briefly summarize the main conclusions and findings of this paper.

2. Forecasting and shift-share models

Shift-share analysis was first developed by DUNN, 1960 as a method for the determination of the components explaining the variations in economic variables, mainly employment. According to this author, the essential component of this statistical technique is the computation of the geographical changes in economic trends.

If we denote by E_{ij} the employment of sector i $(i=1,\ldots,s)$ in the spatial unit j $(j=1,\ldots,r)$ at the initial moment and by E'_{ij} the final value of this employment, the change of this variable can be expressed as:

$$E'_{ij} - E_{ij} = \Delta E_{ij} = E_{ij} r + E_{ij}(r_i - r) + E_{ij}(r_{ij} - r_i) \tag{1.1}$$

where:

$$r = \frac{\sum_{i=1}^{s}\sum_{j=1}^{r}(E'_{ij} - E_{ij})}{\sum_{i=1}^{s}\sum_{j=1}^{r}E_{ij}} \qquad r_i = \frac{\sum_{j=1}^{r}\left(E'_{ij} - E_{ij}\right)}{\sum_{j=1}^{r}E_{ij}} \qquad r_{ij} = \frac{E'_{ij} - E_{ij}}{E_{ij}}$$

According to this identity, three different components can be identified:

$$
\begin{array}{lll}
\text{National Effect} & NE_{ij} = E_{ij} r & \\
\text{Sectorial Effect or Industry} - \text{mix effect} & SE_{ij} = E_{ij}\left(r_i - r\right) & (1.2) \\
\text{Regional Effect or Competitive Effect} & CE_{ij} = E_{ij}\left(r_{ij} - r_i\right) &
\end{array}
$$

The national effect (NE) represents the change of the regional employment that would take place if the regional employment changed at the same rate as the national economy. The sectoral effect (SE) or "industry-mix" collects the positive or negative influence of regional specialization in sectors with growth rates over or under the national average, respectively. Following LOVERIDGE and SELTING, 1998, this component "is the amount of change attributable to differences in the sectoral make-up of the region versus that of the nation". Finally, the competitive effect (CE) measures the special dynamism of the regional economic sectors in comparison with their evolution at the national level and computes the degree to which the region has shifted away from what would be expected if it depended only on national evolution and sectoral composition.

Although shift-share analysis is widely used in regional studies this technique has been the focus of a wide-ranging controversy referring to its theoretical content, its static approach, aggregation issues (from a spatial and sectoral point of view) and inferential and predictive limitations. The works by CASLER (1989); KNUDSEN and BARFF, 1991; KEIL, 1992; HAYNES and DINC, 1997; LOVERIDGE and SELTING, 1998; DINC et al., 1998, FOTOPOULOS and SEPENCE, 1999 and KNUDSEN, 2000, among others, provide interesting reviews on these questions and also some extensions to the shift-share approach.

Regarding the shift-share applications, LOVERIDGE and SELTING, 1998, distinguish three main uses: forecasting, strategic planning and policy evaluation, the first one being the main theme of this paper. Some interesting insights on the forecasting shift-share capability can be found in STEVENS and MOORE, 1980 and KURRE and WELLER, 1989 and recent applications of shift-share as a forecasting tool are provided by OYEWOLE, 2001 and MULLIGAN and MOLLIN, 2004.

Since shift-share analysis computes the deviations experimented by regional sectoral employment with respect to the expected value based on the national evolution, the knowledge of this differential growth (measured by the competitive effect) is the key point in the development of regional forecasts. Different alternatives can be considered for this purpose, the easiest models being based on trend extrapolation with the expressions:

$$E_{ij}^{t+n} = \left(\overline{r}_{ij}\right)^{n} E_{ij}^{t} \tag{1.3}$$

$$E_{ij}^{t+n} = n\left(\overline{r}_{ij}\right) E_{ij}^{t} \tag{1.4}$$

where n is the forecasting horizon and $\overline{r}_{ij}$ is the yearly average growth rate in sector i and region j.

Another option named by HEWINGS, 1976 "share models" is based on shift-share decomposition. More specifically, the available national predictions are assumed in order to calculate the future values of national and industry-mix effects, the competitive effect remaining as the main forecasting problem. In this sense, two simple hypotheses are usually applied in the literature: constant share and constant shift.

The *constant share hypothesis* assumes that the regional industries show a behaviour analogous to the national one. According to this hypothesis, the sectors in a region grow at the same rate as their national counterpart, so the regional weight of sectoral employment will remain constant, leading to a null competitive effect. The described assumption of equal regional and national evolutions leads to the following condition:

$$r_{ij}^{t+1} = \frac{E_{ij}^{t+1} - E_{ij}^{t}}{E_{ij}^{t}} = \frac{E_{i}^{t+1} - E_{i}^{t}}{E_{i}^{t}} = r_{i}^{t+1} \tag{1.5}$$

and the employment of sector i in region j would then be obtained by applying the national rate of growth of the same sector:

$$E_{ij}^{t+1} = (1 + r_i^{t+1})E_{ij}^t \qquad (1.6)$$

This is an easy method to obtain regional forecasts although the assumption is quite unrealistic.

On the other hand, the *constant shift hypothesis* allows some differences between national and regional trends, leading to a competitive effect which is non null but is "naive" since it assigns the same value of the previous period. This simplistic hypothesis is not congruent with the neoclassical theory since the competitive effect (positive or negative) is understood as a transition to the equilibrium state (with null expected value). Nevertheless, the cumulative causation growth theory (as developed, among others, by RICHARDSON, 1973) justifies the constant shift assumption based on the existence of agglomeration economies, suggesting that the competitive component might be nonzero for long periods, or might even increase through time. According to this hypothesis, the employment in each sector will be obtained as:

$$E_{ij}^{t+1} = \left(1 + r_i^{t+1} + s_i^{t+1}\right)E_{ij}^t \qquad s_i^{t+1} = r_{ij}^{t+1} - r_i^{t+1} \qquad (1.7)$$

where r_{ij}^{t+1} is an unknown value and thus the competitive effect $\left(s_i^{t+1}\right)$ should be either substituted by the last observed value or forecasted from its past trend.

This model is equivalent to the one developed by HEWINGS, 1976 and is considered as a suitable method to anticipate the growth deviations between a spatial unit and its upper level. Given the rates of growth between t-n and t:

$$g_i = \frac{E_i^t}{E_i^{t-n}} - 1 \qquad g_{ij} = \frac{E_{ij}^t}{E_{ij}^{t-n}} - 1 \qquad g_i^* = \frac{E_i^{t+n}}{E_i^t} - 1 \qquad (1.8)$$

the employment in t+n could be obtained as:

$$E_{ij}^{t+n} = \left[g_i^* + \left(g_{ij} - g_i\right)\right]E_{ij}^t \qquad (1.9)$$

In this model, it is assumed that the differential growth rate between the region and the nation for sector i in the time period (t-n,t) will remain constant in (t,t+n).

In addition to the described basic hypotheses, some other models can be used to forecast the competitive effect[i]. BROWN, 1969 proposes some variations of the constant share hypothesis, leading to the so-called Ingrow and Super Ingrow models. The first model is based on historical information while the second one assumes the available national forecasts for the value E_i^{t+1}:

$$E_{ij}^{t+1} - E_{ij}^{t} = E_{ij}^{t}\left[\left(\frac{E_i^{t}}{E_i^{t-1}}\right) - 1\right] \tag{1.10}$$

$$E_{ij}^{t+1} - E_{ij}^{t} = E_{ij}^{t}\left[\left(\frac{E_i^{t+1}}{E_i^{t1}}\right) - 1\right] \tag{1.11}$$

BROWN, 1969 points out that the main problem of these models is their lack of stability. This drawback has been studied, among others, by JAMES and HUGHES, 1973.

HELLMAN, 1974 developed four models based on the expression summarized in table 1, including population sizes (P) and taking into account the agglomeration of industries, whose indicator is denoted by C_i. Nevertheless, it must be pointed out that these models provide forecasts only for the total employment (not for the expected changes) and, most importantly, they do not satisfy the additivity property of the shift-share identity[ii].

Table 1. Hellmann's Models

3. Dynamic shift-share analysis and forecast

One of the main criticisms of the shift-share analysis refers to its static character, since the classical identity compares the initial and final periods without considering any intermediate point, thus ignoring the change in both sectoral structure and level of regional employment.

Some solutions to this limitation focus on the definition of weights. Since the consideration of the initial year might ignore the changes experienced by the regional industrial structure, STILWELL, 1969 proposes the use of weights referring to the final year, while some other authors suggest the combination of weights of the initial and final periods.

On the other hand, the classic static shift-share formulation does not consider the continuous changes in the size of total regional employment, which could affect the results of the computed effects. This is what BARFF and KNIGHT, 1988 call the "compounding effect", leading to an underestimation of the national effect when the growth of the regional employment is higher than the national one, and causing an overestimation in the opposite case.

The previously described problems can be solved through the dynamic shift-share model, which allows the splitting of the period of study into two or more sub-periods thus updating the sectoral structure and size of the regional employment. When working with annual data, these effects are computed for each year and therefore industrial structure and employment levels are updated yearly.

Furthermore, since the shift-share predictive capability depends on the stability of the computed effects, there has been a wide-ranging controversy during recent decades, as summarized in MULLIGAN and MOLIN, 2004. While authors such as BROWN, 1969 deny the stability of the shift-share effects some others such as FLOYD and SIRMANS, 1973 and GERKING and BARRINGTON, 1981 consider these models stable enough for predictive purposes.

With regard to this question, the dynamic approach would be especially useful allowing the analysis of the competitive effect through time series techniques, as in KURRE and WELLER, 1989. These authors propose the estimation of the competitive effect by means of a three-year moving period, thus increasing the number of available observations and allowing the use of ARIMA models.

Since the work by BOX and JENKINS, 1976, ARIMA models have become an outstanding forecasting tool. According to these authors, the objective of ARIMA modelling is to derive models possessing maximum simplicity and the minimum number of parameters consonant with representational adequacy, giving information about the system generating time series and providing optimal forecasts of future values of the series.

A general Autoregressive Integrated Moving Average model ARIMA(p,d,q) can be expressed as:

$$\phi_p(L)(1-L)^d Y_t = \theta_0 + \theta_q(L)u_t \tag{1.12}$$

where L is the lag operator, $\phi_p(L)$ is the stationary AR operator $\phi_p(L)=\left(1-\phi_1 L-...-\phi_p L^p\right)$, $\theta_q(L)$ is the invertible MA operator $\theta_q(L)=\left(1-\theta_1 L-...-\theta_q L^q\right)$, Y_t is the considered series (the competitive effect, in this case) and u_t is a Gaussian white noise process $u_t \approx N\left(0,\sigma^2\right)$.

One of the main advantages of ARIMA models is that they perform quite well in forecasting based only on the past observations of the series. In the context of the shift-share competitive effect, this is very useful because of the difficulty to obtain enough information in order to estimate an econometric causal model at a regional level. Furthermore many smoothing results, such as moving averages and exponential smoothing, are special cases of ARIMA forecasting and therefore these models provide a very natural way to obtain the required weights for forecasting (since the user does not have to specify the number of the form of weights as required in another procedures).

Following a dynamic approach, in this paper we compute the competitive effect by considering moving periods instead of breaking the period into a few discrete intervals. Thus, if we denote by 0 and t the initial and final periods, k being the considered width, our approach focuses on the following variations:

$$\Delta E_{0,0+k}; \Delta E_{1,1+k}; \Delta E_{2,2+k}; \cdots; \Delta E_{t-k,t}$$

The results of the computed effects are assigned to the final period and the competitive effect (CE) in t is given by:

$$CE_{ij}^{t,t-k} = CE_{ij}^{t} = E_{ij}^{t-1}\left(r_{ij}^{t,t-k} - r_{i}^{t,t-k}\right) \quad (1.13)$$

computing similarly the national and sectoral effects. The aggregation of all these components leads to the final level of employment E_{ij}^{t} obtained as:

$$E_{ij}^{t} = E_{ij}^{t-k} + NE_{ij}^{t,t-k} + SE_{ij}^{t,t-k} + CE_{ij}^{t,t-k} \quad (1.14)$$

Once the competitive effect is computed for each of the considered sub-periods, the application of the Box-Jenkins methodology allows the forecasting of this effect whose results, together with the national and sectoral effects, lead to a forecasted employment level for each considered sector and region.

The future values of national and sectoral effects in period t+1 are given by

$$NE_{ij}^{t+1,t-k+1} = NE_{ij}^{t+1} = E_{ij}^{t-k+1}\left(r^{t+1,t-k+1}\right) \quad (1.15)$$

$$SE_{ij}^{t+1,t-k+1} = SE_{ij}^{t+1} = E_{ij}^{t-k+1}\left(r_{i}^{t+1,t-k+1} - r^{t+1,t-k+1}\right) \quad (1.16)$$

where $r^{t+1,t-k+1}$ and $r_{i}^{t+1,t-k+1}$ are obtained from the available national and sectoral employment predictions.

4. Empirical application: perspectives of regional employment

The development of a co-ordinated strategy for employment has been specified as an objective in the Treaty establishing the European Community. Since then, many efforts have been made in order to formulate suitable strategies, establishing guidelines and recommendations for the Member States.

The strategic goal "to make the European Union the world's most competitive knowledge-based economy, capable of ensuring sustainable development, full employment and greater social cohesion" was first established at the Lisbon Summit, 2000 and afterwards confirmed by further European Councils.

The existence of different regional and sectoral behaviours in the evolution of the labor markets within the EU has been shown in several investigations (DE JONG and BROCKMAN, 2000; EUROPEAN COMISION, 2003; EUROSTAT, 2003). In some recent works such as MAYOR and LÓPEZ, 2002, 2004, we have applied the shift-share methodology to the European framework, using the information on employment collected by Eurostat in the REGIO database. More specifically, we have studied the period 1980-2000, considering three different sectors (agriculture, industry and services) and following the Nomenclature of Territorial Units for Statistics (NUTS).

The obtained results are summarized in Table 2, which shows some significant differences between countries. A noteworthy case is the Netherlands where all the regions show positive estimated effects, while Portugal, on the other hand, has negative signs in all the estimated effects of its three regions.

Table 2: Classification of European regions (NUTS) according to their sectoral and regional effects

These results can be considered as a starting point for the elaboration of regional forecasts. Nevertheless, a more detailed analysis is advisable in order to define forecasting scenarios for a given region.

In this paper we focus on the Spanish region of Asturias, which corresponds to the NUTS II level and is included in the northwest area, characterised by a negative behaviour of both the sectoral and the competitive effects. The labour market in Asturias shows low activity and employment rates, especially in the case of women and young people, as can be seen in Table 3, which summarizes the main labour indicators in Asturias, Spain and the European Union.

Table 3: Labour Market Indicators in Asturias, Spain and the European Union

For our empirical application we have considered the information provided by the Spanish Statistical Institute (Instituto Nacional de Estadística, INE) through the Economically Active Population Survey (EPA). This survey is a quarterly investigation with reference to a sample of around 200,000 people (65,000 dwellings) whose data are collected by personal and telephone interviews, carried out by interviewers from the INE, carefully filtered and electronically processed. Regarding the sectoral classification, we have considered the four main economic activities: agriculture, industry, construction and services.

The empirical study has two main objectives: firstly, the results of some models described in section two are compared with those provided by the dynamic shift-share, analysing the accuracy of our application is twofold. Once this analysis has been carried out, a second objective is the development of scenarios describing the expected change of regional employment.

Regarding the first objective, we compute ex-post forecasts of the regional employment by activity sectors carried out in the period 2001-2003 under the constant share and the constant shift hypotheses. As expected, this second option (based on more realistic assumptions) leads to better results in terms of accuracy, although both procedures are surpassed by alternative methods, including dynamic analysis.

It must be noticed that the dynamic-constant share is a mix where the competitive effect is null as in (1.6) and r_i^{t+1} is obtained by means of dynamic shift-share decomposition, while the dynamic ARIMA corresponds to the previously described procedure[iii]. Table 4 summarizes the accuracy measures obtained when the considered procedures are used to forecast the regional employment with sectoral detail, showing that the best results correspond to the dynamic ARIMA.

Table 4: Accuracy Measures for the Employment forecasts in Asturias (2001-2003)

Once we have confirmed the good behaviour of those forecasts based on dynamic shift-share, our second objective is the development of scenarios for the evolution of employment in Asturias. With this purpose in mind, we propose a combination of the previously described ARIMA competitive effect forecasts with the national and sectoral effects defined in the considered scenarios, which are generally provided by prospective institutions. More specifically, in this work the basic scenario corresponds to the consensus forecast (obtained as the arithmetic mean) while the maximum and minimum values are considered as defined by the optimistic and pessimistic scenarios, respectively.

The described methodology has been applied to the definition of scenarios for the regional employment of Asturias referring to the period 2004-2006. The recent publication of the EPA employment results for 2004 allows a study of their accuracy, as summarized in Table 5, which collects the mean absolute percentage error and the Theil index.

Table 5: Accuracy Measures for alternative scenarios of the Employment forecasts in Asturias 2004

These results have been obtained from quarterly data referring to 2004 and the competitive effect related to the constant shift hypothesis corresponds to the previous period 2002-2003.

As can be seen, the observed evolution of employment is similar to the one predicted in the baseline scenario, and in general terms the most suitable forecasts are obtained by the combination of dynamic shift-share and ARIMA modelling. We must also point out that the dynamic method combined with the constant share hypothesis leads to satisfactory results (especially in the optimistic scenario), this fact being justified by the consideration of only one-step forecasts. Nevertheless, as the forecasting horizon increases this hypothesis would become less realistic and bigger differences would be expected in favour of the dynamic-ARIMA procedure.

5. Concluding remarks

Shift-share analysis can be a useful tool for predictive purposes as well as having potential as a descriptive one, allowing the computation of geographical changes in economic evolution. Therefore, in this work we have proposed the development of economic scenarios based on shift-share models, assuming hypotheses related to national, sectoral and competitive effects.

Since the usual "constant shift" and "constant share" hypotheses turn out to be very restrictive, we have focused on the dynamic shift-share formulation, allowing the updating of the sectoral structure and the size of regional employment.

The application of this methodology to the development of scenarios for the regional employment of Asturias has led to satisfactory results. Using the quarterly information provided by the Spanish Economically Active Population Survey we have found that dynamic shift-share provides better results in terms of relative error and the Theil index.

It must also be stressed that the proposed method does not require a great volume of information neither does it involve an excessive operational complexity. Therefore, its application would be a good complement to the most common procedures, and it could even provide, as we have seen in our application, more reliable results.

Since the development of a co-ordinated strategy for employment is one of the main goals of the European Union, the building of forecasts under alternative scenarios could be very helpful. To this respect, shift share analysis provides a useful tool not only for forecasting purposes, but also for strategic planning and policy evaluation.

Bibliography

BARFF R.D. and KNIGHT III P.L. (1988) Dynamic Shift-share analysis, *Growth and Change* **19**, 1-10.

BOX G.E. and JENKINS G.M. (1976) *Time Series Analysis: Forecasting and Control,* Holden Day, San Francisco.

BROWN H.J. (1969) Shift-share projections of regional growth: empirical test, *Journal of Regional Science* **9**, 1-18.

CASLER S. D. (1989) A Theoretical Context for Shift and Share, *Regional Studies* **23**, 43-48.

DINC M., HAYNES K.E. and QUIANGSHENG L. (1998) A comparative evaluation of shift-share models and their extensions, *Australasian Journal of Regional Studies* **4**, 275-302.

DE JONG A. and BROCKMAN R. (2000) National and Regional Trends in the Labour Force in the European Union 1985-2050. Recent trends and Prospects, *Report on behalf of the European Commission,* Directorate General XVI Regional POLICY AND COHESION.

DUNN E.S. (1960) A statistical and analytical technique for regional analysis, *Papers of the Regional Science Association* **6**, 97-112.

EUROPEAN COMMISSION (2003) *Employment in Europe 2003. Recent trends and Prospects,* Directorate General for Employment and Social Affairs.

EUROSTAT (2003) Unemployment in the regions of the European Union in 2002, *Statistics in Focus*, Brussels.

FLOYD C.F. and SIRMANS C.F. (1973) Shift and Share projections revisited, *Journal of Regional Science* **13**, 115-120.

FOTOPOULOS G. and SPENCE N. (1999): Spatial variations in net entry rates of establishments in Greek manufacturing industries: an application of the shift-share ANOVA model, *Environment and Planning A* **31**, 1731-1755.

GERKING, S.D. and BARRINGTON J.L. (1981) Are regional share effects constant over time, *Journal of Regional Science* **21**, 163-174.

HAYNES K.E. and DINC, M. (1997) Productivity changes in manufacturing: A multifactor/ shift-share approach, *Growth and Change* **28**, 150-170.

HAYNES K.E. and MACHUNDA Z.B. (1987) Considerations in extending shift-share analysis: a note, *Growth and Change* **18**, 69-79.

HELLMAN D.A. (1974) Agglomeration economies: a model of regional export activity, *Growth and Change* **5**, 12-17.

HEWINGS G.J.D. (1976) On the accuracy of alternative models for stepping-down multi-county employment projections to counties, *Economic Geography* **52**, 206-217.

HUSS W.R. (1988) A move towards scenario analysis, *International Journal of Forecasting* **4,** 377-388.

INE (varios años) *Encuesta de Población Activa,* Madrid.

JAMES F.J.R. and HUGHES J. (1973) A test of shift and share analysis as a predictive device, *Journal of Regional Science* **13**, 213-231.

KEIL S.R.(1992) on the value of homotheticity in the shift-share framework, *Growth and Change* **23**, 469-493.

KNUDSEN D.C. (2000) Shift-share analysis: further examination of models for the description of economic change, *Socio-Economic Planning Sciences* **34**, 177-198.

KNUDSEN D.C. and BARFF R. (1991) Shift-share analysis as a linear model, *Environment and Planning A* **23**, 421-431.

KURRE J.A. and WELLER B.R. (1989) Forecasting the local economy, using time series and shift-share techniques, *Environment and Planning A* **21**, 753-770.

LOVERIDGE S. and SELTING A.C. (1998) A review and comparison of shift-share identities", *International Regional Science Review* **21**, 37-58.

MAYOR M. and LÓPEZ A.J. (2002) The evolution of the employment in the European Union. A stochastic shift and share approach**,** Proceedings of the ERSA 2002 Meeting, Dortmund.

MAYOR M. and LÓPEZ, A.J. (2004) La dinámica sectorial-regional del empleo en la Unión Europea, *Revista de Estudios Europeos* **37**, 81-96.

MULLIGAN G.F. and MOLIN A. (2004) Estimating population change with a two-category shift-share model, *The Annals of Regional Science* **38**, 113-130.

OYEWOLE P. (2001) Prospects for Developing Country Exports of Services to the Year 2010: Projections and Public Policy Implications, *Journal of Macromarketing* **21**, 32-47.

RATCLIFFE J. (2000) Scenario building: a suitable method for strategic property planning?, *Property Management* **8**, 127-144.

RICHARDSON H.W. (1973) *Regional growth theory*, McMillan, London.

STEVENS B.H. and MOORE, C. (1980) A critical review of the literature on shift-share as a forecasting technique, *Journal of Regional Science* **20**, 419-437.

STILWELL F.J. (1969) Regional Growth and Structural Adaptation", *Urban Studies* **4**, 162-178.

[i] A review of the different alternatives to obtain local forecasts by means of shift-share decomposition can be found in STEVENS and MOORE, 1980.

[ii] An interesting explanation of this property is provided by HAYNES and MACHUNDA, 1987.

[iii] In this case the considered width is four years and the series of competitive effect are found to be I(1) with the only exception of the construction which is I(0).

Table 1. Hellmann's Models

Hypotheses	Model
Constant weight of national population	$E_{ij}^{t+1} = E_i^{t+1}\left(\frac{E_{ij}^t}{E_i^t}\right) \qquad (0.1)$
Constant ratio of regional employment/population	$E_{ij}^{t+1} = P_j^{t+1}\left(\frac{E_{ij}^t}{P_j^t}\right) \qquad (0.2)$
Constant shift	$E_{ij}^{t+1} = E_i^{t+1}\left(\frac{E_{ij}^t}{E_i^t}\right) + E_i^{t+1}\left[\left(\frac{E_{ij}^{t+1}}{E_i^{t+1}}\right) - \left(\frac{E_{ij}^t}{E_i^t}\right)\right] \qquad (0.3)$
Explicit shift-share model for export industries	$E_{ij}^{t+1} = E_i^{t+1}\left(\frac{P_j^t}{P^t}\right) + E_i^{t+1}\left[\left(\frac{P_j^{t+1}}{P^{t+1}}\right) - \left(\frac{P_j^t}{P^t}\right)\right] + C_i^t \qquad (0.4)$

Table 2: Classification of European regions (NUTS) according to their sectoral and regional effects

	NEGATIVE SECTORAL EFFECT	POSITIVE SECTORAL EFFECT
NEGATIVE COMPETITIVE EFFECT	**GERMANY:** BADEN-WÜRTTEMBERG **SPAIN:** NOROESTE **FRANCE:** BASSIN PARISIEN, OUEST **ITALY:** EXCEPT CALABRIA **Portugal**	**BELGIUM:** REGION DE BRUXELLES DINAMARCA **GERMANY:** BREMEN, HAMBURG, HESSEN, NIEDERSACHSEN, NORDRHEIN-WESTFALEN, SAARLAND, SCHLESWIG-HOLSTEIN **FRANCE:** ÎLE DE FRANCE, EST, MÉDITERRANÉE **ITALY:** CALABRIA **UNITED KINGDOM:** YORKSHIRE AND THE HUMBER, WEST MIDLANDS, SOUTH WEST, WALES, SCOTLAND, NORTHERN IRELAND
POSITIVE COMPETITIVE EFFECT	**GERMANY:** BAYERN **GREECE:** VOREIA ELLADA, KENTRIKI NISSIA AIGAIOU-KRITI **SPAIN:** NORESTE, CENTRO, ESTE, SUR **FRANCE:** SUD-OUEST **IRELAND**	**BELGIUM:** VLAMAMS GEWEST, REGIÓN WALLONNE **GERMANY:** BERLIN, RHEINLAND-PFALTZ **GREECE:** ATTIKI **SPAIN:** COMUNIDAD DE MADRID, CANARIAS **FRANCE:** NORD-PAS-DE-CALAIS, CENTRE-EST **LUXEMBOURG** **NEDERLANDS** **UNITED KINGDOM:** EAST MIDLANDS

Source: Mayor and López (2002, 2004)

Table 3: Labour Market Indicators in Asturias, Spain and the European Union

	Asturias	Spain	European Union
Unemployment rate (Total, %)	9.8	11.4	7.5
Unemployment rate (Women, %)	14.8	16.4	7.8
Unemployment rate (15-24 years, %)	23.1	22.2	15.2
Employment Sectoral weights (%)			
Agriculture	7.2	5.9	4.0
Industry	31.4	31.2	28.2
Services	61.4	62.9	67.8

Sources: Eurostat and INE

Table 4: Accuracy Measures for the Employment predictions (2001-2003)

		Square Root of Mean Quadratic Error	Mean Absolute Error (%)	Theil Index
Agriculture	Constant share	3.94	14.45%	0.06
	Constant shift	2.75	8.28%	0.04
	Dynamic constant-share	5.69	18.68%	0.09
	Dynamic-ARIMA	1.46	4.85%	0.03
Industry	Constant share	7.85	9.44%	0.05
	Constant shift	3.13	3.29%	0.02
	Dynamic constant-share	4.27	4.46%	0.03
	Dynamic-ARIMA	3.01	3.49%	0.02
Construction	Constant share	4.54	9.46%	0.05
	Constant shift	2.50	4.87%	0.03
	Dynamic constant-share	8.33	17.34%	0.09
	Dynamic-ARIMA	4.49	8.63%	0.05
Services	Constant share	4.21	1.56%	0.01
	Constant shift	15.43	6.55%	0.03
	Dynamic constant-share	6.03	2.13%	0.01
	Dynamic-ARIMA	7.15	2.88%	0.01
Total	Constant share	12.88	2.99%	0.01
	Constant shift	8.67	2.26%	0.01
	Dynamic constant-share	14.46	3.36%	0.02
	Dynamic-ARIMA	9.61	2.23%	0.01

Table 5: Accuracy measures of the employment forecasts in Asturias under alternative scenarios 2004

Pessimistic Scenario	Mean Absolute Percentage Error (%)	Theil Index
Constant share	4.9385	0.0297
Constant shift	5.7713	0.0325
Dynamic Constant-share	4.7165	0.0258
Dynamic-Arima	3.5848	0.0196

Baseline Scenario	Mean Absolute Percentage Error (%)	Theil Index
Constant share	2.8885	0.0163
Constant shift	3.9898	0.0230
Dynamic Constant-share	1.3465	0.0072
Dynamic-Arima	0.6360	0.0042

Optimistic Scenario	Mean Absolute Percentage Error (%)	Theil Index
Constant share	4.7365	0.0292
Constant shift	5.9957	0.0366
Dynamic Constant-share	1.5025	0.0096
Dynamic-Arima	2.2370	0.0126