On the Predictive Content of Production Surveys

Lemmens, A.; Croux, C.; Dekimpe, M.G.

ELSEVIER

On the predictive content of production surveys: A pan-European study

Aurélie Lemmens[a],[*], Christophe Croux[a], Marnik G. Dekimpe[a],[b]

[a]*Department of Applied Economics, Naamsestraat 69, B-3000, K.U.Leuven, Belgium*
[b]*Faculty of Business Administration, Erasmus University Rotterdam, The Netherlands*

Abstract

For over 40 years, Business Tendency Surveys have been collected in multiple member states of the European Union. Previous research has studied the predictive content of the expectation variables included in those surveys through bivariate, within-country, Granger-causality tests. These tests have resulted in mixed conclusions. We extend previous research in various ways, as we (i) explicitly allow for cross-country influences, and (ii) do so using both bivariate and multivariate Granger-causality tests. Specifically, the multivariate El Himdi–Roy (HR) test is adapted to jointly test the forecasting value of multiple production expectation series, to assess whether part of this joint effect is indeed due to cross-country influences, and to determine which countries' expectation series have the most "clout" in predicting the production levels in the other member countries, or have the highest receptivity, in that their production levels are Granger caused by the other countries' expectations. © 2004 Published by Elsevier B.V. on behalf of International Institute of Forecasters.

Keywords: Business surveys; Cross-correlations; Production expectations; Granger causality

1. Introduction

For over 40 years, Business Tendency Surveys have been collected by the European Union in the framework of the Joint Harmonised EU Programme of Business and Consumer Surveys. The Programme was initially set up in 1961 by the European Commission; it currently includes the 15 member states of the European Union. Business Surveys are carried out on a monthly basis by various public and private institutions in the respective member countries. The presentation, methods, and questions of the Business Tendency Surveys are harmonised across countries according to EU guidelines. We refer to the European Commission (2002) for more detailed information on how these surveys are implemented. Two kinds of attitudinal data are collected: (i) "Judgments" (*JUD*), an assessment of the current or past status of a given variable, and (ii) "Expectations" (*EXP*), an estimation of the likely *future* status of that variable. These two types of attitudinal information

are collected for five key components of the economy: Industry, Construction, Consumers, Retail Trade, and Services. In this study, we focus on an *industry*-related indicator, the Production Expectations (*PEXP*).

The sample size for each survey varies across countries according to their population size. Each month, almost 68,000 companies and 27,000 consumers across the European Union are currently surveyed. Not surprisingly, Business Surveys are both expensive and time-consuming. For example, the cost in 2003 for the European Commission of the Harmonised Joint EU Programme of Business and Consumer Surveys amounted to slightly over 4.5 million euros. This figure does not yet incorporate the costs incurred by the respective national institutions that carry out the actual surveys. The latter are estimated to be another 6 to 7 million euros. These costs are often justified on the basis that they represent an early source of information for politicians, economists, researchers, senior executives, and/or media. Indeed, the survey data become publicly available on the last day of each month, whereas Account data (*ACC*)—i.e., the actual, objectively measured, levels of a variable—are generally published only 2 to 4 months later (Buffeteau & Mora, 2000). However, *timeliness* is not a sufficient justification for the continued use of such expensive surveys. They should also prove to have some *predictive content* regarding actual *ACC* data: if Business Tendency Surveys cannot be used as relevant predictors for the future state of the economy, there is no point using them for economic surveillance.

The *performance* of the *PEXP* series will be measured by studying whether these can improve forecasts of future Production Accounts (*PACC*) that are exclusively based on the past of the *PACC* series. More precisely, we will investigate whether the variance of the error in forecasting future values of the *PACC*, using an (optimal) forecast based on the observed values of both *PACC* and *PEXP* series is *strictly smaller* than the variance of the prediction error, using an (optimal) forecast *only* based on the observed values of the *PACC* series. If this is the case, we may conclude that the *PEXP* series Granger causes the *PACC* series (Granger, 1969). In this paper, the "predictive content" always refers to this notion of Granger causality.

The predictive content of Business Surveys has already been investigated in a substantive number of studies. Most of these were based on Scandinavian countries. Bergström (1995) and Teräsvirta (1986) explored the relationship between the *PACC* series and a number of barometer (Business Survey) series using regression models in, respectively, Sweden and Finland. Lindström (2000) extended these analyses by examining the short-term forecasting value of Business Surveys for predicting the volume of manufacturing output growth in Sweden up to 1998. Christoffersson, Roberts, and Eriksson (1992) used a frequency domain analysis to investigate the relationship between *PACC* and Business Survey series of total manufacturing in Sweden. Öller and Tallbom (1996) applied an extended Kalman filter on the Business Survey series. The general picture obtained from these earlier studies is that Business Survey variables have predictive content in explaining future *PACC* series, at least in the considered Scandinavian countries. Hanssens and Vanden Abeele (1987), on the other hand, studied the predictive content of *PEXP* for Belgium, France, Germany, The Netherlands, and Italy. Using bivariate Granger-causality tests, they found that the inclusion of *PEXP* did not systematically improve the forecasting performance of simple univariate time-series extrapolations of the *PACC* series. Hence, previous research ended in mixed results, and the question of the predictive value of Business Tendency Surveys remains open. We will contribute to this ongoing debate in a number of ways.

First, the existing literature focused on a limited subset of countries, ranging from one (e.g., Bergström, 1995; Lindström, 2000) to five (Hanssens & Vanden Abeele, 1987) states. Our analysis, in contrast, uses data of more than ten countries (see Section 3). Moreover, by using information that has just become publicly available, we are able to extend the end date of the analysis from, respectively, 1983 (Hanssens & Vanden Abeele, 1987; Teräsvirta, 1986) and 1998 (Lindström, 2000) to December 2002.

Second, unlike previous studies, we will take potential cross-country relationships into account. Previous studies only allowed for a within-country relationship, checking, for example, whether the French *PEXP* proved useful in predicting France's own future *PACC* series. We extend the scope of

this investigation by testing whether also the *PEXP* in *other* countries have information value in predicting the future evolution of the French *PACC* series. Such cross-country influences may well exist among the various EU countries as the free transfer of ideas, products, and technologies among them is increasingly facilitated (Mahajan & Muller, 1994), resulting in both cross-country word-of-mouth effects (Tellis, Stremersch, & Yin, 2003) and considerable trade among the various member states, as reflected in an intra-EU15 trade/GDP ratio of over 16% (Eurostat, 1999). Because of this economic interdependence, industrial optimism/pessimism in one country, as reflected in the evolution of its *PEXP*, may well affect the *PACC* in another country.

The aforementioned cross-country effects could be investigated through a sequence of bivariate tests. For example, bivariate Granger-causality tests could be implemented to assess whether *PEXP* in country X affects future *PACC* levels in country Y. However, as the number of EU countries increases, the number of tests required to cover all possible combinations would rapidly become excessive, causing the individual p-values to suffer from the well-known multiple-testing problem. As a third contribution, we will therefore apply the *multivariate* test procedure introduced by El Himdi and Roy (1997). Through this procedure, we will first investigate the general predictive content of the collection of all *PEXP* series vis-à-vis the collection of all *PACC* series. This joint Granger-causality test will offer a more powerful test on the predictive value of the ambitious European Union's Business Survey plan than a sequence of bivariate tests.

Next, we will adjust the El Himdi–Roy (HR) test statistic to answer three key questions:

- Can we attribute part of this "general causality" to *cross*-country influences?
- Are there some countries whose *PEXP* are more informative than others for the future evolution of the *PACC* in other countries? Such countries will be denoted as having a lot of "clout". Referring to the notion of asymmetry developed in the market-share literature (Cooper & Nakanishi, 1998, pp. 56–57), "clout" is the ability of a brand or company to influence the other players (i.e.,

brands or firms) in a specific market, and consequently shape the demand and competition in that market. Similarly, in the context of *PEXP*, we denote by "clout" the ability of a country to Granger cause the future production level of other countries.

- Are there countries whose *PACC* series is more predictable (than others) by other countries' *PEXP* series, and whose economy therefore seems to be more "receptive" (see Cooper & Nakanishi (1998, pp. 56–57) for a conceptually similar use of the term in the market-share attraction literature) to changes in other countries' economic climate (as reflected in their respective *PEXP* series)?

Answering these questions should provide new insights into the economic interdependencies among the various member states of the European Union in general, and more specifically, on the relative forecasting value of the Business Tendency Surveys undertaken in these countries.

2. Methodology

In line with existing literature (see, e.g., Hanssens & Vanden Abeele, 1987), we adopt the notion of Granger causality between *PEXP* and future *PACC* to assess the predictive value of the Business Tendency Surveys' *PEXP* series. Unlike previous studies, however, we will conduct the analysis at various levels. First, in Section 2.1, we describe the bivariate Haugh (1976) test. The Haugh test will make it feasible to determine (i) whether the *PEXP* series in country i ($i=1,\ldots, d$ where d is the number of considered countries) Granger causes the *PACC* series in that same country and (ii) whether *PEXP* in country i Granger causes the *PACC* in country j. Next, in Section 2.2, we review the multivariate El Himdi and Roy (1997) test so as to allow to quantify the combined predictive content of all *PEXP* series, considering all countries together. We subsequently modify the El Himdi–Roy statistic to determine whether part of this combined predictive value can be attributed to cross-country influences. Finally, we propose two further modifications to quantify (i) which countries' *PEXP* series are the most informative as to the future *PACC* levels in other countries,

i.e., have most "clout", and (ii) which countries' *PACC* series are most predictable through other countries' *PEXP*, i.e., have a higher "receptivity".

We denote *PACC* in country i at time t by Y_{it}, and use X_{it} to denote the surveyed *PEXP* made at t about the future production level in country i. Each of the aforementioned tests requires stationarity of the series under investigation. In line with prior studies (see, e.g., Hanssens & Vanden Abeele, 1987; Öller & Tallbom, 1996), it was found, by carrying out various (unreported) stationarity tests, that all *PEXP* series (X_{it}) were already stationary, while the *PACC* series (Y_{it}) required seasonal differencing of order 12 ($\nabla^{12}Y_{it} = Y_{it} - Y_{it-12}$) to achieve stationarity.

2.1. Causality tests based on bivariate cross-correlations

For the bivariate test in country i, both time series, X_{it} and $\nabla^{12}Y_{it}$, are first modelled as a univariate ARMA process, i.e.,

$$\Phi^x(L)X_{it} = C^x + \Theta^x(L)u_{it}$$

$$\Phi^y(L)\nabla^{12}Y_{it} = C^y + \Theta^y(L)v_{it} \quad (1)$$

where $\Phi^x(L)$ and $\Phi^y(L)$ are autoregressive polynomials, $\Theta^x(L)$ and $\Theta^y(L)$ moving-average polynomials, and C^x and C^y the deterministic components (here, constant terms). After filtering the series with the above ARMA models, we obtain estimated innovation series $\hat{u}_{it}$ and $\hat{v}_{it}$, which can be regarded as white-noise processes with zero mean, but possibly correlated with each other at different leads and lags.

If we consider both series of innovations, u_{it} and v_{it}, it is well known (see, e.g., Gouriéroux & Monfort, 1996, p. 368) that X_{it} is not Granger causing Y_{it} if and only if all cross-correlations at positive lags between u_{it} and v_{it} are equal to zero. So, with $\rho_{v_i u_i}(k) = \text{corr}(u_{it}, v_{it+k})$:

$$H_0 : X_{it} \nRightarrow Y_{it} \Leftrightarrow \rho_{v_i u_i}(k) = 0 \quad \text{for} \quad k = 1, 2, 3, ..., \quad (2)$$

where $\nRightarrow$ means "does not Granger cause". Note that one could also test for the presence of feedback relationships between X_{it} and Y_{it} by considering the cross-correlations at negative lags between u_{it} and v_{it} instead (see, e.g., Sims, 1972).

The bivariate cross-correlations are estimated as

$$\hat{\rho}_{v_i u_i}(k) = \frac{\sum_{t=1}^{T-k} \hat{u}_{it}\hat{v}_{it+k}}{\left(\sum_{t=1}^{T} \hat{u}_{it}^2\right)^{\frac{1}{2}} \left(\sum_{t=1}^{T} \hat{v}_{it}^2\right)^{\frac{1}{2}}}. \quad (3)$$

If the null hypothesis of no Granger causality holds, $\hat{\rho}_{v_i u_i}(k)$ should be close to zero for all positive lags. A test statistic for the hypothesis of no Granger causality is then provided by Haugh (1976):

$$Q_M = T \sum_{k=1}^{M} \left(\hat{\rho}_{v_i u_i}(k)\right)^2 \sim \chi_M^2, \quad (4)$$

where χ_M^2 is a Chi-square distribution with M degrees of freedom. For a pre-specified value of M (here, the square root of the length of the series), Q_M is computed and the hypothesis of no Granger causality is rejected if $Q_M > \chi_{M,1-\alpha}^2$, where $\chi_{M,1-\alpha}^2$ is the $(1-\alpha)$ quantile of the Chi-square distribution with M degrees of freedom.

2.2. Multivariate Granger-causality tests

Let X_t and Y_t be two multivariate time series, $X_t \in \mathbb{R}^{d_1}$ and $Y_t \in \mathbb{R}^{d_2}$. In our case, $d=d_1=d_2$, the number of EU countries under consideration. In a first step, the multivariate time series X_t and $\nabla^{12}Y_t$ are modelled separately, using Vector Autoregressive (VAR) models, i.e.,

$$X_t = C^x + \Phi_1^x X_{t-1} + \Phi_2^x X_{t-2} + ... + \Phi_{\rho_x}^x X_{t-\rho_x} + U_t$$

$$\nabla^{12}Y_t = C^y + \Phi_1^y \nabla^{12}Y_{t-1} + \Phi_2^y \nabla^{12}Y_{t-2} + ... + \Phi_{\rho_y}^y \nabla^{12}Y_{t-\rho_y} + V_t, \quad (5)$$

with U_t and V_t two, possibly correlated, multivariate white-noise series, $U_t \in \mathbb{R}^{d_1}$ and $V_t \in \mathbb{R}^{d_2}$. The order of each VAR model is determined by the SBIC (Schwartz Bayesian Information Criterion). Furthermore, C^x and C^y are deterministic components; Φ_i^x and Φ_j^y are autoregressive polynomials, $\Phi_i^x \in \mathbb{R}^{d_1 \times d_1}$ for $i=1,...,\rho_x$ and $\Theta_j^y \in \mathbb{R}^{d_2 \times d_2}$ for $j=1,...,\rho_y$. We denote:

$$U_t = \begin{pmatrix} u_{1,t} \\ \vdots \\ u_{d_1,t} \end{pmatrix} \text{ and } V_t = \begin{pmatrix} v_{1,t} \\ \vdots \\ v_{d_2,t} \end{pmatrix}. \quad (6)$$

Note that the series U_t obtained after filtering with a VAR model are likely to differ from the series obtained by filtering each individual component of X_t through univariate models. Indeed, the innovations U_t obtained from (5) are independent of the past of every single component of X_t. With a univariate filtering procedure, in contrast, the innovation series from the first series may still carry information related to the past of the other series of X_t. Such indirect effects among the components of the X_t (or $\nabla^{12} Y_t$) vector are filtered out in the VAR-based approach of (5).

The estimated innovations U_t and V_t are cross-correlated at various leads and lags:

$$
\hat{R}^{VU}(k) = CORR(\hat{U}_t, \hat{V}_{t+k})
$$
$$
= \begin{pmatrix} \hat{\rho}_{v_1 u_1}(k) \; \hat{\rho}_{v_1 u_2}(k) \cdots \hat{\rho}_{v_1 u_{d_1}}(k) \\ \vdots \qquad\qquad\qquad \vdots \\ \hat{\rho}_{v_{d_2} u_1}(k) \cdots \qquad \cdots \hat{\rho}_{v_{d_2} u_{d_1}}(k) \end{pmatrix} \in \mathbb{R}^{d_2 \times d_1}
$$
(7)

with $k = \ldots, -2, -1, 0, 1, 2, \ldots$

The corresponding auto-correlations are defined as

$$
\hat{R}^{UU}(k) = CORR(\hat{U}_t, \hat{U}_{t+k}) \in \mathbb{R}^{d_1 \times d_1},
$$
$$
\hat{R}^{VV}(k) = CORR(\hat{V}_t, \hat{V}_{t+k}) \in \mathbb{R}^{d_2 \times d_2}.
$$
(8)

Since the two series of innovations U_t and V_t are multivariate white noise, we know that $R^{UU}(k) = 0 = R^{VV}(k)$ for any $k \neq 0$.

Similar to (2), one can prove (see Gouriéroux & Monfort, 1996, pp. 369–370) that

$$
H_0 : X_t \nRightarrow Y_t \Leftrightarrow R^{VU}(k) = 0, \quad \text{for all } k > 0.
$$
(9)

A test-statistic for the hypothesis of no Granger causality was proposed by El Himdi and Roy (1997). This test looks, for every $k = 1, \ldots, M$ where M equals the maximum lag (again, the square root of the length of the series) at the vector:

$$
vec\,\hat{R}^{VU}(k)
$$
$$
= \left(\hat{\rho}_{v_1 u_1}(k) \quad \hat{\rho}_{v_2 u_1}(k) \cdots \hat{\rho}_{v_1 u_2}(k) \cdots \hat{\rho}_{v_{d_2} u_{d_1}}(k) \right)^t
$$
(10)

i.e., the correlation matrix $\hat{R}^{VU}(k)$ is vectorized into a vector of length $d_1 d_2$. Under the null hypothesis, all components of this vector should be small. Note, however, that not all components are independent of each other. Indeed, one can show that, under the null hypothesis and for $k > 0$,

$$
cov\left(\hat{\rho}_{v_i u_j}^{(k)}, \hat{\rho}_{v_{i'} u_{j'}}^{(k)}\right) \approx \frac{R^{vv}(0)_{ii'}\, R^{uu}(0)_{jj'}}{T},
$$
(11)

with $1 \le i, i' \le d_2$ and $1 \le j, j' \le d_1$ and $\approx$ standing for asymptotical equivalence.

Using this vector, one can compute (similar to (4)) the following multivariate test-statistic:

$$
Q_{HR}^k = T[vec\,\hat{R}^{VU}(k)]^t A^{-1}[vec\,\hat{R}^{VU}(k)],
$$
(12)

where A is the asymptotic covariance matrix of $\sqrt{T}\, vec\,\hat{R}^{VU}(k)$, so $A = \hat{R}^{VV}(0) \otimes \hat{R}^{UU}(0)$, with $\otimes$ the Kronecker product. The values of Q_{HR}^k can be plotted against k, giving an idea of the strength of the cross-correlation at various lags. The above quadratic form follows a $\chi^2_{d_1 d_2}$ distribution under the null hypothesis, leading to the El Himdi and Roy (1997) test-statistic:

$$
Q_{HR} = \sum_{k=1}^{M} Q_{HR}^k \sim \chi^2_{M d_1 d_2}.
$$
(13)

This multivariate procedure provides a more powerful test than the bivariate analogues of Section 2.1. The power gain is derived from two sources. First, all countries are pooled to find evidence of Granger causality. Moreover, it automatically permits one to look for Granger causality across countries, meaning that we already allow for the possibility that the *PEXP* in one country Granger causes the *PACC* in another country. El Himdi and Roy (1997) applied this multivariate test to investigate the causal relations between money (M1 and M2) and income (Gross National Product) for Canada, as well as to study the causal directions between the Canadian and American economies.

Knowing the predictive content of *PEXP* in all considered EU countries together, one could wonder whether part of this causality can be attributed to cross-country influences. This is a natural extension of the bivariate cross-country analysis of Section 2.1. To test whether the joint cross-country causality is significant, we state the following null hypothesis:

$$
H_0: \hat{R}^{VU}(k) = 0 \quad \text{for all } k > 0,
$$
(14)

where $\tilde{R}^{VU}(k)$ is equal to $R^{VU}(k)$ without the elements on the diagonal, yielding a $d_1 \times (d_1 - 1)$ matrix.

The test statistic is adjusted accordingly to:

$$Q_{HR}^{cross} = T \sum_{k=1}^{M} \left[vec\ \hat{\tilde{\boldsymbol{R}}}^{VU}(k) \right]^t \tilde{A}^{-1} \left[vec\ \hat{\tilde{\boldsymbol{R}}}^{VU}(k) \right], \quad (15)$$

which is $\chi^2_{Md_1(d_1-1)}$ distributed, where $\tilde{A}$ is the asymptotic covariance matrix of $\sqrt{T}\ vec\ \hat{\tilde{\boldsymbol{R}}}^{VU}(k)$, $\tilde{A} = \hat{\tilde{\boldsymbol{R}}}^{VV}(0)\ \hat{\tilde{\boldsymbol{R}}}^{UU}(0)$. In fact, $\tilde{A}$ is simply equal to A, from which the rows and columns corresponding to the diagonal elements of $R^{VU}(k)$ are deleted. An analogous reasoning can be applied to obtain a within-country test statistic Q_{HR}^{within}, which will be $\chi^2_{Md_1}$ distributed.

Finally, in order to more deeply understand the underlying interdependencies within the European Union, one could further modify the multivariate procedure to also investigate whether the *PEXP* series in country i Granger causes the *PACC* of all other countries $j=1,\ldots, d$, $i \neq j$, and therefore offer a quantification for that country's "clout". To test for the "clout" of country i, only the single component X_{it} has to be taken into account to test whether the latter Granger causes the collection of all other series Y_{jt}, with $j \neq i$. The El Himdi–Roy procedure is then applied as outlined above, with $d_1=1$ and $d_2=d-1$. Similarly, we may want to test whether the *PACC* series of a given country j is Granger caused by the *PEXP* of all other countries $i=1,\ldots, d$, $i \neq j$, giving a measure of the "receptivity" of country j. In this case, $d_1=d-1$ and $d_2=1$. In both cases, the distribution of the test statistic is a $\chi^2_{(d-1)M}$.

3. Data

The Production Expectations *PEXP* series are provided by the Directorate General Economy and Finance of the European Commission.[1] They are by definition subjective, reflecting the respondents' optimism/pessimism with respect to the evolution of the production (excluding construction). They are expressed in Balance (*Bal=Pos−Neg*). Specifically, one asks the responding firms *whether they expect their production to increase, decrease or remain unchanged over the next three months*, and subse-

quently subtracts all decrease (*Neg*) answers—in percentage points of total answers—from the percentage of increase (*Pos*) ones. A directional questionnaire is used as directions of change have been found to be easier to predict than point values (Jonung, 1986). Balance data were also used in Bergström (1995) and Lindström (2000), among others.[2] Note, however, that problems with balance data may arise when positive and negative answers are not symmetrically distributed around zero (Entorf, 1993; Öller, 1990).

The Production Account *PACC* series are the monthly *Industrial Production Indices* reported in the OECD's publication, *Main Economic Indicators*.[3] These production indices are collected by the OECD from the different national institutions and are expressed as an index with 1995 scaled as base index 1 (at constant prices). Industrial production includes mining, manufacturing and production of electricity, gas and water, excluding construction (compatible with ISIC Rev. 3).

We selected 12 EU countries out of the (pre-2004) member states: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, and the United Kingdom. Three countries (Portugal, Spain and Sweden) were not selected, as this would have resulted in the loss of multiple data points due to missing observations, since monthly surveys in these countries began later. However, the 12 retained EU countries represent over 85% of the Gross Domestic Product of the EU15 in 2002 (at current prices and exchange rates). All time series are collected on a monthly basis. The data range from January 1985 to December 2002, resulting in 216 monthly observations. As, among other remarkable events, Germany's reunification took place during the considered time span, we also examined the existence of structural breaks in the time series. According to standard CUSUM tests based on recursive least squares, structural stability was found to be plausible during the whole time period, and no structural dummies were included.
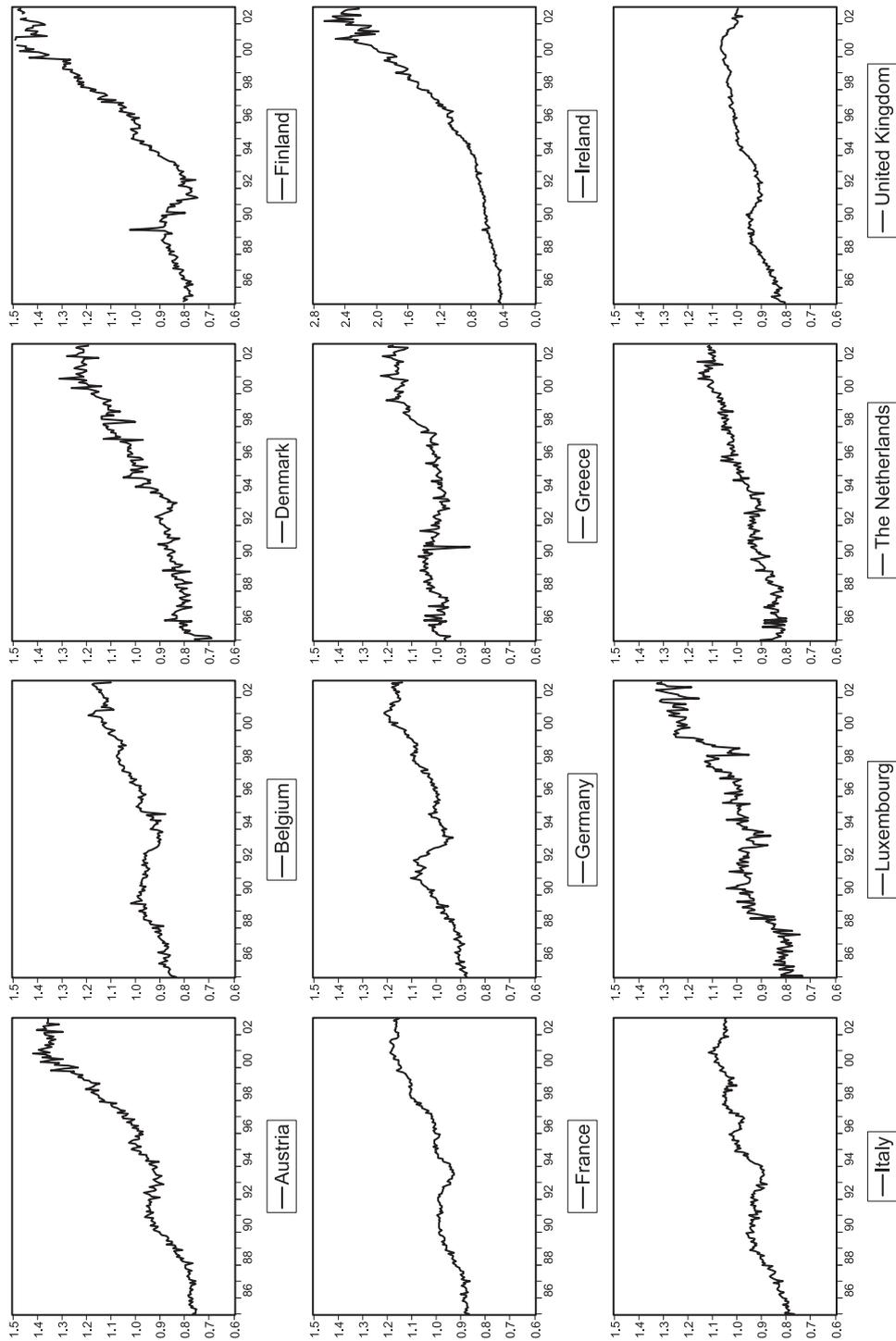
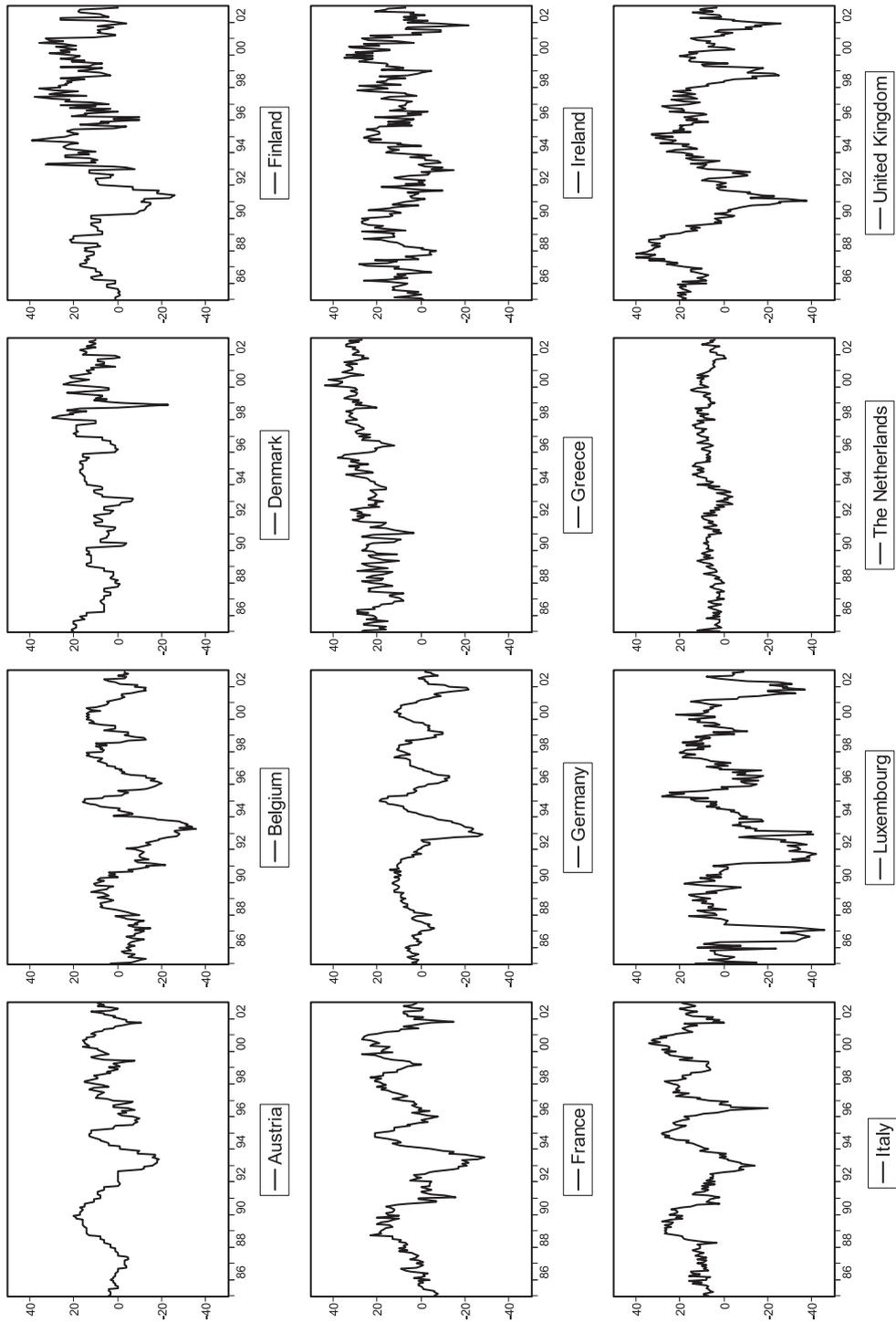Fig. 1. Production account *PACC* (raw) time series of the 12 EU countries.

Fig. 2. Production expectations *PEXP* (raw) time series of the 12 EU countries.

A visual inspection of the raw time series (see Fig. 1) reveals some apparent similarities in the *PACC* series among various member countries. Several of the series shows a pronounced upward trend, but suffered from a temporary slowdown in the early 1990s (see, e.g., the graphs for Belgium, Finland, France, Germany and the United Kingdom, among others). Still, this slowdown was much less pronounced in countries like Denmark and The Netherlands, and even less so in Ireland. Note that the Irish *PACC* exhibits a curvilinear trend.[4]

Also in the *PEXP* series (see Fig. 2), some similarities seem to be present (see, in this respect, the graphs for Belgium, France, and Germany), while countries like Ireland and Denmark seem to follow a more idiosyncratic evolution.

In summary, this preliminary visual inspection suggests that (i) some cross-country commonalities and influences could well be present, but that (ii) this will probably not be homogeneous across all member states.

4. Results

4.1. Bivariate within-country predictive content in Europe

Traditionally, the *within*-country forecasting value of the *PEXP* series was assessed by bivariate causality tests. In our setting, this results, in 12 tests, whose *p*-values are reported in the diagonal of Table 1.

The findings confirm our earlier observation that the evidence is mixed concerning the *within*-country predictive content of *PEXP*, although some strong Granger causalities clearly appear in the table. Indeed, the null hypothesis of no Granger causality is rejected for 7 of the 12 countries at the 5% level. In line with Teräsvirta (1986), we find a significant predictive content for the Finnish *PEXP* series ($p=0.000$). Note, however, that this result cannot be generalized to all Scandinavian countries, as the null hypothesis could not be rejected for Denmark ($p=0.193$). This was also the case for Ireland ($p=0.189$) and the United Kingdom ($p=0.132$).

4.2. Bivariate cross-country predictive content in Europe

The possibility that *PEXP* may influence not only their own *PACC* series, but also (some) other countries' can be formally investigated by running an additional 132 bivariate Haugh tests, as summarized in the off-diagonal elements of Table 1. A value situated in the ith row and j^{th} column of Table 1 represents the *p*-value for the test that the *PEXP* in country i Granger causes *PACC* in country j. Note that, because of the multiple-testing issue explained below, we test at a stricter significance level of 1%.

More than predicting its own *PACC*, German *PEXP* also Granger causes *PACC* changes in several other countries, i.e., in Belgium, Finland, France, and The Netherlands (at the 1% level). A similar "clout" can be attributed to France and Belgium. The former result is not surprising, as France and Germany are often seen as two of the key forces (both economically and politically) of the European unification. In addition, their respective populations are found to have among the highest rates of contact with other countries (Putsis, Balasubramanian, & Kaplan, 1997). As for Germany, our findings provide further evidence in support of the German leadership hypothesis, thereby complementing the findings of Sensier, Artis, Osborn, and Birchenhall (2004), who found that Germany's composite leading indicator had a particularly marked effect on the Italian economy, and of Artis and Zhang (1998) and Barassi, Caporale, and Hall (2000), among others, who studied the leading role of German interest rates. The finding for Belgium, in turn, may be linked to its central role in the location of the European Union's administration.

The British *PEXP*, in contrast, does not Granger cause any country's *PACC* at the 1% probability level, not even its own. Even if this result cannot be overstated, it could reflect the distinct position of the United Kingdom in terms of geography, economy and culture (see Northcott (1995) for a more elaborate discussion).

Note further that Table 1 is not symmetric. Consider, for example, Luxembourg. Its *PEXP* series is not informative for the future evolution of the *PACC* series of its neighbor Belgium, while that country's *PEXP* series Granger causes the *PACC* series of Luxembourg.

---

[4] A log-transform of the Irish series was considered, and found not to affect the results.

Table 1
Bivariate cross-country analysis: p-values for the Haugh test for testing whether PEXP in country i (ith row) Granger causes PACC in country j (jth column)

| | | Production accounts PACC | | | | | | | | | | | |
	p-value*	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	The Netherlands	The United Kingdom
Production expectations PEXP	Austria	0.008*	0.246	0.019	0.234	0.002*	0.072	0.983	0.797	0.046	0.721	0.227	0.302
	Belgium	0.013	0.003*	0.003*	0.102	0.000*	0.137	0.068	0.052	0.006*	0.010*	0.019	0.015
	Denmark	0.004*	0.134	0.193	0.003*	0.185	0.780	0.927	0.247	0.139	0.530	0.311	0.191
	Finland	0.086	0.138	0.014	0.000*	0.048	0.293	0.694	0.012	0.268	0.103	0.510	0.125
	France	0.000*	0.002*	0.001*	0.013	0.000*	0.001*	0.008*	0.013	0.001*	0.051	0.002*	0.134
	Germany	0.125	0.000*	0.152	0.010*	0.003*	0.001*	0.036	0.552	0.162	0.039	0.006*	0.441
	Greece	0.395	0.016	0.152	0.023	0.393	0.107	0.080	0.448	0.183	0.297	0.272	0.056
	Ireland	0.032	0.053	0.039	0.290	0.395	0.105	0.961	0.189	0.460	0.019	0.042	0.486
	Italy	0.022	0.076	0.090	0.524	0.013	0.463	0.196	0.444	0.001*	0.009*	0.024	0.252
	Luxembourg	0.252	0.140	0.285	0.062	0.084	0.377	0.009*	0.709	0.200	0.013	0.347	0.931
	The Netherlands	0.131	0.020	0.138	0.021	0.293	0.071	0.145	0.674	0.027	0.444	0.057	0.311
	The United Kingdom	0.347	0.063	0.620	0.328	0.756	0.520	0.757	0.144	0.143	0.138	0.592	0.132

* Significant at the 1% probability level.

Although the aforementioned examples provide some face validity to the figures of Table 1, it is obvious that the interpretation of that many test results is quite cumbersome, and may, not surprisingly, lead to some apparent "anomalies". For example, it is not immediately clear why PEXP in Luxembourg would Granger cause PACC in Greece, but not in its neighbor, Belgium, which is more similar culturally and economically. Moreover, although 20 of the 132 off-diagonal p-values turned out to be smaller than 0.01, one should keep in mind that the p-values in Table 1 may suffer from the multiple-testing problem, and be biased downwards (Bauer, Hommel, & Sonnemann, 1988). Therefore, the predictive power of the PEXP surveys is likely to be lower than what might be inferred from Table 1. A multivariate extension of the bivariate Granger-causality tests can address these concerns.

4.3. Multivariate European predictive content

The El Himdi–Roy (HR) test for the null hypothesis of no Granger causality between PEXP and PACC at the joint European level resulted in a test statistic $Q_{HR}=2687.760$, with associated p-value=0.000. The multivariate test procedure therefore established that, in combination, the 12 PEXP series from the European Business Surveys' program have predictive value in forecasting the actual PACC series, thereby offering further justification for their continued use.

In order to get insight into the distribution of the predictive content of PEXP over time, we also consider the strength of the cross-correlation at lag k as measured by Q_{HR}^k, the kth term of the test statistic Q_{HR}, defined in (14). In Fig. 3, the values of Q_{HR}^k are plotted with respect to the lag length, and compared with the marginal critical value $\chi^2_{d_1 d_2, 1-\alpha}$, as in El Himdi and Roy (1997).

Fig. 3 illustrates that the predictive content of the PEXP slowly decreases over time, and completely drops under the significance cut-off after a few years.

4.4. Multivariate cross-country predictive content in Europe

When testing for the joint nullity of all cross-correlations at positive lags (14), we obtain $Q_{HR}^{cross}=2390.276$ (with $132 \times M$ degrees of freedom), with associated p-value=0.000, and $Q_{HR}^{within}=230.793$ (with
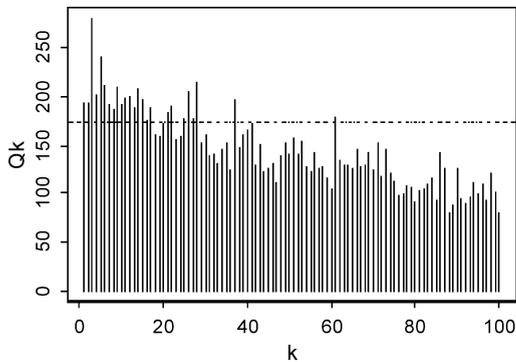
Fig. 3. Measure Q_{HR}^k of multivariate Granger causality of *PEXP* on *PACC*, for lags up to $k=100$ months.

$12 \times M$ degrees of freedom), with associated *p*-value= 0.000. This implies that cross-country influences clearly exist, and contribute to the high combined predictive content of *PEXP* series in Europe.

4.5. Multivariate clout and receptivity in Europe

Table 2 reports the results of the tests assessing the "clout" and the "receptivity" of each of the twelve EU countries. The second column provides the *p*-value for testing the Granger causality of the *PEXP* in the country mentioned in the first column on all other countries' *PACC* series. The smaller this value, the higher the "clout" of the country. The third column of Table 2 represents the *p*-value related to the test for Granger causality of the *PEXP* in all other countries on the *PACC* in that specific country. The smaller this value, the higher the "receptivity" of the country.

First of all, we may observe that only the *PEXP* series of Germany and France have highly significant predictive content (in the multivariate Granger sense) on future *PACC*. These findings are in line with our previous bivariate analysis, and confirm common intuition that those two economies are two key *economic drivers of the European integration*. The economic climate in those countries (as reflected in their balance scores on the *PEXP* series) is found to Granger cause the subsequent actual production in the rest of the European Union, which offers further justification for the quite large sample sizes[5] (and

hence higher costs of data collection) in those countries' Business Tendency Surveys. In contrast, Germany has a low "receptivity" score: while it drives the European Union, it is less likely to be influenced by the other member countries.

Another key fact illustrated by the multivariate test is that many countries have no significant "clout", not even at very liberal significance levels; see, e.g., Austria ($p=0.889$), Denmark ($p=0.810$), Ireland ($p=0.345$), Italy ($p=0.812$), and the United Kingdom ($p=0.533$). This suggests that the highly significant multivariate predictive content of the *PEXP* series will be mainly driven by a few key countries such as France and Germany. One could even question the usefulness of a continued use of the Business Tendency Surveys in countries like Denmark, Ireland, or the United Kingdom, as they do not have a significant predictive power for the actual economic evolution in the other member countries (Table 2), nor for their own actual economic evolution (cf. diagonal elements of Table 1). The latter conclusion is, however, conditional on the analyzed *PEXP* and *PACC* series. As indicated in Section 1, the Business Tendency Surveys also collect data on other components of the economy such as retail trade, services, construction..., and more research is necessary to assess whether this conclusion also holds in these other domains.

In terms of the "receptivity", we find a significant ($p<0.05$) effect for three countries: Austria, Denmark, and Finland. Our findings for Denmark are in line

---

[5] According to European Commission (2002) France and Germany together represent more than 25% of the industry-related surveyed units across the European Union.

Table 2
p-values of the El Himdi–Roy test for assessing the "clout" and the "receptivity" of a selected country

Country	Clout	Receptivity
Austria	0.889	0.005*
Belgium	0.058	0.159
Denmark	0.810	0.029*
Finland	0.122	0.028*
France	0.000*	0.052
Germany	0.004*	0.427
Greece	0.096	0.253
Ireland	0.345	0.476
Italy	0.812	0.250
Luxembourg	0.098	0.148
The Netherlands	0.156	0.357
The United Kingdom	0.533	0.796

* Significant at the 5% probability level.

with Putsis et al. (1997), who showed that this country derives a higher percentage of its contacts from outside its borders than internal. This corroborates the fact that Denmark has low within-country predictive power ($p=0.193$), while having high "receptivity" ($p=0.029$; Table 2). As for Austria and Finland, more than 60% of the total trade of these former EFTA countries is directed towards the EU (Sapir, 1998), which may well explain their high-receptivity scores.

Finally, it is worth noting that the United Kingdom and Ireland score low on both dimensions. This may reflect their geographically distinct position, but also—at least for the United Kingdom—the country's relative distinctiveness in terms of economic integration and culture (Northcott, 1995). The low "receptivity" and "clout" of Ireland, in turn, is in line with the pan-European study of Mahajan and Muller (1994), who found the Irish population to be much less sensitive to word-of-mouth influences, which is a key mechanism through which cross-country *PEXP* may influence future *PACC* levels.

5. Conclusions

Each month, for over 40 years, the European Union, together with institutions from the fifteen member states of the European Union, carries out costly and time-consuming Business Tendency Surveys on the past, actual, and future states of the European Economy. Since they are, on a regular basis, used for economic surveillance by several parties, there is a concern about their *performance* in predicting actually realized Account data, especially since existing literature on the topic offers mixed evidence on the Surveys' predictive content.

In this paper, we tested the Granger causality between *PEXP* and *PACC* series from twelve European countries. Instead of only focusing on a sequence of bivariate within-country analyses, we also undertook a simultaneous, *multivariate* approach. Indeed, when predicting the future production level in a country, there is no reason to ignore, a priori, the information conveyed by Business Surveys in other countries. In this sense, the predictive content of *PEXP* series could be evaluated both at the *national* (bivariate test) and at the *European* (multivariate test) level.

While confirmation of Granger causality at the individual country level was not found for every country—7 countries out of 12 showed a significant predictive content at the 5% level—very strong evidence of Granger causality was discovered at the multicountry level. It also turned out that the cross-country Granger causalities were jointly strongly significant, indicating that it could indeed be advantageous to exploit these correlations in multivariate forecast methods.

Moreover, according to the multivariate analysis, some countries (i.e., France and Germany) have more "clout" than others, while others are more "receptive" (i.e., Austria, Finland and Denmark). Finally, the United Kingdom and Ireland seem to occupy a fairly isolated position. They both have no "clout" and no "receptivity".

As a conclusion, we state that the harmonization of European Business Tendency Surveys allows one to exploit cross-country relations between the different series and to improve forecasts of future Account data for an individual country by using a multivariate approach. More research is open to generalize these findings to other variables that are routinely collected in the EU Business Tendency Surveys.

References

Artis, M. J., & Zhang, W. (1998). The linkage of interest rates within the EMS. *Weltwirtschaftliches Archiv*, *134*, 117–132.

Barassi, M. R., Caporale, G. M., & Hall, S. G. (2000, June). Interest rate linkages: A Kalman Filter Approach to detecting structural change, *Imperial College Management School Working Papers*, *5*.

Bauer, P., Hommel, G., & Sonnemann, E. (1988). *Multiple hypotheses testing*. Berlin: Springer.

Bergström, R. (1995). The relationship between manufacturing production and different business survey series in Sweden 1968–1992. *International Journal of Forecasting*, *11*, 379–393.

Buffeteau, S., & Mora, V. (2000, December). Predicting the national accounts of the Euro zone using business surveys, *INSEE Conjuncture in France*.

Christoffersson, A., Roberts, R., & Eriksson, U. (1992). The relationship between manufacturing and various business tendency survey series in Sweden illuminated by frequency and complex demodulate methods, *NIER Working Paper Stockholm*, *15*.

Cooper, L. G., & Nakanishi, N. (1998). *Market-share analysis*. Massachusetts: ISQM Kluwer Academic Publishers.

El Himdi, K., & Roy, R. (1997). Tests for non-correlation of two multivariate ARMA time series. *Canadian Journal of Statistics*, *25*, 233–256.

Entorf, H. (1993). Constructing leading indicators from non-balanced sectoral business surveys series. *International Journal of Forecasting*, *9*, 211–225.

European Commission (2002). The joint harmonised Eu Programme of business and consumer surveys, User Guide 2002. Directorate General, Economic and Financial Affairs. http://europa.eu.int/comm/economy-finance/indicators/business-consumer-surveys/userguide-en.pdf.

Gouriéroux, Ch., & Monfort, A. (1996). *Time series and dynamic models*. Glasgow: Cambridge University Press.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, *37*, 424–438.

Granger, C. W. J. (1980). *Forecasting in business and economics*. New York: Academic Press.

Hanssens, D. M., & Vanden Abeele, P. M. (1987). A time-series study of the formation and predictive performance of EEC production survey expectations. *Journal of Business and Economic Statistics*, *5*, 507–519.

Haugh, L. D. (1976). Checking the independence of two covariance-stationary time series: A univariate residual cross-correlation approach. *Journal of the American Statistical Association*, *71*, 378–385.

Jonung, L. (1986). Uncertainty about inflationary perceptions and expectations. *Journal of Economic Psychology*, *7*, 315–325.

Klein, P. A., & Moore, G. H. (1983). The leading indicator approach to economic forecasting-retrospect and prospect. *Journal of Forecasting*, *2*, 119–135.

Lindström, T. (2000, November). Qualitative survey responses and production over the business cycle, *Central Bank of Sweden-Working Paper Series*, *116*.

Mahajan, V., & Muller, E. (1994). Innovation diffusion in a borderless global market: Will the 1992 unification of the European community accelerate diffusion of new ideas, products, and technologies? *Technological Forecasting & Social Change*, *45*, 221–235.

Northcott, J. (1995). *The future of Britain and Europe*. London: Policy Studies Institute Research Report.

Öller, L. -E. (1990). Forecasting the business cycle using survey data. *International Journal of Forecasting*, *6*, 453–461.

Öller, L. -E., & Tallbom, C. (1996). Smooth and timely business cycle indicators for noisy Swedish data. *International Journal of Forecasting*, *12*, 389–402.

Putsis, W. P., Balasubramanian, S., Kaplan, E. H., & Sen, S. K. (1997). Mixing behavior in cross-country diffusion. *Marketing Science*, *16*, 354–369.

Sapir, A. (1998). The political economy of EC regionalism. *European Economic Review*, *42*, 717–732.

Sensier, M., Artis, M., Osborn, D. R., & Birchenhall, C. (2004). Domestic and international influences on business cycles regimes in Europe. *International Journal of Forecasting*, *20*, 343–357.

Sims, C. A. (1972). Money, income, and causality. *The American Economic Review*, *62*, 540–552.

Tellis, G. J., Stremersch, S., & Yin, E. (2003). The international takeoff of new products: The role of economics. *Culture and Country Innovativeness, Marketing Science*, *22*, 188–208.

Teräsvirta, T. (1986). Model selection with business survey data: Forecasting the output of Finnish metal and engineering industries. *International Journal of Forecasting*, *2*, 191–200.

Biographies: Aurélie LEMMENS is Ph.D student at the Catholic University Leuven (Belgium). Her research interests are marketing modeling and applied statistics. She focuses on time-series analysis, classification models, and their marketing applications.

Christophe CROUX is Professor of Statistics and Econometrics at the Catholic University Leuven (Belgium). His research interests are robust statistics, multivariate data analysis, classification, computational statistics, and applied time-series analysis. His work has been published in *Biometrika*, the *Journal of the American Statistical Association*, the *Journal of Multivariate Analysis,* and the *Review of Economics and Statistics*, among others. He serves on the editorial board of *Computational Statistics* and *Data Analysis*.

Marnik G. DEKIMPE (Ph.D., UCLA) is Professor of Marketing at the Catholic University Leuven (Belgium) and is Professor of Marketing Management at the Erasmus University Rotterdam (The Netherlands). His work has been published in *Marketing Science*, *Management Science*, the *Journal of Marketing Research*, the *Journal of Marketing*, the *International Journal of Research in Marketing* and the *Journal of Econometrics*, among others. He serves on the editorial board of *Marketing Science*, the *Journal of Marketing Research*, the *International Journal of Research in Marketing*, the *Review of Marketing Science*, and the *Journal of Interactive Marketing*.