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The Extent of Seasonal/Business Cycle Interactions in European Industrial Production

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ABSTRACT

Recent literature has uncovered evidence that the seasonal pattern in industrial production changes over the business cycle, with seasonality typically being less pronounced in periods of high growth than in the low growth (or recession) business cycle phase. Matas Mir and Osborn (2003a) examine this effect using monthly data for various OECD countries, finding that the change in the seasonal pattern is typically concentrated in the summer months. The present paper extends this analysis in a specifically European context, by presenting measures of the extent of seasonal/business cycle interactions for industrial production series from the countries of the European Union. The analysis is undertaken using a nonlinear threshold model that allows the overall mean and seasonal characteristics to change with the regime. The extent of seasonality in each regime is represented as the average absolute deviation of the steady-state growth in each month from the overall steady-state mean growth in that regime. Seasonal/business cycle interaction is then measured in two ways, namely as the difference and the ratio of the regime-dependent seasonality. All these measures are computed over all months, and also separately for the summer and non-summer months. The results reinforce previous findings of reduced seasonality in higher growth periods, with the seasonal pattern sometimes being moderated by 20 percent or more (both over the year and in the summer months).

JEL Classifications: E32, C22

KEYWORDS: Business cycles, seasonality, TAR models, industrial production

1. INTRODUCTION

The title of this colloquium is "Modern Tools for Business Cycle Analysis", and there is no doubt that nonlinear models have provided a whole class of new tools for business cycle analysis. These nonlinear models have been embraced and further developed, both theoretically and empirically, by economists over the last decade or so. Their popularity is partly because they typically fit historical data better than linear models. More importantly, however, nonlinear models are popular because they provide practical tools that allow economists to investigate issues concerned with how economic responses vary over business cycle phases in a way that is not possible within the confines of a linear framework.

This paper uses nonlinear models to examine an issue that is important to statisticians working in official statistical agencies, but (for reasons that are not immediately obvious) has attracted relatively little interest among economists. This issue is the nature of seasonality, specifically seasonality in industrial production for the countries of the European Union. It is well documented that seasonality dominates the short-term (month-to-month or-quarter to-quarter) movements in such series; see, for example Miron and Beaulieu (1996) or Matas Mir and Osborn (2003a). Nevertheless, the widespread view among economists is that these movements associated with seasonality contain no economic information, and hence they prefer to estimate their models using seasonally adjusted data. It is, therefore, not surprising that virtually all the key papers developing nonlinear models for business cycle analysis (including the seminal study of Hamilton, 1989) have been set in a nonseasonal context, either explicitly or implicitly using.seasonally adjusted data.

Despite the predominance of the use of seasonally adjusted data, there has recently been a strain of literature that has found evidence of interactions between seasonality and the business cycle, with contributions including Ghysels (1993, 1994), Canova and Ghysels (1994), Cecchetti and Kashyap (1996), Miron and Beaulieu (1996), Cecchetti, Kashyap and Wilcox (1997), Carpenter and Levy (1998), Krane and Wascher (1999), van Dijk, Strikholm and Teräsvirta (2003), Teräsvirta, Strikholm and van Dijk (2003), Matas Mir and Osborn (2003a, 2003b). Perhaps the most compelling theoretical case for anticipating a seasonal/business cycle interaction is that of Cecchetti and Kashyap (1996), who argue that the seasonal slowdown in production during the summer months should be less marked at business cycle peaks compared with troughs, because when there are capacity constraints due to high demand around the peak of the cycle it will be cost effective for producers to utilise the spare capacity that occurs in the summer months in order to meet this demand.

In Matas Mir and Osborn (2003a), we take up this issue, using a nonlinear threshold model to capture the business cycle regimes while allowing the seasonal parameters (as well as the intercept) to change with the regime. Applying the model to monthly industrial production series for 16 OECD countries, using data from 1960 to 1995, we find evidence of a significant seasonal/business cycle interaction in about a third of the 74 series analysed. Further, examining the seasonal patterns by month for each business cycle regime, our evidence supports the arguments of Cecchetti and Kashyap (1996) that changes in seasonality associated with the business cycle are evident primarily in the summer months, when seasonality is muted during the upper regime (where growth is higher) in comparison with the seasonality exhibited in the lower regime.

The present paper again examines this issue, but now focusing exclusively on the countries of the European Union. Further, here we provide measures of the change in seasonality over the business cycle, comparing changes for all months of the year to changes for the summer months alone, in order to examine the extent to which seasonal/business cycle interactions are confined to the summer months. The outline of the remainder of the paper is that Section 2 presents the particular version of the nonlinear threshold model we employ, while Section 3 presents the substantive results. Some conclusions (Section 4) complete the paper.

2. MODELING AND MEASURING SEASONAL/BUSINESS CYCLE INTERACTIONS

The model we employ here is almost identical to that used in our earlier study, Matas Mir and Osborn (2003a). As discussed below, however, we now take a simpler approach to testing for significance of the nonlinearity. The model is of the threshold autoregressive (TAR) class, which is particularly appropriate in the context of business cycle phases, as it allows the parameters to change when growth exceeds some threshold. In the present context the specific parameters permitted to change with the threshold are the (nonseasonal and seasonal) intercept coefficients, thereby allowing the underlying seasonal pattern to vary over business cycle regimes.

Subsection 2.1 outlines the model we employ, while subsection 2.2 then considers estimation and inference issues. Finally, subsection 2.3 discusses the measures we employ for the extent of seasonal/business cycle interactions.

2.1 The Model

As in Matas Mir and Osborn (2003a), the model we employ has the form

$$\phi(L)\Delta y_t = \delta_0 + \eta_0 t + \gamma_0 I_t + \sum_{j=1}^{11}\delta_j s_{jt} + \sum_{j=1}^{11}\eta_j s_{jt} t + \sum_{j=1}^{11}\gamma_j I_t s_{jt} + \varepsilon_t \qquad (1)$$

where Δy_t is the monthly growth in industrial production with disturbance process $\varepsilon_t \sim NID(0, \sigma^2)$. The autoregressive operator $\phi(L)$, defined in terms of the usual lag operator L, is assumed to have all roots strictly outside the unit circle. Seasonality is captured through the variables s_{jt} which are defined by $s_{jt} = D_{jt} - D_{12t}$, $j = 1, \ldots, 11$ where D_{jt} are the conventional monthly seasonal dummy variables. In the lower regime at time t ($I_t = 0$), the coefficients δ_j ($j = 1, \ldots, 11$) measure the seasonal intercept shift in each of eleven months compared with the overall intercept δ_0, with the intercept shift for the final month computed as $\delta_{12} = -\sum_{j=1}^{11}\delta_j$.

We define the regime indicator I_t by:

$$I_t = \begin{cases} 1 & \text{if } (1 + L + L^2)\Delta_{12} y_{t-1}/3 \geq r \\ 0 & \text{if } (1 + L + L^2)\Delta_{12} y_{t-1}/3 < r \end{cases}. \qquad (2)$$

Equations (1) and (2) then define a restricted TAR model, where r is the (single) threshold parameter[1]. The coefficients γ_j ($j = 0, \ldots, 12$) give the amount by which the overall intercept and seasonal intercept terms shift in the upper regime ($I_t = 1$) compared with the lower, where the seasonal intercept shift omitted from (1) can be computed as $\gamma_{12} = -\sum_{j=1}^{11}\gamma_j$. Through the specification of (1), combined with the regime shift defined in (2), we can separate monthly regime-dependent seasonal patterns around the

[1] In Matas Mir and Osborn (2003a) we removed a linear trend from the threshold variable to allow for the possibility that Δy_t trends over time. We do not do so in the present analysis, however, since the overall trend η_0 was rarely significant in (1).

mean from the overall steady-state mean growth within the regime. This is discussed in subsection 2.3 below.

From a behavioural perspective, (2) allows seasonality to change when, over the previous three months, the average increase in production is more than some threshold amount *r* compared with a year earlier. For many European countries, production peaks during the spring and early summer, before falling (sometimes dramatically) during July or August; see, for example, the monthly growth rate patterns in Miron and Beaulieu (1996, Table 3). The business cycle indicator in (2) then allows the possibility that the seasonal pattern in July/August may alter as a consequence of conditions that have operated in the spring. However such changes are not restricted to the summer, since changes in the seasonal pattern may occur in (1) in any month of the year that the business cycle regime shifts.

It may be noted that our model restricts changing seasonal behaviour to the seasonal intercepts, with no effect operating through the dynamics in $\phi(L)$. This keeps the parameterisation simple, but nevertheless captures the essential feature of any relationship between seasonality and the business cycle.

Seasonal trend terms are included in (1) to allow for the trends over time in the seasonal pattern that occurs for many series in at least some months of the year. Although van Dijk *et al*. (2003) model changing seasonality as logistic time trends we prefer the simpler approach of linear seasonal trends. In Matas Mir and Osborn (2003a) we report the joint significance of these seasonal trends. Although we do not do so in the present paper, they are highly significant for almost all series examined.

2.2 Estimation and Inference

Estimation of a threshold model, such as (1), can be undertaken through a grid search over values of the threshold r with ordinary least squares (OLS) applied conditional on its value. This is implemented by searching over the empirical distribution function of the threshold variable in (2), excluding its extremes. For the present analysis we search over the central 50 percent of the distribution, thereby not allowing the threshold to be in the upper or lower quartiles of the distribution of the average annual growth rate threshold variable. This is to avoid the problem that one "regime" may correspond to only a small number of observations and hence we hope to obtain reliable estimates of the regime-dependent monthly seasonal coefficients δ_j and γ_j in (1).

Chan (1993) shows that, for a given order of $\phi(L)$, searching over all possible values of r to minimise the sum of squared residuals produces a super-consistent estimate of the threshold. In practice we use a fixed autoregressive order of 24 for $\phi(L)$, thereby allowing for dynamics of up to two years.

Conventional inference cannot be applied in (1) for the coefficients related to the business cycle nonlinearity, namely γ_j (j = 0, 1, …, 11), since these depend on the unobserved threshold r. The solution adopted in Matas Mir and Osborn (2003a) is to use a simulation procedure to obtain finite sample p-values corresponding to a test of the null joint hypothesis $\gamma_j = 0$ (j = 0, 1, …, 11). Such a test is important since it provides information on whether there is any business cycle nonlinearity in (1), and hence whether there could be a seasonal/business cycle interaction. However the simulation method is very costly in computing time. Therefore in the present paper we take the simpler approach of testing the joint significance of these terms using the Hansen (1997) approximation to the asymptotic distribution of tests for structural change, where in our context the structural change is associated with the threshold variable rather than time. The number of parameters of (1) subject to potential structural change over the business cycle is $m = 12$, namely the intercept and eleven seasonal intercept coefficients.

2.3 Measuring seasonal/business cycle interactions

As already noted, the model of (1) allows the separation of the overall mean from the deterministic seasonal effects. The overall steady-state mean for Δy_t corresponding to the lower regime (with $I_t = I_{t-1} = \ldots = 0$) is given by $\mu_0 = \phi^{-1}(1)\delta_0$.. As shown in Matas Mir and Osborn (2003a), the implied deviation in steady state for each month in relation to this overall mean can be calculated from the parameters of (1), and here we denote these monthly steady-state mean deviations in the lower regime by λ_{0j} (j = 1, …, 12)[2]. These monthly mean deviations provide a convenient measure of the nature and extent of seasonality over the year.

Within the upper regime, the overall steady state mean is given by $\mu_1 = \phi^{-1}(1)[\delta_0 + \gamma_0]$, while corresponding steady-state deviations from this mean in each month of the year can also be computed. These upper regime steady-state monthly deviations are denoted by λ_{1j} (j = 1, …, 12). Matas Mir and Osborn (2003a) provide a graphical analysis of these lower and upper regime steady-state seasonal deviations. Here, however, we present numerical measures of the extent of seasonal/business interaction based on these.

In the context of our model, an obvious measure of the extent of seasonality within a regime is the average absolute value of these monthly mean deviations namely

$$S_i = \frac{\sum_{j=1}^{12} \left|\lambda_{ij}\right|}{12} \qquad i = 0, 1 \tag{3}$$

Similarly, the corresponding average over the summer months (j = 7, 8, 9) provides a measure of the extent of summer seasonality in each regime. Note that the summer production decline occurs in either July or August depending on the specific country, but that seasonal decline is then followed by a rebound in production in the following month (August or September). Therefore, averaging over these three months allows for both the summer decline and the subsequent recovery to more normal production levels. In an analogous way, we also measure the extent of seasonality over the non-summer months, that is excluding July, August and September[3].

Building on (3), there are then two natural measures of the interaction of seasonality and the business cycle, namely the difference between the seasonality measure of (3) for the upper regime compared with the lower regime, namely $S_1 - S_0$, and the ratio S_1/S_0. Both of these measures are reported below, with these computed over all months, and also separately over the summer and non-summer months.

The only other study of which we are aware that provides any measure of such interaction between seasonality and the business cycle is Cecchetti and Kashyap (1996), who use the ratio of the estimated variance of the seasonal effects at given stages of the business cycle for this purpose. This is clearly a measure similar in spirit to the ratio S_1/S_0 that we present. However we believe that it is important to supplement this with information about the extent of seasonality, captured in our case by S_0 and the

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[2] Matas Mir and Osborn (2003a) show that each monthly seasonal mean deviation in steady state will depend on all seasonal intercepts in (1) with weigths that are nonlinear functions of the autoregressive parameters.

[3] Seasonality over all months is then, of course, an appropriate weighted average of the summer and non-summer seasonality measures.

difference S_1 - S_0, since the ratio is a dimensionless measure and by itself does not reflect the practical relevance of the seasonal/cyclical interaction.

3. RESULTS

We analyse seasonally unadjusted monthly indexes of industrial production for the fifteen countries of the European Union, as available from the OECD *Main Economic Indicators* database. Since we need to have sufficient observations available for individual months to estimate intercept parameters associated with each of two regimes, we require data covering a long time span. Therefore, the specific variables analysed are those available from the 1970s. The analysis here uses the period from the beginning of 1970, or the earliest date for which the series is available[4]. Typically, our sample period ends in April or May 2003. Only one series (total industrial production) is available for Germany, so that we supplement this by including series for the former West Germany, despite the fact that these finish in December 1994. Information about the sample period used for all series can be found in the Appendix. Prior to analysis, all series are transformed to monthly percentage growth rates by taking first differences of the (natural) logarithms and multiplying by 100.

Some series exhibit a small number of outliers, which may be associated with strikes or other one-off events. Outliers are removed prior to analysis, with the Appendix providing details of the number of outliers removed from each series[5].

[4] In Matas Mir and Osborn (2003a) we use data from 1960. Here, however, we start later as a graphical analysis indicated the possiblity of a structural break in some series around 1970.

[5] Outlier removal was based on a linear version of (1) , namely an AR(24) model with seasonal dummy variables and seasonal trends. Any observation for which the corresponding residual was greater than 4 standard errors was replaced by the forecast value from this linear specification. Although 4 standard errors is a relatively conservative criterion, we wish to avoid the removal of observations associated with seasonal/business cycle interactions that may appear to be outliers in a linear model.

The discussion below considers first the nonlinear business cycle characteristics uncovered and then the extent of seasonal/business cycle interactions.

3.1 Business cycle regime characteristics

Table 1 provides the results of the test of the joint null joint hypothesis $\gamma_j = 0$ (j = 0, 1, …, 11) in (1), which (as discussed above) is a test of the null hypothesis of linearity. The information presented includes the *p*-values obtained using the approximation of Hansen (1997) to the asymptotic distribution of the test statistic, together with the percentile (between 25 and 75) of the distribution of the threshold variable that minimises the residual sum of squares of (1) and the corresponding threshold value, *r*, of (2).

TABLE 1 ABOUT HERE

Of the 64 European industrial production series that we analyse, 25 evidence significant nonlinearity at the 10 percent level. Indeed, 17 are significant at 5 percent, including 9 at 1 percent or lower. Therefore, these European series overall shown substantial evidence of nonlinearity associated with the business cycle. The proportion of rejections at this level (40 percent) is higher than that found in our previous study, Matas Mir and Osborn (2003a), that covered a wider range of countries.

In common with our previous results, the nonlinearity is particularly notable in some countries. The extreme significance of this nonlinearity for total industrial production and manufacturing production for Spain and Finland, is particularly noteworthy. Further, the evidence of nonlinearity is as strong at the aggregate level of industrial production or manufacturing overall, with 6 from 13 and 5 from 13 series, respectively, significant at 10 percent for these two categories[6]. Also echoing our previous results, there is again substantial evidence of nonlinearity in the production of Intermediate goods, with this significant at 1 percent for three countries (France, UK, Italy), and in addition is significant at 10 percent for West Germany

Of the 64 series included in Table 1, the threshold value occurs at the 30th percentile or lower for 14 series and at the 70th percentile or higher for 18 series. In the former case, the lower regime can be associated with recession, with the associated threshold value almost always negative. In the latter case, the lower regime identified is negative or "normal" growth, compared with the upper regime of high growth. In the remaining cases, the threshold is in the intermediate interval of the observed distribution of the average annual growth threshold variable. In these cases, the regimes may be described as distinguishing higher from lower growth. Although Cecchetti and Kashyap (1996) argue that the seasonal/business cycle interaction will be particularly associated with business cycle peaks, the threshold percentiles and values in Table 1 suggest that such interactions may be spread over the business cycle, depending on the specific characteristics of the industry and country.

3.2 Seasonal/business cycle interactions

The results of principal interest, namely the measures of the extent of interaction between seasonality and the business cycle, are shown in Table 2.

TABLE 2 ABOUT HERE

[6] In counting the number of significant industrial production series, West Germany is not counted separately from Germany, although results for both are presented in Table 1.

The results in this table based on differences $S_1 - S_0$ confirm the hypothesis of Cecchetti and Kashyap (1996) that seasonality is less marked in the upper regime of the business cycle, with 46 values negative when this difference is calculated over all months of the year. Indeed, when the summer months alone are considered, the figure rises to 50, while only 33 of the 64 series exhibit an average decline in seasonality in the upper regime over the non-summer months. Thus, in terms of the number of series for which seasonality is reduced in the upper business cycle regime, the reduction is concentrated in the summer months rather than being spread over all months.

When examined through the average reduction in seasonality across all 64 series, as presented in the bottom row of Table 2, the summer reduction in the seasonal pattern in the upper regime is approximately 2¼ percentage points of the level of the series. This is substantially stronger than the average reduction over all months of 0.49 and compares with a small average increase of 0.09 in the non-summer months. In terms of the ratio of seasonality in the two regimes averaged across all 64 series, the summer reduction is around 9 percent.

Alongside these general statements about averages across all series, it should be noted that the interaction with the business cycle sometimes causes seasonality, as captured by our measure in (3), to be reduced dramatically. This is the case, for example, for total industrial production in both Spain and Finland, where seasonality in the upper regime is 60 to 70 percent of its magnitude in the lower regime. While seasonality in industrial production for both countries is much stronger in the summer than in other months (compare the magnitude of seasonality in the lower regime for the summer and non-summer months), nevertheless the effect of reduced seasonality in the upper regime occurs across all months of the year in these cases. Indeed, it is worth remarking that for these two aggregate industrial production series, the proportional reduction is quite similar for the summer and non-summer months.

Another feature of Table 2 is that, irrespective of significance of the business cycle nonlinearity in Table 1, seasonality over all months is reduced in the upper regime for all series in the Scandinavian countries of Finland and Sweden, although this is not the case in Denmark. In terms of the ratio S_1/S_0, the reduction for the first two countries is particularly marked in the summer, with the ratio then being on average approximately 0.70. In terms of magnitude, these changes in seasonality over the business cycle are not trivial. In the case of Finland, for example, the difference S_1 - S_0 for the summer months is approximately 10 on average, implying a reduction in the magnitude of seasonal movements by around 10 percentage points of the level series in the upper regime. Interestingly, according to Table 2, seasonality often appears to increase in the upper (compared to the lower) regime for the non-summer months in these two countries. However, given that the magnitude of seasonality in these months is relatively small, these results may not be reliable.

Overall, the scale of cyclical change in the seasonal pattern for some months, and specifically the summer, may be substantially larger than the typical size of a business cycle fluctuation. The threshold values in Table 1 present one measure of the size of a business cycle fluctuation, by showing the average annual growth rate that triggers the regime shift for each series. It is clear that if these are scaled to monthly averages by dividing by 12, these threshold values would generally be much smaller in magnitude than the extent of the change in summer seasonality over regimes. An extreme example is industrial production in Spain, where the threshold of Table 1 corresponds to a monthly average growth of 0.49, whereas the average monthly change in the seasonal pattern over regimes for the summer is larger than 15. As a result of the extent of such interaction, standard seasonal adjustment methods, which assume that seasonal and cyclical fluctuations are orthogonal, may produce misleading results for such months.

Although the general pattern is of reduced summer seasonality in the upper business cycle regime, there are some exceptions to this. For example, for consumer non-durables for Belgium and consumer goods for West Germany, significant (at 5 percent) nonlinearity is indicated in Table 1, while Table 2 shows seasonality to be increased in the summer in this regime. Indeed, the pattern of interactions for West Germany consumer goods is unusual, because here seasonality is increased in the upper regime during the summer but it is lower in the non-summer months, and overall compared with the lower regime.

5. CONCLUSIONS

This paper has provided numerical measures of the extent of the interaction of seasonality and the business cycle. In order to focus on whether changes in the seasonal pattern over the business cycle are concentrated in the summer months, in addition to seasonality measured over the year, we separately consider seasonality in the summer and non-summer months.

Our results confirm the extent of the reduction in seasonality in the upper regime of the business cycle, with this reduction being as much as 30 percent or more in some cases when measured in terms of average seasonality over the year. More generally, however, the reductions are of the order of 10 to 20 percent. Seasonality in the lower regime can imply substantial average month to month movements, but these changes over business cycle regimes may moderate these movements by the order of 10 percentage points of the level of the series, thus having the potential of being larger than the average monthly business cycle variation.

In general, our findings also confirm that the seasonal/business cycle interaction effects are concentrated primarily in the summer months, with the summer slowdown being muted in the upper (higher growth) regime of the business cycle. In addition to showing their importance in terms of statistical significance, with the interaction being significant at the 10 percent level for 40 percent of our series, our results here also establish the practical importance in terms of the magnitudes of changes in seasonality over the business cycle. We believe that these are of sufficient importance to merit further investigation, to see what economic information is conveyed by the changes in these seasonal effects.

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Table 1. Data and Nonlinear Characteristics of the Threshold Model

	Nonlinearity	Threshold	
	p-value	Percentile	Value
Austria			
Industrial production	.831	38	2.45
Manufacturing	.997	44	3.45
Belgium			
Construction	.064	39	-2.42
Total inc. construction	.187	71	4.32
Industrial production	.053	64	3.39
Manufacturing	.211	63	3.48
Consumption durables	.087	75	5.03
Consumption non-durab.	.001	65	3.45
Intermediate goods	.965	29	0.14
Investment goods	.282	25	-3.95
Germany			
Industrial production	.542	53	2.60
West Germany			
Industrial production	.440	25	-0.73
Consumer goods	.014	25	-1.99
Intermediate goods	.376	69	4.60
Investment goods	.003	45	2.47
Denmark			
Manufacturing	.273	71	5.00
Consumption durables	.035	75	6.80
Investment goods	.001	26	-1.15
Spain			
Industrial production	.000	75	5.84
Manufacturing	.000	73	5.83
Naval construction	.254	28	-26.06
Consumer goods	.598	50	2.66
Intermediate goods	.662	53	3.54
Investment goods	.101	36	0.31
Finland			
Industrial production	.000	42	3.67
Manufacturing	.000	69	7.14
Consumer goods	.056	75	5.62
Intermediate goods	.176	34	2.34
Investment goods	.139	65	12.22
France			
Construction	.230	54	1.33
Energy	.879	71	4.92
Industrial production	.272	30	0.46
Manufacturing	.056	49	1.89
Agriculture & food	.147	74	2.74
Consumer goods	.843	25	-0.86
Intermediate goods	.000	41	0.70
Investment goods	.798	25	-0.38

Table 1 (continued)

	Nonlinearity	Threshold	
	p-value	Percentile	Value
United Kingdom			
Industrial production	.018	75	3.75
Manufacturing	.066	47	0.94
Intermediate goods	.001	69	3.49
Investment goods	.083	65	3.24
Greece			
Industrial production	.358	74	7.09
Manufacturing	.331	25	-0.50
Consumption durables	.517	75	10.43
Consumption non-durab.	.260	73	7.48
Investment goods	.266	63	4.44
Ireland			
Industrial production	.157	73	11.56
Manufacturing	.233	70	11.62
Consumer goods	.202	74	6.03
Intermediate goods	.777	69	14.24
Capital goods	.854	619	14.44
Italy			
Industrial production	.029	39	1.12
Consumer goods	.621	33	-0.39
Intermediate goods	.000	67	3.06
Investment goods	.016	28	-2.73
Luxembourg			
Construction	.259	72	7.17
Industrial production	.299	68	5.20
Manufacturing	.519	41	1.75
Netherlands			
Industrial production	.032	28	-0.23
Manufacturing	.848	75	5.09
Portugal			
Industrial production	.684	25	0.02
Manufacturing	.347	25	-0.01
Sweden			
Mining & manufacturing	.011	69	5.56
Manufacturing	.022	68	5.35

Table 2. The Extent of Seasonality and the Seasonal/Business Cycle Interaction

	Average lower regime seasonality			Relative seasonality upper compared to lower regime					
				Difference			Ratio		
	All months	Summer	Non-summer	All months	Summer	Non-summer	All months	Summer	Non-summer
Austria									
Industrial production	5.60	11.17	3.74	0.06	-0.66	0.30	1.01	0.94	1.08
Manufacturing	6.17	12.20	4.16	0.20	-0.18	0.32	1.03	0.99	1.08
Belgium									
Construction	26.91	66.65	13.66	-4.48	-7.62	-3.44	0.83	0.89	0.75
Total inc. construction	9.41	26.78	3.62	-0.50	-0.84	-0.39	0.95	0.97	0.89
Industrial production	7.48	19.79	3.37	-0.38	-1.05	-0.16	0.95	0.95	0.95
Manufacturing	7.91	21.65	3.32	-1.49	-3.28	-0.90	0.81	0.85	0.73
Consumption durables	11.82	31.64	5.22	1.41	0.47	1.72	1.12	1.02	1.33
Consumption non-durab.	5.61	11.46	3.66	0.88	3.17	0.11	1.16	1.28	1.03
Intermediate goods	7.82	20.81	3.48	-0.84	-2.19	-0.40	0.89	0.89	0.89
Investment goods	10.68	26.10	5.53	-2.45	-1.76	-2.68	0.77	0.93	0.52
Germany									
Industrial production	5.38	9.30	4.07	-0.55	-0.30	-0.63	0.90	0.97	0.84
West Germany									
Industrial production	5.42	8.55	4.38	-0.66	0.88	-1.18	0.88	1.10	0.73
Consumer goods	7.56	9.25	6.99	-1.85	0.89	-2.76	0.76	1.10	0.61
Intermediate goods	4.09	4.82	3.85	-0.28	-1.53	0.14	0.93	0.68	1.03
Investment goods	7.43	14.32	5.14	-0.48	0.60	-0.84	0.93	1.04	0.84
Denmark									
Manufacturing	11.59	27.39	6.32	-1.06	-1.35	-0.96	0.91	0.95	0.85
Consumption durables	13.37	34.01	6.49	5.38	9.58	3.98	1.40	1.28	1.61
Investment goods	17.12	34.88	11.19	0.11	2.94	-0.83	1.01	1.08	0.93
Spain									
Industrial production	13.05	35.92	5.43	-5.49	-15.54	-2.15	0.58	0.57	0.60
Manufacturing	12.92	40.34	3.78	-1.49	-12.13	2.05	0.88	0.70	1.54
Naval construction	16.82	36.44	10.27	6.22	25.97	-0.36	1.37	1.71	0.96
Consumer goods	13.90	34.70	6.97	-3.09	-5.82	-2.18	0.78	0.83	0.69
Intermediate goods	11.81	30.32	5.64	-2.33	-4.29	-1.68	0.80	0.86	0.70
Investment goods	30.21	89.18	10.56	-2.20	-10.09	0.43	0.93	0.89	1.04

Table 2 (continued)

	Average lower regime seasonality			Relative seasonality upper compared to lower regime					
				Difference			Ratio		
	All months	Summer	Non-summer	All months	Summer	Non-summer	All months	Summer	Non-summer
Finland									
Industrial production	11.11	32.57	3.96	-3.84	-11.91	-1.15	0.65	0.63	0.71
Manufacturing	10.50	33.99	2.66	-1.79	-16.48	3.10	0.83	0.52	2.17
Consumer goods	10.59	30.94	3.81	-0.58	-7.24	1.64	0.95	0.77	1.43
Intermediate goods	10.14	22.43	6.05	-2.61	-4.38	-2.02	0.74	0.80	0.67
Investment goods	15.37	52.24	3.08	-1.73	-15.64	2.90	0.89	0.70	1.94
France									
Construction	12.58	34.28	5.35	-0.92	-3.67	-0.00	0.93	0.89	1.00
Energy	7.42	8.01	7.23	-0.10	-1.86	0.49	0.99	0.77	1.07
Industrial production	8.60	26.17	2.75	-0.25	-1.71	0.24	0.97	0.93	1.09
Manufacturing	9.38	28.19	3.11	-0.64	-1.72	-0.28	0.93	0.94	0.91
Agriculture & food	7.42	5.46	8.08	0.03	-2.78	0.97	1.00	0.49	1.12
Consumer goods	10.65	31.12	3.82	-0.09	-1.79	0.48	0.99	0.94	1.13
Intermediate goods	13.11	37.59	4.94	-2.00	-5.70	-0.76	0.85	0.85	0.85
Investment goods	8.08	13.14	6.39	1.80	4.32	0.96	1.22	1.33	1.15
United Kingdom									
Industrial production	4.99	8.10	3.96	0.69	-0.14	0.97	1.14	0.98	1.24
Manufacturing	5.43	9.29	4.15	0.78	-1.02	1.38	1.14	0.89	1.33
Intermediate goods	5.29	8.26	4.30	0.13	-1.32	0.62	1.02	0.84	1.14
Investment goods	7.56	10.46	6.59	0.40	-2.66	1.42	1.05	0.75	1.22
Greece									
Industrial production	4.62	7.95	3.51	-0.66	-1.66	-0.32	0.86	0.79	0.91
Manufacturing	5.94	10.14	4.53	-0.85	-1.00	-0.80	0.86	0.90	0.82
Consumption durables	15.33	45.57	5.25	3.64	-2.68	5.74	1.24	0.94	2.09
Consumption non-durab.	4.46	5.71	4.05	0.33	-0.34	0.55	1.07	0.94	1.14
Investment goods	7.72	19.08	3.93	0.23	-3.56	1.49	1.03	0.81	1.38
Ireland									
Industrial production	6.13	13.80	3.57	-0.35	-2.17	0.26	0.94	0.84	1.07
Manufacturing	6.56	14.97	3.75	-0.11	-1.42	0.33	0.98	0.90	1.09
Consumer goods	6.02	7.89	5.40	-0.28	1.85	-1.00	0.95	1.23	0.82
Intermediate goods	8.38	18.73	4.93	-0.13	-3.69	1.05	0.98	0.80	1.21
Capital goods	10.08	17.89	7.47	-0.83	-0.23	-1.03	0.92	0.99	0.86

Table 2 (continued)

	Average lower regime seasonality			Relative seasonality upper compared to lower regime					
				Difference			Ratio		
	All months	Summer	Non-summer	All months	Summer	Non-summer	All months	Summer	Non-summer
Italy									
Industrial production	17.90	53.13	6.15	-4.01	-7.29	-2.92	0.78	0.86	0.53
Consumer goods	17.46	48.79	7.02	-0.78	2.80	-1.97	0.96	1.06	0.72
Intermediate goods	18.51	55.90	6.05	-2.66	-4.50	-2.04	0.86	0.92	0.66
Investment goods	24.72	79.79	6.37	-5.79	-16.73	-2.14	0.77	0.79	0.66
Luxembourg									
Construction	20.92	43.72	13.32	9.25	25.83	3.72	1.44	1.59	1.28
Industrial production	7.13	20.21	2.77	-0.29	-4.58	1.15	0.96	0.77	1.41
Manufacturing	8.31	23.22	3.34	-1.64	-6.09	-0.16	0.80	0.74	0.95
Netherlands									
Industrial production	8.14	12.60	6.65	-3.62	-2.15	-4.11	0.56	0.83	0.38
Manufacturing	4.78	10.56	2.85	0.92	1.86	0.61	1.19	1.18	1.21
Portugal									
Industrial production	8.35	23.86	3.18	-0.83	-1.11	-0.74	0.90	0.95	0.77
Manufacturing	9.11	24.68	3.98	-0.33	1.18	-0.83	0.96	1.05	0.79
Sweden									
Mining & manufact.	15.52	51.09	3.66	-2.96	-17.85	2.00	0.81	0.65	1.55
Manufacturing	15.70	51.29	3.83	-3.04	-16.45	1.43	0.81	0.68	1.37
Average									
All series	9.87	23.76	5.24	-0.49	-2.25	0.09	0.95	0.91	1.05

APPENDIX

Data

	Sample Period	# Outliers removed
Austria		
Industrial production	1970:01-2002:12	1
Manufacturing	1970:01-2002:12	1
Belgium		
Construction	1970:01-2003:04	1
Total inc. construction	1970:01-2003:04	1
Industrial production	1970:01-2003:04	0
Manufacturing	1970:01-2003:04	0
Consumption durables	1970:01-2003:04	2
Consumption non-dur.	1970:01-2003:04	1
Intermediate goods	1970:01-2003:04	1
Investment goods	1970:01-2003:04	2
Germany		
Industrial production	1970:01-2003:04	1
West Germany		
Industrial production	1970:01-1994:12	1
Consumer goods	1970:01-1994:12	0
Intermediate goods	1970:01-1994:12	0
Investment goods	1970:01-1994:12	1
Denmark		
Manufacturing	1976:02-2003:04	0
Consumption durables	1976:02-2003:04	3
Investment goods	1976:02-2003:04	1
Spain		
Industrial production	1970:01-2003:04	0
Manufacturing	1970:01-2003:04	0
Naval construction	1977:02-2002:12	1
Consumer goods	1970:01-2003:04	2
Intermediate goods	1970:01-2003:04	1
Investment goods	1970:01-2003:04	3
Finland		
Industrial production	1970:01-2003:05	0
Manufacturing	1970:01-2003:05	1
Consumer goods	1970:01-2003:05	0
Intermediate goods	1970:01-2003:05	1
Investment goods	1970:01-2003:05	0
France		
Construction	1970:01-2003:04	0
Energy	1970:01-2003:04	0
Industrial production	1970:01-2003:04	0
Manufacturing	1970:01-2003:04	0
Agriculture & food	1970:01-2003:04	0
Consumer goods	1970:01-2003:04	1
Intermediate goods	1970:01-2003:04	0
Investment goods	1970:01-2003:04	1

APPENDIX (continued)

	Sample Period	# Outliers removed
United Kingdom		
Industrial production	1970:01-2003:04	1
Manufacturing	1970:01-2003:04	1
Intermediate goods	1970:01-2003:04	1
Investment goods	1970:01-2003:04	0
Greece		
Industrial production	1970:01-2003:03	1
Manufacturing	1970:01-2003:03	2
Consumption durables	1974:02-2003:03	0
Consumption non-dur.	1970:01-2003:03	1
Investment goods	1970:01-2003:03	2
Ireland		
Industrial production	1977:08-2003:03	0
Manufacturing	1977:08-2003:03	0
Consumer goods	1977:08-2003:03	0
Intermediate goods	1977:08-2003:03	0
Capital goods	1977:08-2003:03	0
Italy		
Industrial production	1970:01-2003:04	2
Consumer goods	1979:02-2003:04	1
Intermediate goods	1979:02-2003:04	1
Investment goods	1973:02-2003:04	1
Luxembourg		
Construction	1970:01-2003:03	3
Industrial production	1970:01-2003:03	1
Manufacturing	1970:01-2003:03	1
Netherlands		
Industrial production	1970:01-2003:04	1
Manufacturing	1970:01-2003:04	1
Portugal		
Industrial production	1970:01-2003:05	1
Manufacturing	1970:01-2003:05	1
Sweden		
Mining & manufacturing	1970:01-2003:04	2
Manufacturing	1970:01-2003:04	2