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Dating Recessions from Industrial Production Indexes: An Analysis for Europe and the US

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ABSTRACT

In this paper we analyze the business cycles of 15 European countries and the US. We locate the expansionary and recessionary periods by dating the turning points of an industrial production index using the Bry-Boschan procedure. We find that there is high concordance in the business cycles of European countries, especially in terms of the characteristics of the cycle phases (duration and amplitude of expansions and contractions). However, some significant differences still persist, most notably in the concordance of peaks and troughs and in the cycles of a set of non-core countries, which includes Finland, Greece and, less so, Ireland and Italy.

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1 Introduction

"Wherever productivity growth is today, my guess is that in six months or a year, it will be higher still," "About once in 100 years, something really big happens, and this is it." Risking the scorn of skeptics, Mr. Slifer added that he had begun to believe that recessions were no longer inevitable. "Is it inconceivable to think this thing can keep going, and in 2010 we could see the 20th year of this expansion?" he asked. "No." (Stephen Slifer, the chief US economist at Lehman Brothers. September 10, 2000).[1]

It's deja vu all over again. The above quote surely reminds of the years, in the late 1960's, when economists where already organizing conferences on the death of the business cycle (Bronfenbrenner, 1969) just before the oil crisis hit with all its might in the early 1970's. Now as before, a period of a extraordinarily long expansion, in this case also hand in hand with the impressive stabilization of growth rates achieved by developed economies throughout the 90's, prompted us to forget that the existence of cycles is inherent to the very economic activity itself, as the already abundant literature on business cycles has forcefully stated.

Recessions are not dead, just as the business cycle is not, and will probably never be, dead. In fact, the most recent recession, which also put an end to the hype and glamour generated by the so called New Economy, has brought to the general attention, again and in what seems to be becoming customary after each recessionary period, the analysis of business cycles: Why does the economy suffer periodic (even though the period may not be regular, as in most problems in physics) oscillations? Can we predict or anticipate the turning points of economic activity?

Leaving aside the causes of business cycles, a topic that would itself generate heated debate among economists, the detection or even prediction of the cycles in the evolution of an economy is one of the most exciting, although sometimes frustrating measurement problems in economics. Given the current public awareness and economic policy relevance, the identification and analysis of the phases of economic cycles becomes extremely important. However, there is as of now not a single unified framework for the analysis of the cycles. First of all, there are conflicting methodologies for the identification of the cycle phases, which for the public can be summarized in identifying the recessionary periods. These methodologies differ both in their conceptual understanding of the cycle and in the steps followed to identify it. Thus, resulting cycles (and therefore, resulting contractionary phases) may differ substantially.

Once the cycles have been identified, then it is key to understand the behavior of economic variables within the phases of the cycle:[2] It is already a known fact that the cycle phases (expansions and contractions or "recessions"[3]) are

[1] I am extremely grateful to Edward E. Leamer for this quote, which he also used in Leamer (2001).

[2] See Leamer (2001) for a thorough treatment of economic variables during expansions and in the onset of recessions.

[3] Throughout the paper we use the terms contraction and recession interchangeably. There is, of course, a subtle difference in that recessions are identified as periods of sustained con-

asymmetric: Real economic variables, such as unemployment or output, behave differently during expansions or contractions, and the phases themselves are evidently different in terms of their duration or amplitude. Given the current interdependency of the world economies, the analysis of the parallelism of the business cycles, or of the alignment in time of business cycles across countries, is a fertile avenue of research, which promises to deepen our understanding of economic fluctuations and economic relationships among nations.

In this paper we analyze the most recent business cycles in some European countries and in the US. We first identify the different phases of the cycles and then compare the characteristics of the expansionary and contractionary phases and the alignment of the cycles across countries. Our analysis confirms that phases of the cycles are asymmetric and significantly different across European countries. Also, concordance of cycle phases across European countries seems to be high, especially for a set of core countries that includes France, Germany and the Netherlands and Belgium.

The article is organized as follows. Section 2 briefly describes some of the different techniques that have been used to date business cycles. Section 3 presents our methodology of choice for business cycle dating and the data that will be used to date expansionary and recessionary periods in some major European countries. Section 4 presents the results of the dating of the business cycle phases, and comments on the characteristics and alignment of the cycles and of the cycle phases (expansions and contractions) across the countries in our sample. Section 5 concludes.

2 Dating Business Cycles: Alternative Methodologies

Several different methodologies have been proposed to try to identify the cycles that some economy goes through. However, we know by now that these different methodologies may lead to identifying different cycles (Canova, 1998) or even to the appearance of spurious cycles (King and Rebelo 1993, Osborn 1995). We review now the three main methodologies that have been utilized.

Probably the set of techniques that has been more consistently used to identify economic fluctuations is that which relies on detrending methods. That is, a trend model is fitted to some economic time series and the deviations of the series around that trend which correspond to movements of frequencies above the seasonal level are identified with the business cycles of the economy. As Artis et al. (1997) mention, these techniques can be more generally characterized as techniques for the identification of growth cycles, where deviations are with respect to an upward trend, but they do not necessarily correspond to up and down cycles (i.e. to expansionary and contractionary periods, which

traction in economic activity. However, given the arbitrariness of the classical or "official" definitions of recessions, we will equate the contractionary phases identified by our analysis with economic recessions regardless of their duration or amplitude of the decrease of economic activity.

would correspond more exactly to the concept of the business cycle). Numerous papers have applied these techniques to different economies, and have studied the performance and risks involved in fitting trend models: Backus and Kehoe (1992), Backus, Kehoe and Kydland (1992), King and Rebelo (1993, 1999), Osborn (1995), Canova (1998), Stock and Watson (1999) and, more recently, the book on filtering methods by Kaiser and Maravall (2001). Besides the different conceptual focus mentioned, the main problem with these methodologies is that there is no real guidance to the choice of the trend model, and this choice has been shown to lead to substantially different estimates of the cycles (Canova, 1998) or to the appearance of spurious cycles (King and Rebelo, 1993).

García-Ferrer and Queralt (1998), depart from purely trend-based methods by using the spectrum of the time series to anticipate turning points in the evolution of the series. Thus, their methodology is based on both a trend-type of technique and an analysis of the turning points (peaks and troughs) of the series.

In fact, the latter is the focus of the other two methodologies that have been used, and now are being increasingly used, especially because of the relative failure of trend models, to locate the cycles. Both techniques look, in a completely different manner, for the turning points of a series, that is, for the moments when the series changes its behavior from expansionary to contractionary or viceversa.

One of the techniques, pioneered by Hamilton (1989) advocates a parametric specification of the data generating process of the variable of interest, where two different regimes are allowed, one of which corresponds to the expansions (and therefore contains some type of upward trend) and another one that corresponds to the contractions and therefore contains a downward trend. Thus, the turning points that define the recessions and expansions correspond to those moments where the time series switches from one regime to another. Examples of this approach, apart from the original reference, are Goodwin (1993), Diebold and Rudebusch (1996) and those contained in the book by Kim and Nelson (1999) for real cycles and Hamilton and Lin (1993), Ramchand and Susmel (1998) and Maheu and McCurdy (2000), for stock market cycles.

The second approach takes a nonparametric focus, and instead of fitting a fully-specified statistical data generating process, looks at the original data series in search for the specific features of the cycle. That is, this procedure looks for periods of generalized upward trend, which will be identified with the expansions, and periods of a generalized downward trend that will be identified with the contractions. The key feature of this analysis is, of course, the location of the turning points (peaks and troughs) in the series. These turning points, that correspond to the switch from an expansion to a contraction (peak) and viceversa (trough) determine the different phases of the cycle, which can then be subsequently analyzed. This approach was first applied by Bry and Boschan (1971) to the location of business cycles, and has since then been used also by Watson (1994), Artis et al. (1997), Stock and Watson (1999) and Harding and Pagan (2000, 2002a) for business cycles and by Edwards et al. (2002) and Pagan and Sossounov (2002) for stock market cycles.

We do not comment on the advantages /disadvantages of one approach vs. the other. A fascinating discussion can be found in the exchange between Hamilton (2002) and Harding and Pagan (2002b, 2002c) and we refer the reader to those papers. In any case, we have to mention that, as Boldin (1994) shows, the cycles resulting from both methodologies can be very different. We consider that the advantages of the nonparametric approach, and its intuitiveness make it a preferred methodology both to a Markov-Switching based and to a trend-based methodology, and so in this paper we use the Bry-Boschan business cycle dating algorithm (Bry and Boschan, 1971) as operationalized by Watson (1994) and used in Artis et al. (1997) to detect cycles in Western European countries.

3 Methodology

We are interested in dating the business cycle phases (expansions and contractions) in a set of 14 major European countries and the US. We describe now the methodology that we have used for the identification of the turning points of the series, that determine the cycle phases. A further explanation can be found in Artis et al. (1997), an article whose results have been used as a reference for the dates of recessions in some of the countries in our sample. We extend their analysis by using the most recent data on the countries, thus including the deceleration (or full recession) in 2001, and by including all of the European Union countries, with the exception of Luxembourg.

3.1 Dating the Recessions

Artis et al.'s (hereafter, AKO) version of the Bry-Boschan algorithm focuses only on the industrial production series of the specific country under the analysis, whereas, for instance, NBER or OECD dating methodologies look at a set of different series. We prefer the simpler methodology that in any case produces results comparable to those of the most comprehensive methods (Artis et al., 1997). We explain now step by step the algorithm.

The procedure starts by a detection and elimination of outlying observations. Given that the algorithm is based on a local comparison of the values of the industrial production index (IIP), extreme outliers can be too influential and induce spurious cycles. An outlier is determined as an observation whose (log)change with respect to the previous and posterior observation is bigger in absolute value than 3.5 times the standard deviation of the (log)changes of the series. These outliers are substituted by an average of the two observations around them: $IIP_t = \frac{IIP_{t-1}+IIP_{t+1}}{2}$.

Once the outliers have been identified and smoothed out, the procedure follows by analyzing a smoothed version of the original IIP series. A seven month centered moving average of the IIP series is taken, and local maxima and minima of the smoothed series, which will be identified with the peaks and troughs, are then located. A peak/trough in the series of industrial production

Y_t is defined if Y_t[4] is the highest/lowest in a window of width 12.[5] That is, there is a peak at t if

$$[Y_{t-12}, ..., Y_{t-1} < Y_t > Y_{t+1}, ..., Y_{t+12}] \tag{1}$$

and there is a trough at t if

$$[Y_{t-12}, ..., Y_{t-1} > Y_t < Y_{t+1}, ..., Y_{t+12}] \tag{2}$$

Once the local peaks and troughs are identified, alternation is enforced. This implies that if there are two consecutive peaks (troughs), then the highest (lowest) of them is selected and the other one is deleted.

Having identified the turning points in the smoothed series, then the original unsmoothed series is analyzed. Local peaks and troughs are located using, as before, a twelve month window width around each observation. Alternation of turns is enforced again, before proceeding to some censoring criteria that ensure that the cycles identified are not spurious or reflect fluctuations that are too short to be considered a cycle. First, if two consecutive observations that have the same value of the IIP are identified as a turning point (a flat segment) then the last of the two is identified as the turning point. Also, if some of the original outliers is identified as a turning point, this turning point is excluded. Alternation of turns is enforced again after this last operation, which may have eliminated a turning point and created two consecutive peaks or troughs. Two additional censoring criteria are implemented. The first excludes cycles that are too short to be considered business cycle fluctuations, and that therefore correspond to transitory short-term fluctuations. Thus, cycles that have a duration of less than 15 months (from peak to peak or from trough to trough) are eliminated, and the highest (lowest) of the turning points is kept. Phases that are too "small" are also eliminated. In this case the criterion is that all phases, either expansionary or contractionary, must have a total amplitude from trough to peak or peak to trough at least as big as one standard error of the (log)changes in the monthly IIP index. Otherwise, the turning point that determines that phase is eliminated. Alternation of the turning points is enforced once again.

Given the above, one now has two sets of turning points, one corresponding to the smoothed series and one that corresponds to the unsmoothed, original series. Both sets of turning points are compared, and those in the unsmoothed series that do not correspond to similar turns (situated plus or minus 5 months around the original) of the moving average, smoothed, series are eliminated. Final turning points are identified with those in the unsmoothed series.[6]

[4] Throughout the paper, y_t denotes the natural log of the industrial production index, $\ln(Y_t)$. It is clear that the peaks and troughs for both series have to be the same.

[5] The results may be slightly sensitive to the choice of the window width, although it is usually the shorter, and thus the more suspicious, cycles that are affected by the window width. We use twelve months to keep the parallel with Artis et al. (1997).

[6] Some discretion was allowed at this step, for the elimination of outliers in the first step of the algorithm (using the cutoff in Artis et al., 1997) failed to eliminate some outliers that made the turning point in the unsmoothed series be obviously misidentified. In those cases, we opted for choosing the turnign point identified in the smoothed series.

The different steps of the procedure are outlined in Table 1. Once the turning points have been located, then the expansionary and recessionary months are, of course, identified with those from the trough to the peak (expansions) and those from the peak to the trough (recessions).

Insert Table 1

3.2 Data

We have applied the above dating algorithm to the IIP data of the 14 major EU countries and the US. The countries are Austria (AUT), Belgium (BEL), Denmark (DEN), Finland (FIN), France (FRA), Germany (GER), Greece (GRE), Ireland (IRE), Italy (ITA), Netherlands (NET), Portugal (POR), Spain (SPA), Sweden (SWE) and the UK. Luxembourg has been excluded for its industrial production is likely not a good index of economic activity in the country. We initially intended to include Switzerland as well, but the IIP series was not available in any of the two sources we used.

The industrial production data come from the OECD main economic indicators. The series is identified as the seasonally adjusted production index from the coincident and leading indicators database, constructed by the OECD for its own turning point dating purposes. The dating procedures followed by the OECD take into account a few different series for each country, and so they are not uniformly comparable across countries. Furthermore, some of the countries that we are interested in have not been analyzed (e.g. Portugal) and some of the results (e.g. Spain) look too preliminary and seem to include spurious cycles. In the case of the Netherlands, Belgium and Denmark, the industrial production index is not available in the OECD database, so we used the IIP provided by the IMF's International Financial Statistics instead.

The data run from January, 1970 to some month posterior to February, 2002 (The last observation differs slightly for most of the countries), except for those countries whose data come from the IFS, Belgium, the Netherlands and Denmark, where the series run to December 2000, October 2001 and June 2000 respectively. Data for Denmark starts in January, 1974, being the only country that has some data missing at the beginning of the sample.

4 Comparing the Cycles across Europe

Results from the application of the dating algorithm to the 15 countries for which we have information appear in Table 2 and in Figures 1 to 15. Each of the figures presents the original, unsmoothed and uncorrected for outliers, IIP series, where the turning points have been identified by shading the recessionary periods. Table 2 presents the dates of the peaks and troughs identified for each country in chronological order. We have tried to align the peaks and troughs that occur at similar dates to make the comparison of the cycles across countries easier.

We do not comment on the peaks and troughs of the fifteen countries one by one. However, we believe that the comparison of those cycles that are simultaneous or concordant across countries is quite relevant.

Insert Figures 1-15

Insert Table 2

It can be seen in Table 2 that the European countries are subject to cycles that seem to be quite coincident over time. All of them present a peak at the time of the oil crisis, which seemed to hit Germany and the US first, but then extended to the rest of the countries. Austria, Finland, France, Italy and Sweden were the last ones to be hit by the subsequent recession, but all countries were significantly affected. It is interesting to note that the first country to recover from the crisis was Greece, where the recession seemed to last for less than half a year. It may have been that the Greek economy, traditionally intensive on agriculture, was less hit by a shock that affected the cost structure of the more industrialized countries. However, this explanation would lead to find a similarly shorter recession in the other Mediterranean countries (Portugal, Spain and Italy), which is not the case. It is true, thought, that the peaks and troughs, and consequently the cycles, in Greece seem to become disconnected from that moment on, until 1993, when it recovers the synchronicity during the recovery from the recession of 1990, which hit Greece earlier than it hit most of other countries (although at a similar time as it hit Italy, Spain and Portugal, which is a sensible result). Finland and Sweden show a similarity in the oil crisis period, in that it took them significantly longer than it took the rest of the countries to come out of the recession. Maybe the intense relationship of both these countries with Norway, an oil producing country, aggravated the recession. In any case, the surprising finding is that aside from that result, both countries show totally dissimilar cycles, with their phases not being at all coincident. It is also interesting to see that Denmark, an obvious candidate for a close relationship with the two Scandinavian countries is the other country of the group of 14 that seems to not go in synchronicity with any of the other European countries. Except for the 1979-80 recession, that hit most of the European countries and even the US, Denmark's cycles are completely misaligned with respect to those in the rest of Europe.

As mentioned above, most countries suffered a recession during the period 1979-82, although some of them seemed to show a "double dip" type of phenomenon, with the recession being divided into two periods, one from 1979-80, followed by a mild recovery, and another covering 1981 and 1982. France, the US and, less clearly, the Netherlands and Belgium show this result. More frequent is the finding of a three year long recession from late 1979 to early 1983, as it was the case of Austria, Germany, Italy, Spain, Sweden and, though shorter, the UK. Ireland, Greece, Finland and Portugal seemed to escape this recession, which could then be identified as an industrial recession, given that the above four countries were at that time heavily agricultural.

By 1983 most economies were recovered from the recession and started a long expansionary period that normally would conclude in late 1989 or early 1990 when most countries also fell simultaneously into a recession that would last in some cases for less than two years (Austria and Denmark, which entered into recession in late 1992, Finland, Netherlands, and the USA) but in general was longer lasting (almost 4 years in Belgium, though including a mild recovery, three and a half years in Greece, around three years in Italy, Portugal, Spain and Sweden, and above two years in Germany, France and the UK). Ireland is the only country that does not present any signs of having been affected by this recession.

This seems to be the last recession that most of the countries in our sample suffered, although there is a conspicuous set of countries that suffered another recession in 1994-1995. These countries were Austria, Germany, Italy and Spain. Even though the recession was mild and short lived, the synchronicity of this "outlying" recession is striking.

The last significant turning point can now be identified as the 2001 recession, or what in some of our countries will be officially termed a deceleration of economic activity. Except for France, for which the recession seems to have started too late for our algorithm to locate it (though it can be seen in Figure 5 that whenever additional observations become available, the French economy will also present a peak in 2001), all the other countries[7] have suffered the deceleration that started in the US (the estimate for the beginning of the recession is in mid-2000, as people like Leamer, 2001, have already suggested) and expanded to the rest of the countries, hitting them in late 2000 (UK, Finland, Austria, Sweden, Spain and Italy) or early 2001 (Germany, Greece, Ireland and, most likely, France). Thus, maybe the recession will not qualify as an "official" recession in some countries (GDP in Spain, for instance, did not present negative growth in any of the quarters up to the time of the writing of this draft), but the deceleration in economic activity is evident.

We have to make a comment about the comparison of our estimated dates with those of AKO. The series we have used, calculated by the OECD is probably different from the one used by AKO (who do not cite the source of their IIP, although to our knowledge the OECD was not calculating the CLI IIP at that time). Even so, and despite some mild differences in the timing of the last turning point in the AKO sample (a difference probably due to data revisions that are now available to us), the dates coincide almost perfectly. There are two exceptions, though. The first, more noticeable one, is Spain, for which we find a cycle in 1980-1982 whereas we do not find a shorter one in 1991. We believe the missing of the 1980 recession in AKO is a result of their not having smoothed, or of the sole effect, of a single outlier.[8] Figure 12 shows clearly

[7] As mentioned above, the data series for Belgium, the Netherlands and Denmark are slightly shorter, and we do not have enough information to "officially" locate the peak, which is evident for Netherlands, although not for Belgium and Denmark, given that these are the shortest series.

[8] The comparison in Table D1 of AKO of their results with those of a traditional Bry-Boschan algorithm shows that the BB algorithm does capture this cycle for the case of Spain.

that there is evidence of a deceleration, if not a full recession, in Spain during those two years. The 1991 cycle, which in the case of Belgium, for example, is captured by both our procedure and AKO's, is a shorter cycle that we may have missed for data reasons, given that it is also clear from Figure 12 that it does not correspond to a major fluctuation. A second difference refers to a short recession for the Netherlands, that AKO find in 1987. Our analysis detects this recession in the unsmoothed series but not in the smoothed series. Accordingly, we omit that recession, which can be seen in Figure 10 to be quite mild.

In any case, it is evident that our results are perfectly coherent with those in AKO but, of course, we profit from having a significantly longer series and the unified data (at least for 12 countries) coming from the OECD.

Insert Table 3

4.1 General Characteristics: Describing Expansions and Contractions

In order to describe the characteristics of the phases of the cycle for each country we use three measures of the behavior of the phases of the cycle. These measures are the duration in months of the phase, the average monthly growth (or decrease) in the IIP index, and the total amplitude of the phase (the total growth or decrease over the phase).

For simplicity of calculation, we use an indicator of whether the economy is in an expansionary or a contractionary phase. We define a dummy variable, S_t, which takes the value 1 if the economy is in an expansionary phase at time t, i.e. if $Y_t - Y_{t-1} = \Delta Y_t$ belongs to the expansion.[9] Given that $S_t = 1$ if the economy is in an expansion at t, we first calculate two ancillary statistics: *Total time* spent in expansions is $\sum_{t=1}^{T} S_t$ and total time spent in contractions is $\sum_{t=1}^{T} C_t$, where $C_t = 1 - S_t$ is an indicator for contractionary months. The *Number of peaks* (expansions) is $NTP = \sum_{t=1}^{T} S_t(1 - S_{t+1}) + 1$ (NTP is short for "Number of Trough to Peak") and, of course, the *Number of troughs* (contractions) is $NPT = \sum_{t=1}^{T} C_t(1 - C_{t+1}) + 1$.

The three characteristics of the phases of the cycle that we study are:

1) *Duration (D):* Average duration in months of expansions and contractions can be calculated as

$$\widehat{D}_{ex} = \frac{1}{NTP} \sum_{t=1}^{T} S_t,\ \widehat{D}_{con} = \frac{1}{NPT} \sum_{t=1}^{T} B_t \tag{3}$$

2) *Amplitude of the phase (A):* Average amplitudes of the phases, in total

[9] This differs from Harding and Pagan (2002a) for they use $S_t = 1$ if $Y_{t+1} - Y_t = \Delta Y_t$ is expansionary. There is therefore a slight difference with respect to the above paper in some of the formulas that we present. Note that the expansions correspond to the periods between a trough and a peak of the series, and the contractions to the periods between a peak and a trough.

percentage of growth or decrease, are

$$\widehat{A}_{ex} = \frac{1}{NTP}\sum_{t=1}^{T} S_t \Delta y_t,\ \widehat{A}_{con} = \frac{1}{NPT}\sum_{t=1}^{T} B_t \Delta y_t \tag{4}$$

3) Monthly amplitude (M): The average growth or decrease for a single month in the phase is

$$\widehat{M}_{ex} = \frac{\widehat{A}_{ex}}{\widehat{D}_{ex}},\ \widehat{M}_{con} = \frac{\widehat{A}_{con}}{\widehat{D}_{con}}, \tag{5}$$

Table 4 summarizes the characteristics of the cycles in the different countries. Even though we have seen that the cycles seem to be aligned, it is apparent that the characteristics of the cycles are quite different across countries. A general comment that was already made in AKO, and that applies here as well, is the asymmetry of the cycle phases. Expansions are three to four times longer (an average of 56 months) than contractions (an average of 17 months). This generates cycles than, on average, last for 73 months (slightly above 6 years). Also, the total amplitude of expansions is much bigger than that of contractions: During expansions, production in our economies grows an average of 27%, whereas the decay for each contraction is slightly above 10%. Still another consistent result is the fact that monthly losses during contractions are bigger than monthly gains during expansions (-0.64% and 0.47%, respectively). This means that recessions are short lived, but the decline is more intense during the months of the recession.

As to the results across different countries, it can be seen that the length of expansions varies more (from a minimum of 31 expansionary months for Italy to 84 in Ireland or 82 in Portugal) than the length of contractions, which seem to be more uniform across the board (8 months of very intense decline in Denmark to 25 for Sweden). The total duration of the cycles is, however, quite stable, with most values ranging from 63 months to 79 months. There are some exceptions, most notably Finland, Ireland and Portugal, that present cycles of over 95 months and, on the lower end, Italy, whose cycles seem to last for only 48 months. Monthly amplitudes of the expansions are very stable, around the average value of 0.47%. Monthly contractions, on the other hand, are very dissimilar, with losses ranging from -0.36% in the case of Sweden to an astonishing -1.18% for Denmark). However, it can be seen that countries with shorter recessions tend to have more steep declines, whereas those with longer recessions suffer more mild monthly declines. Total amplitudes of contractions and expansions are also very different across countries, although the amplitude of the contractions is a little more uniform (ranging only from -8.3% for the Netherlands to -21% for Finland). The amplitude of expansions ranges from 15% for the UK to an staggering 67% for Ireland.

Regarding the specific countries, some cases are noteworthy. Finland is a totally outlying country. It has the second longest cycle (96 months), with very long expansions (75 months or, approximately, 8 years!) and also long contractions (21 months). Amplitude and monthly amplitude of the expansions are the second largest after Ireland (49.5% and 0.66% respectively) while at the same time the contractions are long (21 months) and deep (Finland presents, by far, the deepest contractions with an average loss of 21%). Denmark is also sort of an outlier in that it presents very short contractions but with intense monthly declines. Portugal and Ireland show the longest, and very ample, expansions, though their contractions are shorter than average and not especially intense. There is a set of countries, namely Austria, Belgium, France, Germany, Greece, the Netherlands, Spain, the UK and the US, that are very similar to the average and, therefore, to one another. Sweden presents the longest contractions (25 months) and quite short expansions (39 months), but the size of both phases is around the average. Finally, Italy presents the shortest expansions (31 months long) of all countries, and the shortest cycle, lasting only for 48 months (4 years).

Insert Table 4

4.2 Concordance of the Cycles

The last part of our analysis relates to the concordance of the cycles across European countries and with the US. that is, do European countries tend to be in the same phase of the cycle or are their phases uncorrelated? This evidence is complementary to the more casual examination of the dates of the peaks and troughs that we carried out at the beginning of the section. We present here a formal statistic that gives an idea of the degree of concordance of the cycle phases across countries. The test is based on a contingency table of dichotomous variables, and it relates the number of months that the two countries that are being compared spend in the same phase or in different phases with the marginal proportions of the phases. We start from the following contingency table,

		Country A		
		Expansion	Contraction	**Total**
	Expansion	n_{11}	n_{12}	$\mathbf{n}_{1\cdot}$
Country B	Contraction	n_{21}	n_{22}	$\mathbf{n}_{2\cdot}$
	Total	$\mathbf{n}_{\cdot 1}$	$\mathbf{n}_{\cdot 2}$	**N**

where n_{ij} is the number of months that the two countries spend in phase i (first country) and phase j (second country). The marginal frequencies, $n_{i\cdot}$ and $n_{\cdot j}$, count the total number of months that the first country spends in phase i and the second country spends in phase j, respectively. Define now the contingency coefficient of the table as $CC = \sqrt{\frac{\chi^2}{N+\chi^2}}$ where $\chi^2 = \sum_j \sum_i \frac{[n_{ij}-(n_{i\cdot}n_{\cdot j}/N)]^2}{n_{i\cdot}n_{\cdot j}/N}$. Notice that this coefficient is a direct function of the traditional chi-square test for independence of the two dimensions of the table. CC can be understood as a measure of the strength of the relationship between the two dimensions (AKO mention that it can be understood as a correlation coefficient, but notice that CC can only be positive, thus giving a measure of how much the two dimensions are related but not of the direction of the relationship). There is a problem of interpretation of CC given that, by construction, its maximum value in a 2×2 contingency table can be $\sqrt{1/2}$. Thus, a corrected contingency coefficient, scaled to be between 0 and 100 can be found by applying the formula $CC_{cor} = 100\frac{CC}{\sqrt{1/2}}$.

Table 5 presents all the bilateral corrected contingency coefficients in our sample, where a few relevant results are apparent. First, there seems to be a group of highly related countries, formed by France, Germany, Belgium and the Netherlands. This was to be expected: It is more surprising, though, that the rest of the countries do not form clusters or groups in terms of their similarity. Italy only seems to be strongly related to Spain, but Spain, on the other hand, seems to be more similar, apart from Italy, to France, Germany and, surprisingly, Austria. The UK is highly related to Ireland and Sweden. The US does not seem to have any clear counterpart, although the CC_{cor} with respect to Austria, Ireland and Spain is above 50, but more surprising is the case of Finland, which shows absolutely no relation to any of the other countries except, maybe, Sweden. Thus, there is evidence for concordance of the cycle phases in Europe, but, except for a core group of countries that now only includes Belgium, France, Germany and the Netherlands (in AKO, this core group of countries also included Italy and Ireland, but these two countries seem to have become increasingly different in the last years of the sample) the cycles are in general correlated but this correlation is not strong and, in the cases of Finland, Greece, Denmark and Portugal, it seems to be actually quite low.

Insert Table 5

Figures 16 and 17 present a related analysis, where we have plotted the corrected contingency coefficients of all countries with respect to France and Germany (Figure 16)and to the UK and the US (Figure 17). As we have already mentioned, all countries seem to be mildly related with the UK and the US, but the association with France and Germany is stronger. The core group of countries is clearly visible in the graph, but there is evidence that also Spain, Portugal, Denmark and Sweden are becoming part of that core, whereas Italy and Ireland are farther away, and Greece and Finland look completely dissimilar.

Insert Figures 16-17

The conclusions are, then, that the cycles in European countries are indeed related, but they still present significant differences, both in terms of the characteristics of the cycle phases and in terms of their concordance in time. It seems, though, that there is still a core of European countries with highly similar and concordant cycles (Belgium, France, Germany and the Netherlands), a set of countries that are becoming more concordant, at least judging by the fact that they were not part of the core in AKO but they show much stronger similarity to the core now (Denmark, Portugal, Spain, Sweden and maybe Austria) and a group of countries that have become more dissimilar during the last years (Ireland and Italy) or stay highly dissimilar (the UK, and Finland and Greece).

5 Conclusions

We have analyzed the business cycles, and more concretely, the expansions and contractions of European countries during the last 30 years. We use a dating algorithm based on Bry-Boschan's procedure to locate the turning points of an industrial production series, and thus detect the contractionary and expansionary phases of the cycles.

We find that cycles in Europe tend to be aligned, with the turning points (peaks and troughs) happening at similar moments in time, but there are still idiosyncratic recessions that only some of the countries suffer. The business cycles are very similar also in their characteristics: Most of them are asymmetric across phases, with expansions being longer and less intense in their monthly changes, whereas contractions tend to be short but the monthly loss is significantly higher.

We find a set of core European countries, formed by Belgium, France, Germany and the Netherlands. Cycles in these countries are very concordant, which means that their economies tend to be in the same phase at the same time. Also, the characteristics of their cycle phases are very similar. A second group of countries presents also similar phases, although the concordance of these phases is a little weaker: Austria, Denmark, Spain and Sweden are part of this group, with Portugal sharing similar concordance but having different cycle characteristics. The rest of the countries analyzed show very little concordance with the core European countries, this being especially noticeable for the cases of Finland, Greece, the UK and the US and, less so, for Italy and Ireland. Cycles in the UK and the US are, nevertheless, similar to those in the core countries. Finland, Greece, Italy and Ireland, on the other hand, have not only non-concordant cycles but also their cycles are completely different to those of the other European countries.

We have tried to provide a thorough description of the cycles of economic activity in Europe. However, there is still much work to be done, not only from the applied perspective but also from the methodological. There is still not one unified set of criteria to define the cycle phases or to characterize the recessions, and some of the methods used give substantially different results. Also, the effects of the last world recession are still to be detected, given that there are some countries for which we did not have all the data necessary to date the beginning of the last recession. Obviously, the dating of the trough of the current recession will have to wait till data from the expansion is available.

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Table 1

Steps of the modified version of the Bry-Boschan Algorithm as operationalized by (Artis et al., 1997)

1		**Determination and smoothing of extreme values**
2		**Analysis of cycles of a 7 month centered moving average**
	2.1	Local maxima and minima in a two sided 12 month window
	2.2	Forced alternation of turns by selecting highest or consecutive peaks (lowest trough)
3		**Analysis of cycles of original unsmoothed series**
	3.1	Local maxima and minima in a two sided 12 month window
	3.2	Forced alternation of turns
	3.3	If two peaks / troughs have the same value, the last one is taken
	3.4	Exclusion of outliers from turning points
	3.5	Forced alternation of turns
	3.6	Exclusion of short cycles (less than 15 months from peak to trough)
	3.7	Minimum amplitude of phase required: 1std. error of log changes
4		**Comparison of turning points of both series**
		Those in the unsmoothed that do not correspond to similar turns of the moving average are eliminated

Table 2
Dates of the Peaks and Troughs identified for the 15 Countries
(Data for Denmark are only available from 01/74 to 6/00

	AUT	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NET	POR	SPA	SWE	UK	USA
Trough				03/71					04/71				01/72	01/72	
Peak	06/74	05/74		07/74	08/74	08/73	02/74	02/74	06/74	09/74	03/74	01/74	06/74	06/74	11/73
Trough	10/75	08/75	03/75		05/75	07/75	07/74	10/75	04/75	09/75	08/75	01/75		08/75	03/75
Peak		03/77			01/77				01/77	09/76					
Trough		10/77		03/77	12/77				06/77	05/78			06/78		
Peak	12/79	01/80	11/79		08/79	12/79		09/79	03/80	03/80		03/80	12/79	06/79	06/79
Trough		11/80	11/80		11/80			12/80						05/81	07/80
Peak					12/81										07/81
Trough	01/83				08/82	11/82			05/83	11/82		08/82	11/82		12/82
Peak			08/86				10/85				11/84		09/85	01/84	
Trough			01/87				01/87				02/85		12/85	08/84	
Peak		05/90		07/89	01/91	01/91	02/90		12/89	02/91	08/90	06/90	12/90	06/90	04/89
Trough		08/91		06/91											03/91
Peak	06/92	02/92	07/92												
Trough	12/92	02/94	05/93		08/93	07/93	07/93		12/92	12/92	10/93	04/93	02/93	05/92	
Peak	06/95					12/94			12/95			05/95			
Trough	12/95					10/95			12/96			04/96			
Peak									04/98						
Trough									12/98						
Peak	11/00			10/00		02/01	02/01	02/01	12/00			11/00	11/00	08/00	06/00

Table 3
Comparison of the Dates of the Peaks and Troughs with those in Artis et al. (1997)
Comparison is made only for those countries for which both papers have information

	BEL		FRA		GER		IRE		ITA		NET		SPA		USA	
	GB	**AKO**	**GB**	**AKO**	**GB**	**AKO**	**GB**	**AKO**	**GB**	**AKO**	**GB**	**AKO**	**GB**	**AKO**	**GB**	**AKO**
Trough									04/71							
Peak	05/74	04/74	08/74	08/74	08/73	08/73	02/74	02/74	06/74	06/74	09/74	08/74	01/74	08/74	11/73	11/73
Trough	08/75	07/75	05/75	05/75	07/75	07/75	10/75	04/75	04/75	04/75	09/75	08/75	01/75	08/75	03/75	03/75
Peak	03/77	10/76	01/77	01/77					01/77	01/77	09/76	09/76				
Trough	10/77	09/77	12/77	12/77					06/77	06/77	05/78	05/78				
Peak	01/80	12/79	08/79	08/79	12/79	12/79	09/79	09/79	03/80	03/80	03/80	03/80	03/80		06/79	03/80
Trough	11/80	12/80	11/80	11/80			12/80	12/80							07/80	07/80
Peak			12/81	12/81											07/81	07/81
Trough			08/82	08/82	11/82	11/82			05/83	06/83	11/82	11/82	08/82		12/82	12/82
Peak												01/87				
Trough												04/88				
Peak																
Trough																
Peak	05/90	03/90	01/91	04/92	01/91	06/91			12/89	12/89	02/91	03/91	06/90	01/90	04/89	04/89
Trough	08/91	08/91												03/91	03/91	03/91
Peak	02/92	12/91												12/91		

Table 4

Business Cycle Characteristics

Durations are expressed in months. Total Amplitude and Monthly Amplitude in percentage

	Expansions			Contractions			Total Cycle
	Duration	**Amplitude**	**Monthly**	**Duration**	**Amplitude**	**Monthly**	**Duration**
AUT	50.8	25.16%	0.49%	15.8	-9.40%	-0.59%	66.6
FIN	75.0	49.44%	0.66%	21.3	-20.98%	-0.99%	96.3
FRA	51.7	16.26%	0.31%	12.3	-6.43%	-0.52%	64.0
GER	45.8	16.97%	0.37%	21.8	-10.38%	-0.48%	67.6
GRE	62.4	27.27%	0.44%	17.3	-11.45%	-0.66%	79.7
IRE	84.5	67.09%	0.79%	15.0	-10.51%	-0.70%	99.5
ITA	30.9	16.88%	0.55%	17.1	-9.13%	-0.53%	48.0
POR	81.5	42.17%	0.52%	14.5	-10.45%	-0.72%	96.0
SPA	47.3	22.18%	0.47%	20.0	-8.41%	-0.42%	67.3
SWE	39.0	20.00%	0.51%	25.0	-9.02%	-0.36%	64.0
UK	46.0	14.79%	0.32%	17.8	-8.17%	-0.46%	63.8
US	49.3	21.66%	0.44%	17.6	-9.28%	-0.53%	66.9
BEL	49.2	22.94%	0.47%	12.7	-12.50%	-0.99%	61.8
DEN	69.0	26.95%	0.39%	8.2	-9.64%	-1.18%	77.2
NET	59.0	19.53%	0.33%	17.2	-8.30%	-0.48%	76.2
Average	56.1	27.29%	0.47%	16.9	-10.27%	-0.64%	73.0

Table 5

Corrected Contingency Coefficients

All CCcor's have been calculated for the period 1970:1-2001:10 except for Belgium, Netherlands and Denmark, which have been calculated for the range of the available IIP data

	AUT	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NET	POR	SPA	SWE	UK	US
AUT		39.2	50.0	21.6	43.1	77.7	3.1	70.0	58.5	70.0	21.6	72.6	65.1	41.4	55.5
BEL	39.2		56.4	26.5	72.7	55.1	51.1	53.4	39.2	51.0	76.7	54.0	42.5	43.8	24.7
DEN	50.0	56.4		2.6	55.1	61.2	38.4	73.2	20.8	22.3	46.1	48.9	32.7	37.7	42.8
FIN	21.6	26.5	2.6		0.3	4.5	21.3	37.8	44.8	18.7	26.1	16.8	55.0	54.4	44.7
FRA	43.1	72.7	55.1	0.3		68.6	38.9	41.6	47.7	74.5	66.3	57.4	61.2	39.1	25.5
GER	77.7	55.1	61.2	4.5	68.6		48.2	59.5	56.4	72.6	61.9	83.1	61.1	43.2	47.6
GRE	3.1	51.1	38.4	21.3	38.9	48.2		15.8	36.2	13.9	67.3	59.2	20.1	27.1	24.3
IRE	70.0	53.4	73.2	37.8	41.6	59.5	15.8		28.3	35.7	33.2	43.7	44.2	59.5	55.5
ITA	58.5	39.2	20.8	44.8	47.7	56.4	36.2	28.3		67.7	36.5	70.5	63.5	56.4	44.2
NET	70.0	51.0	22.3	18.7	74.5	72.6	13.9	35.7	67.7		42.8	63.8	90.0	50.2	20.8
POR	21.6	76.7	46.1	26.1	66.3	61.9	67.3	33.2	36.5	42.8		58.8	35.9	41.6	15.0
SPA	72.6	54.0	48.9	16.8	57.4	83.1	59.2	43.7	70.5	63.8	58.8		56.7	49.9	52.1
SWE	65.1	42.5	32.7	55.0	61.2	61.1	20.1	44.2	63.5	90.0	35.9	56.7		64.8	23.5
UK	41.4	43.8	37.7	54.4	39.1	43.2	27.1	59.5	56.4	50.2	41.6	49.9	64.8		40.8
US	55.5	24.7	42.8	44.7	25.5	47.6	24.3	55.5	44.2	20.8	15.0	52.1	23.5	40.8	

Figure 1
AUSTRIA
Evolution of IIP and Estimated Recessions (Shaded)

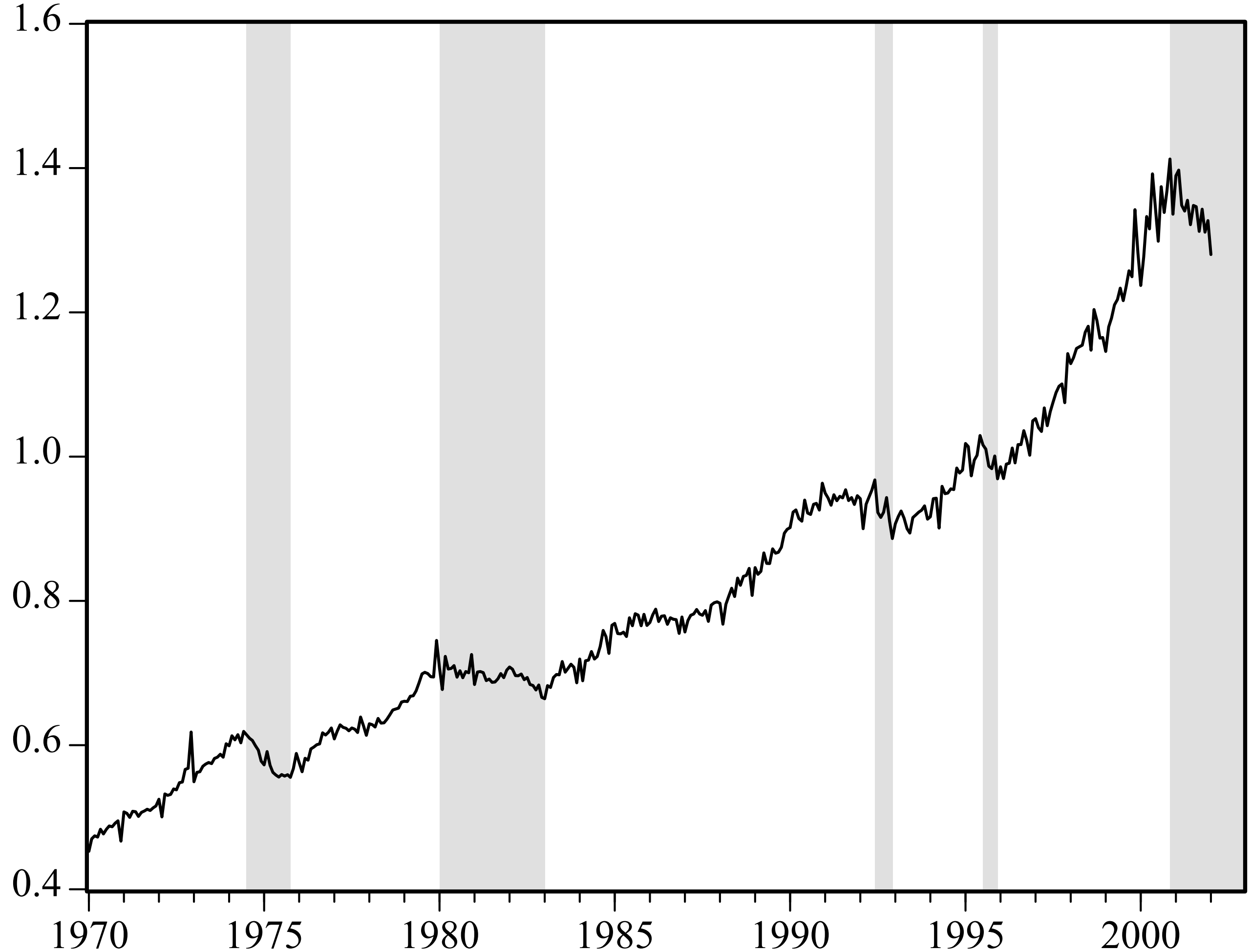

Figure 2
BELGIUM
Evolution of IIP and Estimated Recessions (Shaded)

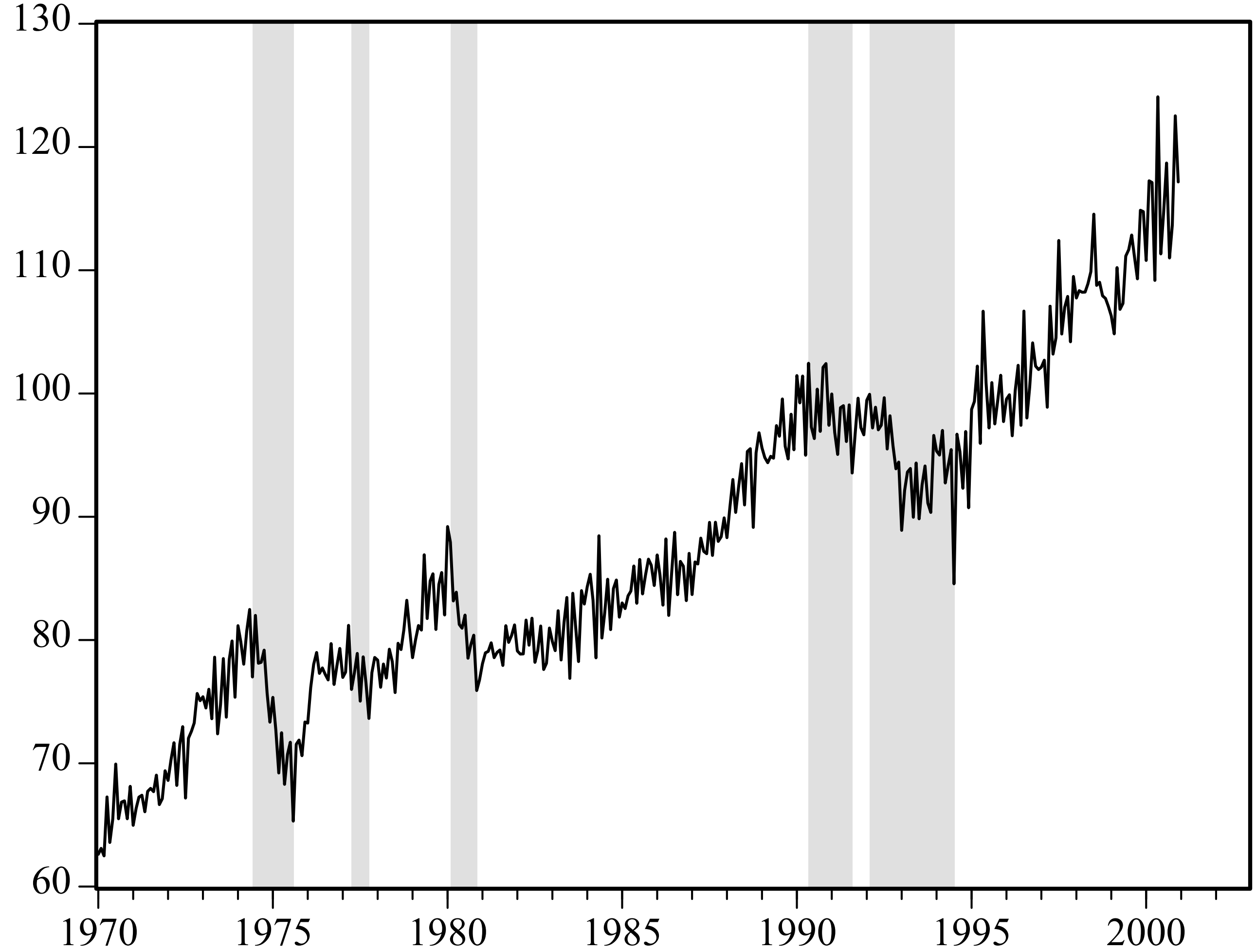

Figure 3
DENMARK
Evolution of IIP and Estimated Recessions (Shaded)

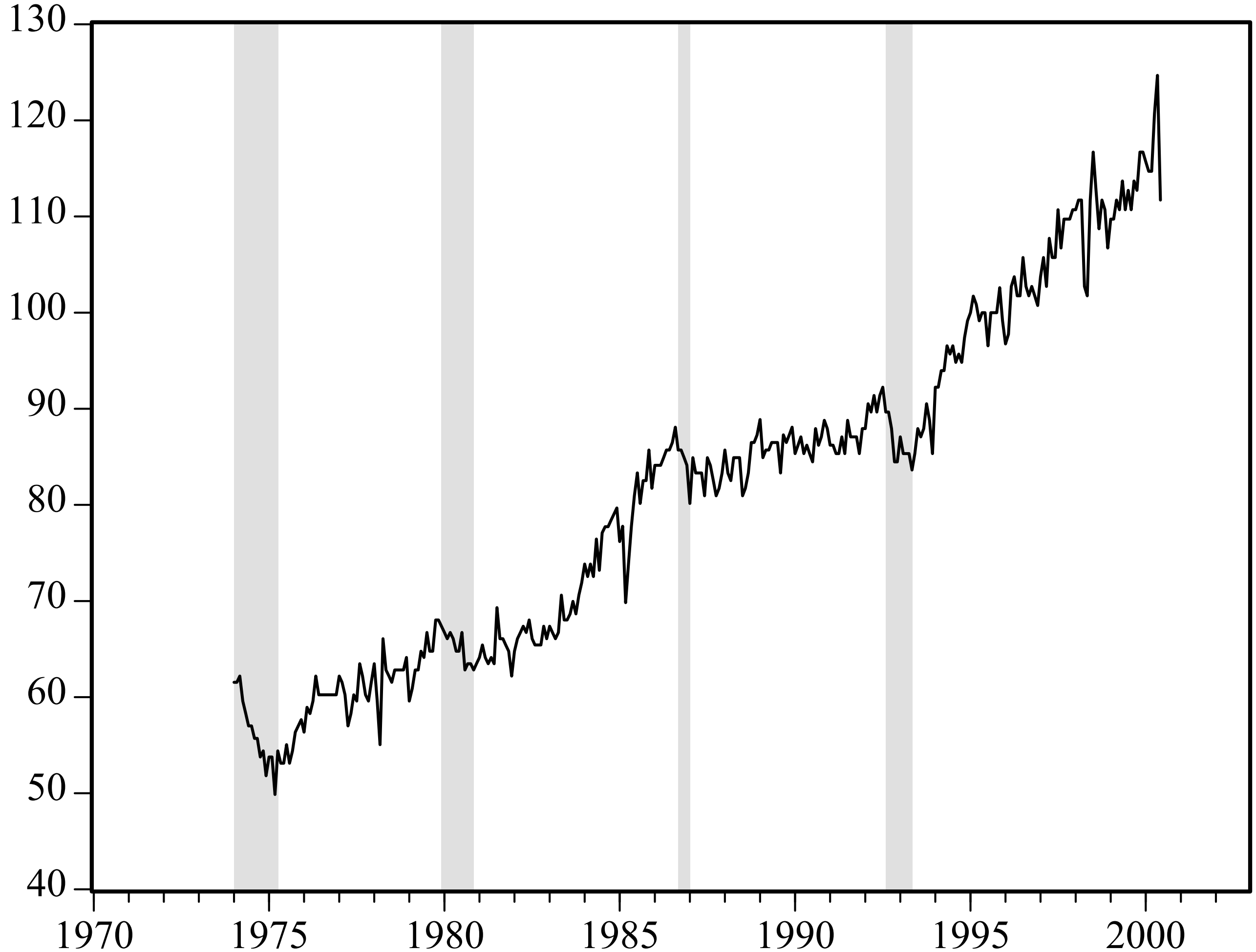

Figure 4
FINLAND
Evolution of IIP and Estimated Recessions (Shaded)

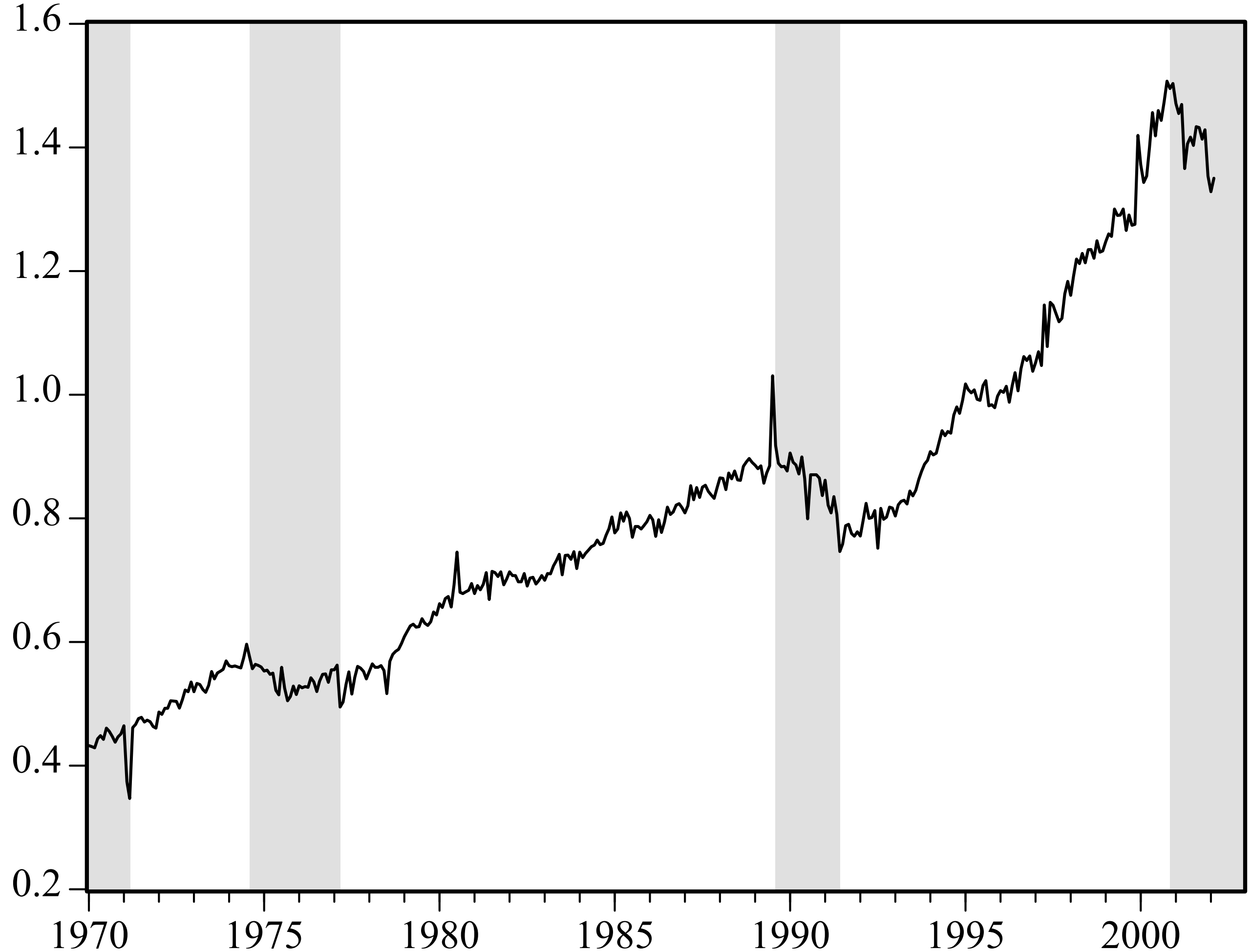

Figure 5
FRANCE
Evolution of IIP and Estimated Recessions (Shaded)

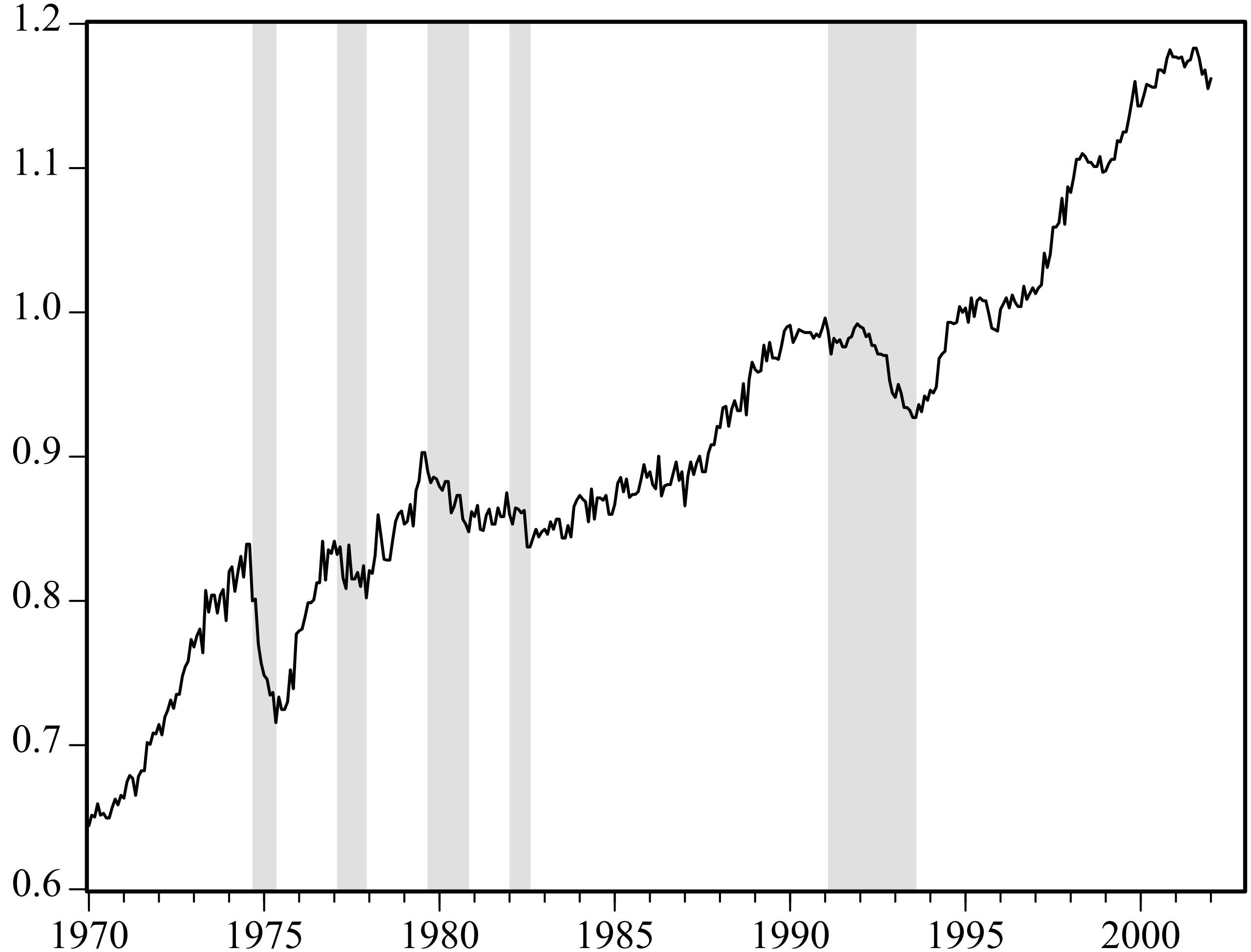

Figure 6
GERMANY
Evolution of IIP and Estimated Recessions (Shaded)

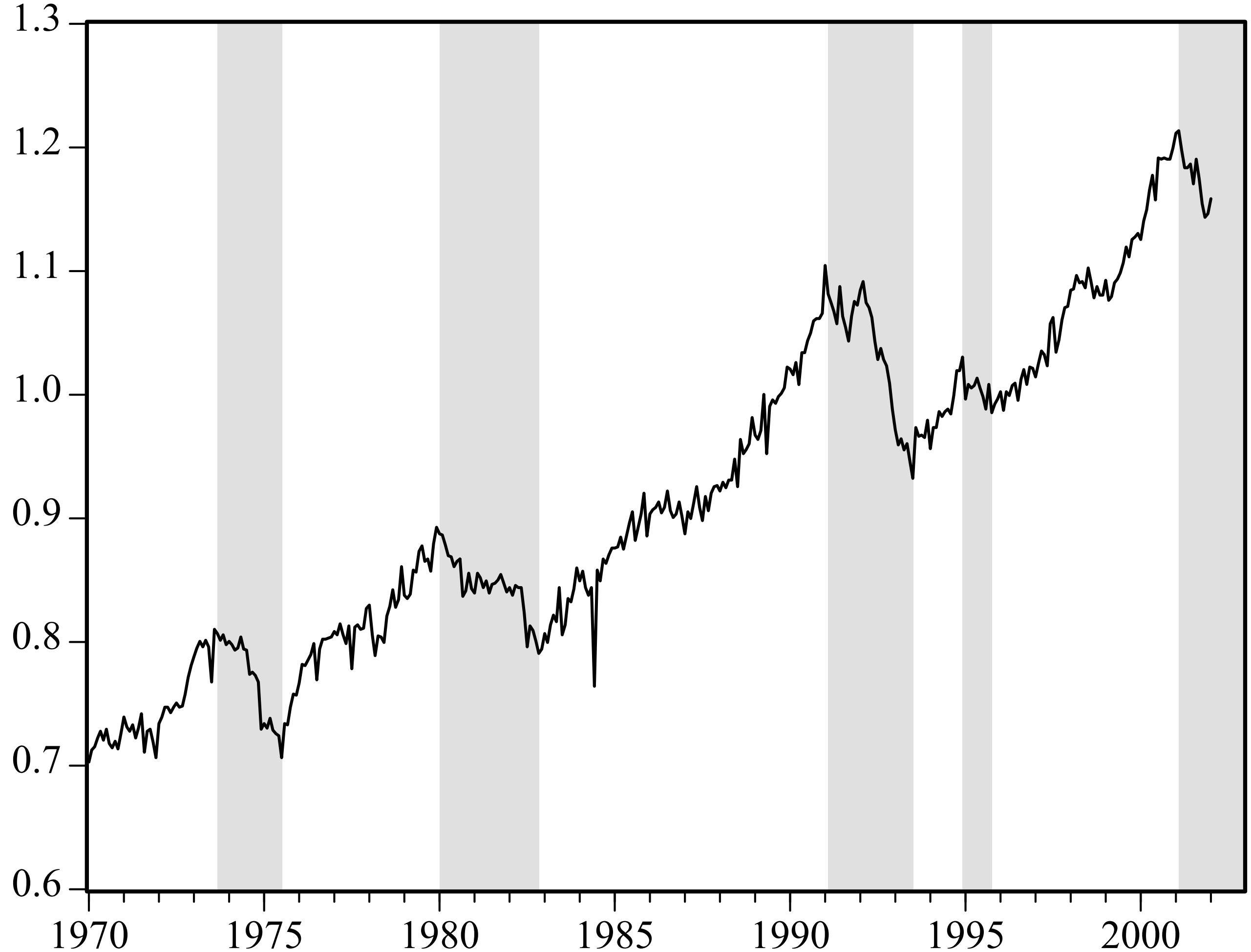

Figure 7
GREECE
Evolution of IIP and Estimated Recessions (Shaded)

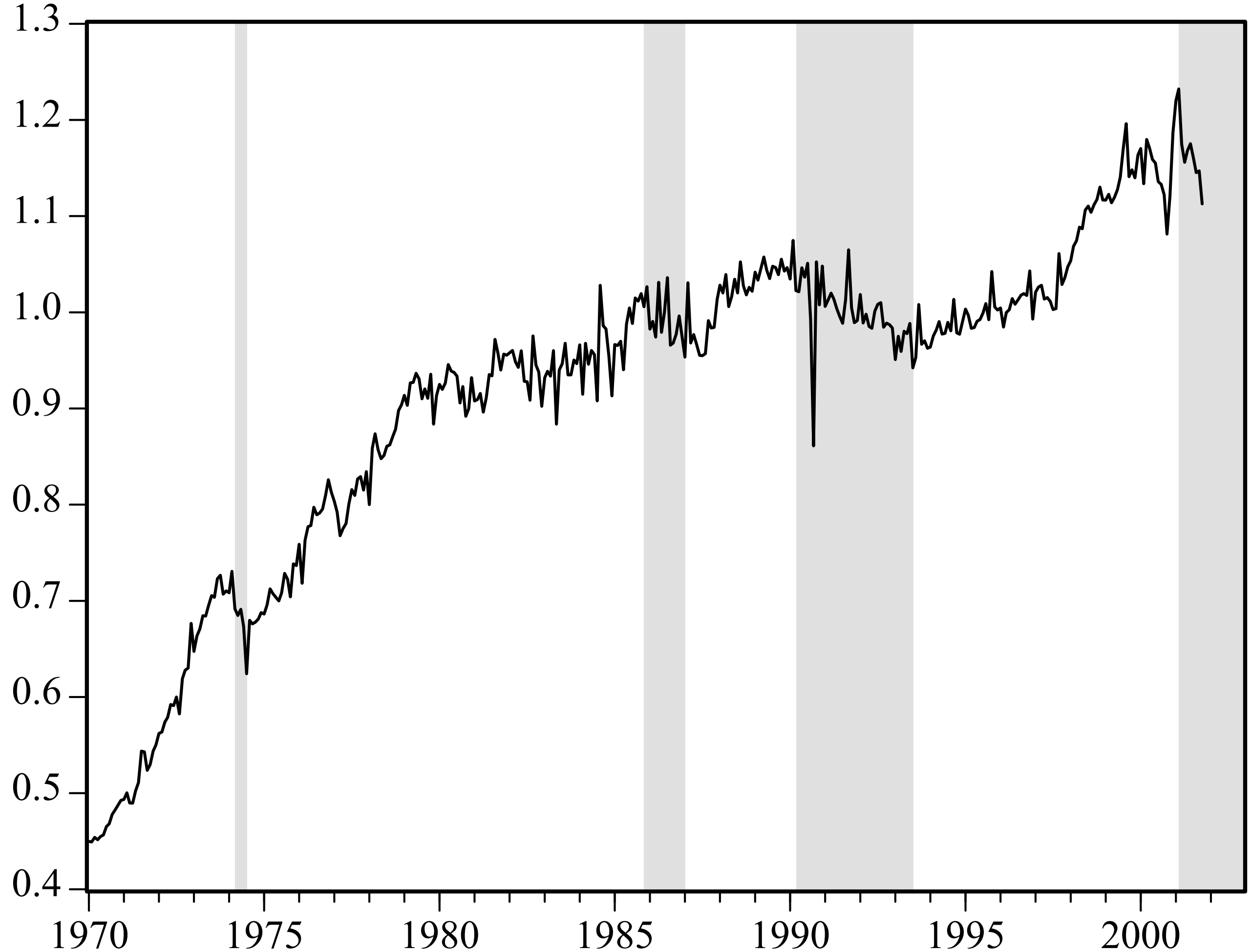

Figure 8
IRELAND
Evolution of IIP and Estimated Recessions (Shaded)

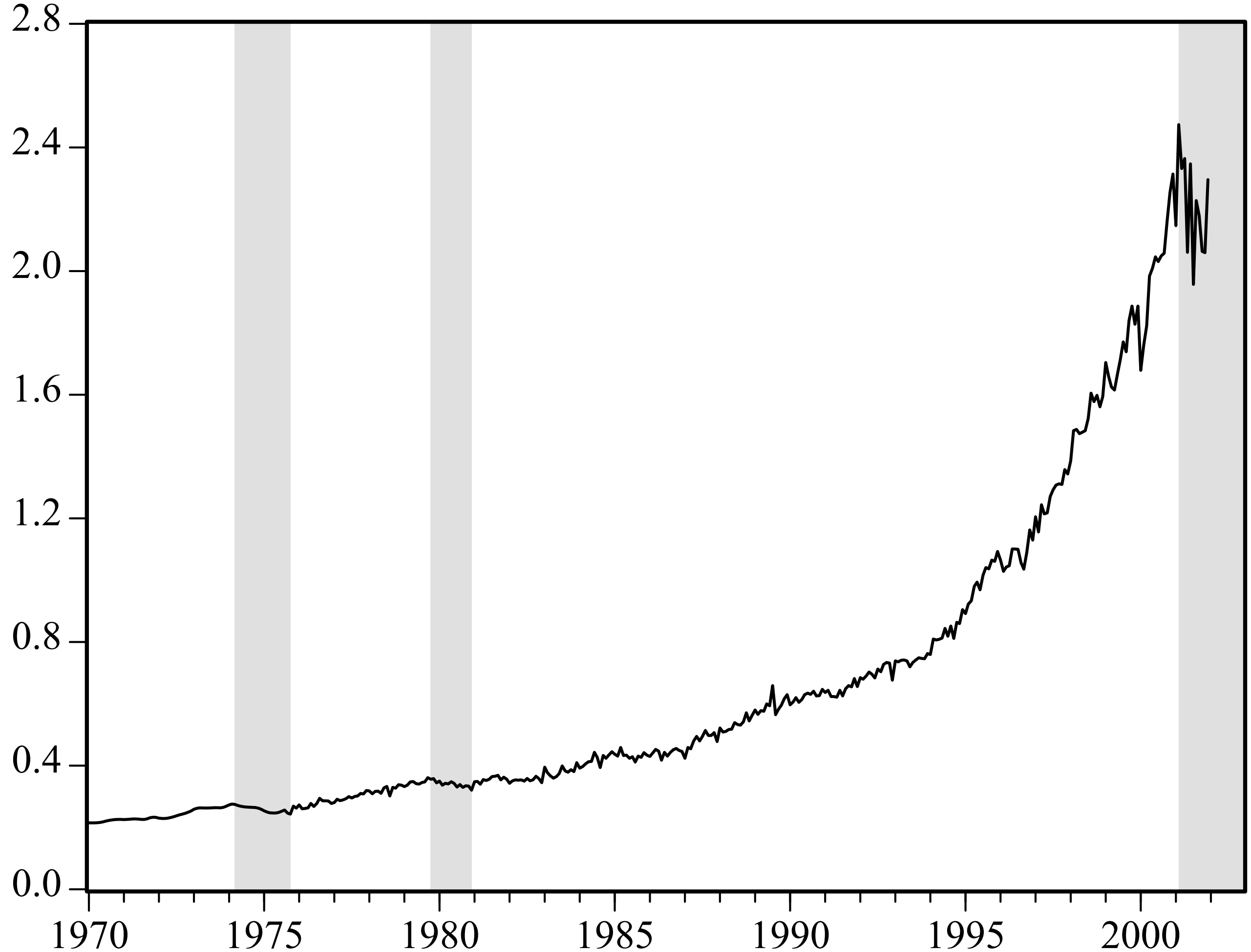

Figure 9
ITALY
Evolution of IIP and Estimated Recessions (Shaded)

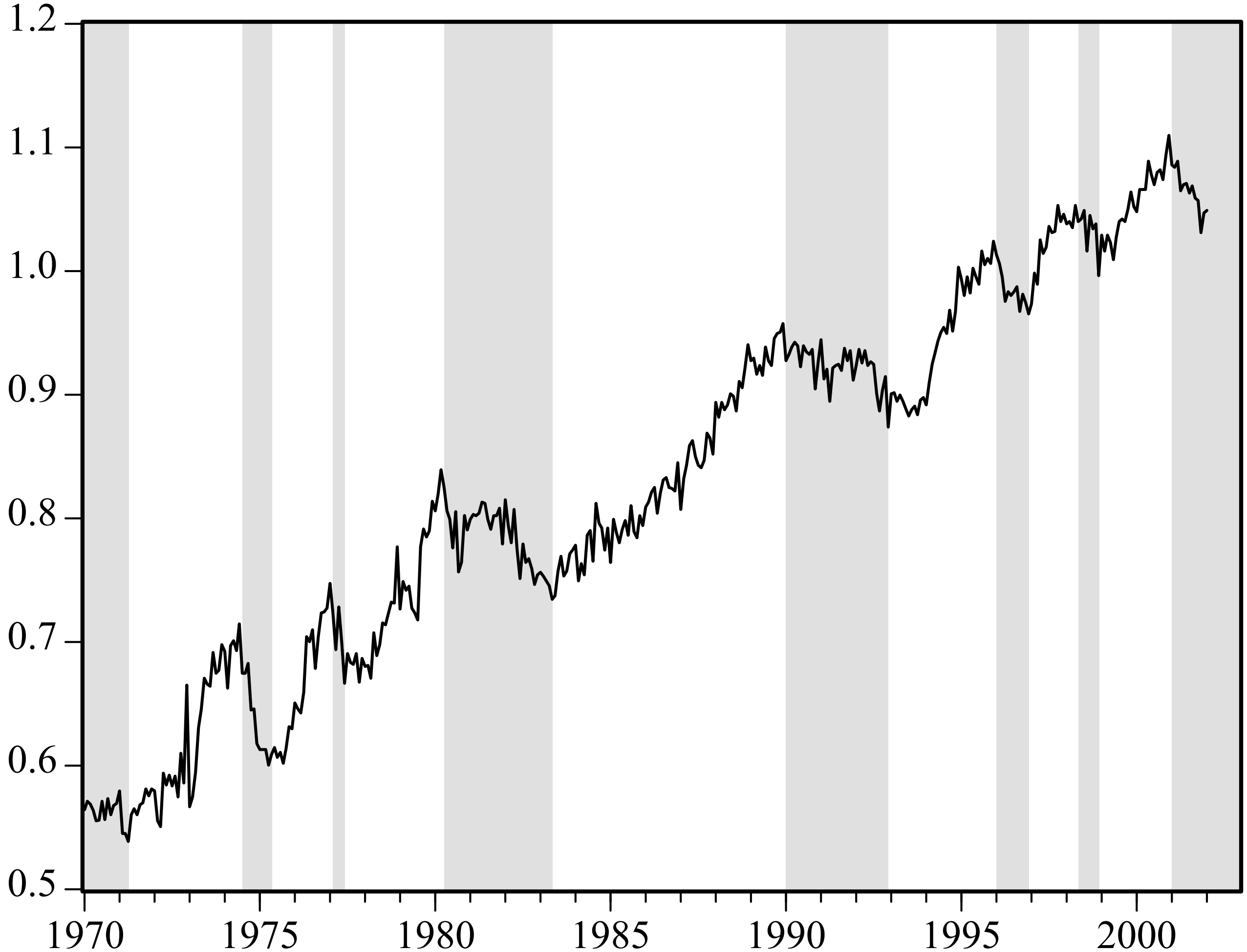

Figure 10
NETHERLANDS
Evolution of IIP and Estimated Recessions (Shaded)

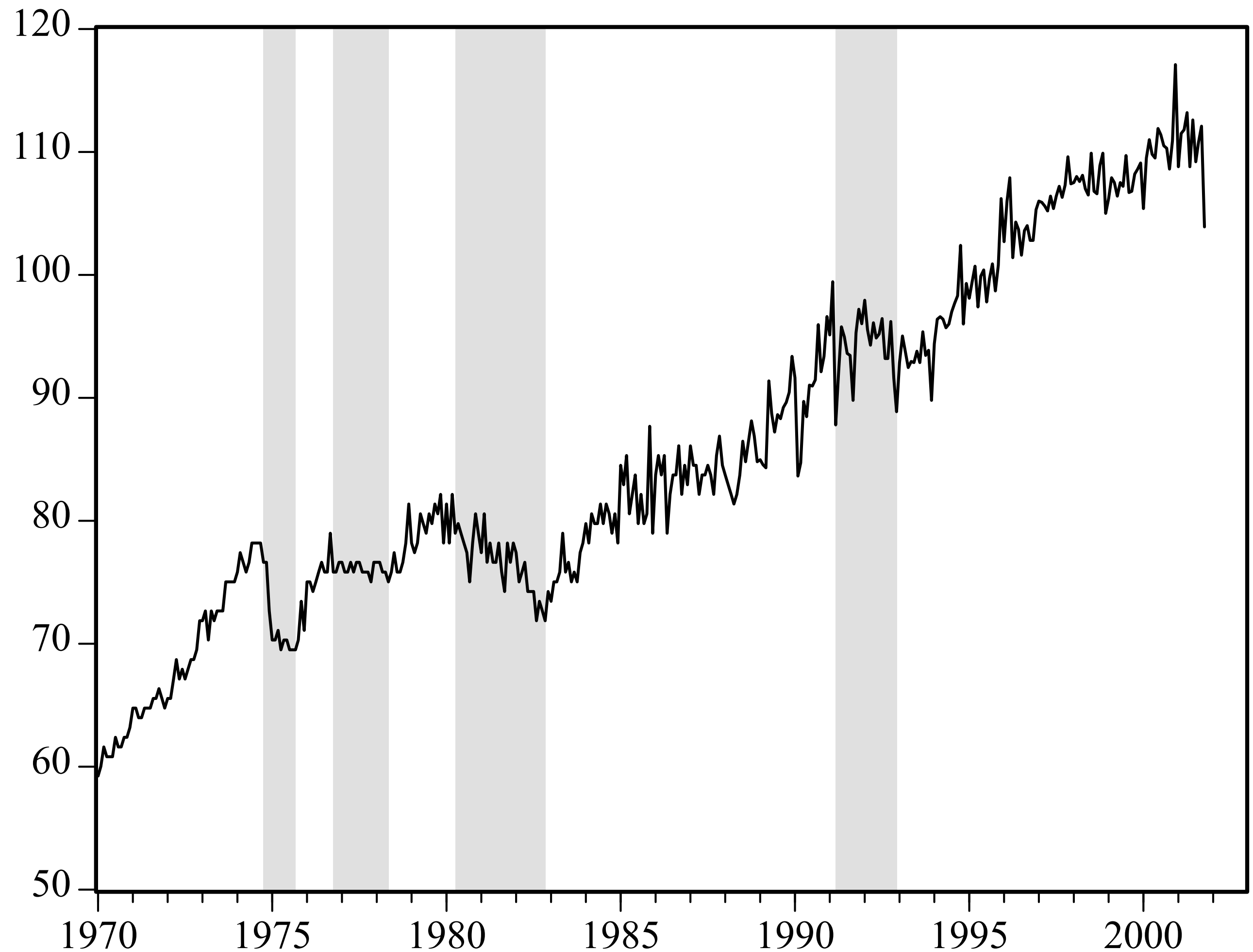

Figure 11
PORTUGAL
Evolution of IIP and Estimated Recessions (Shaded)

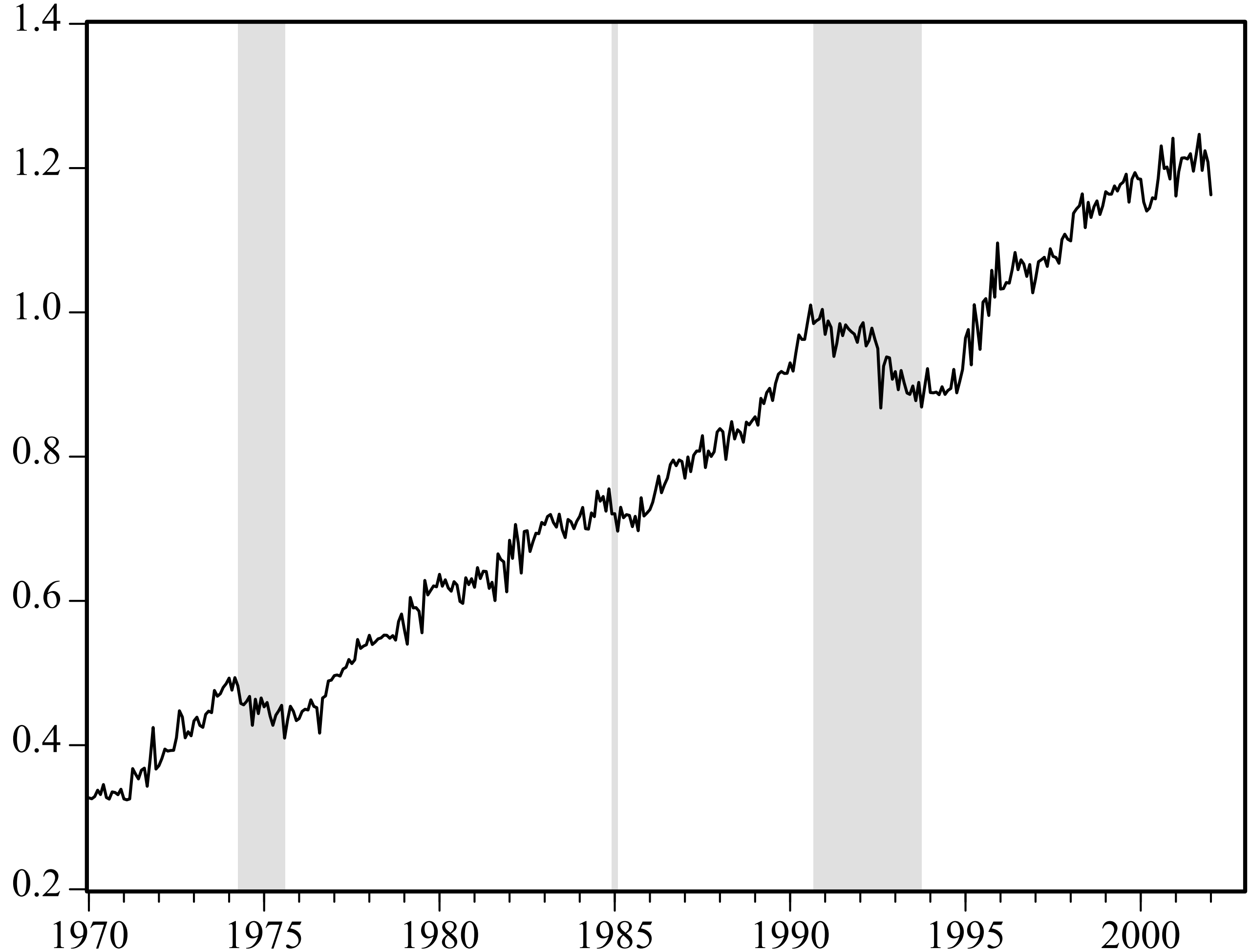

Figure 12
SPAIN
Evolution of IIP and Estimated Recessions (Shaded)

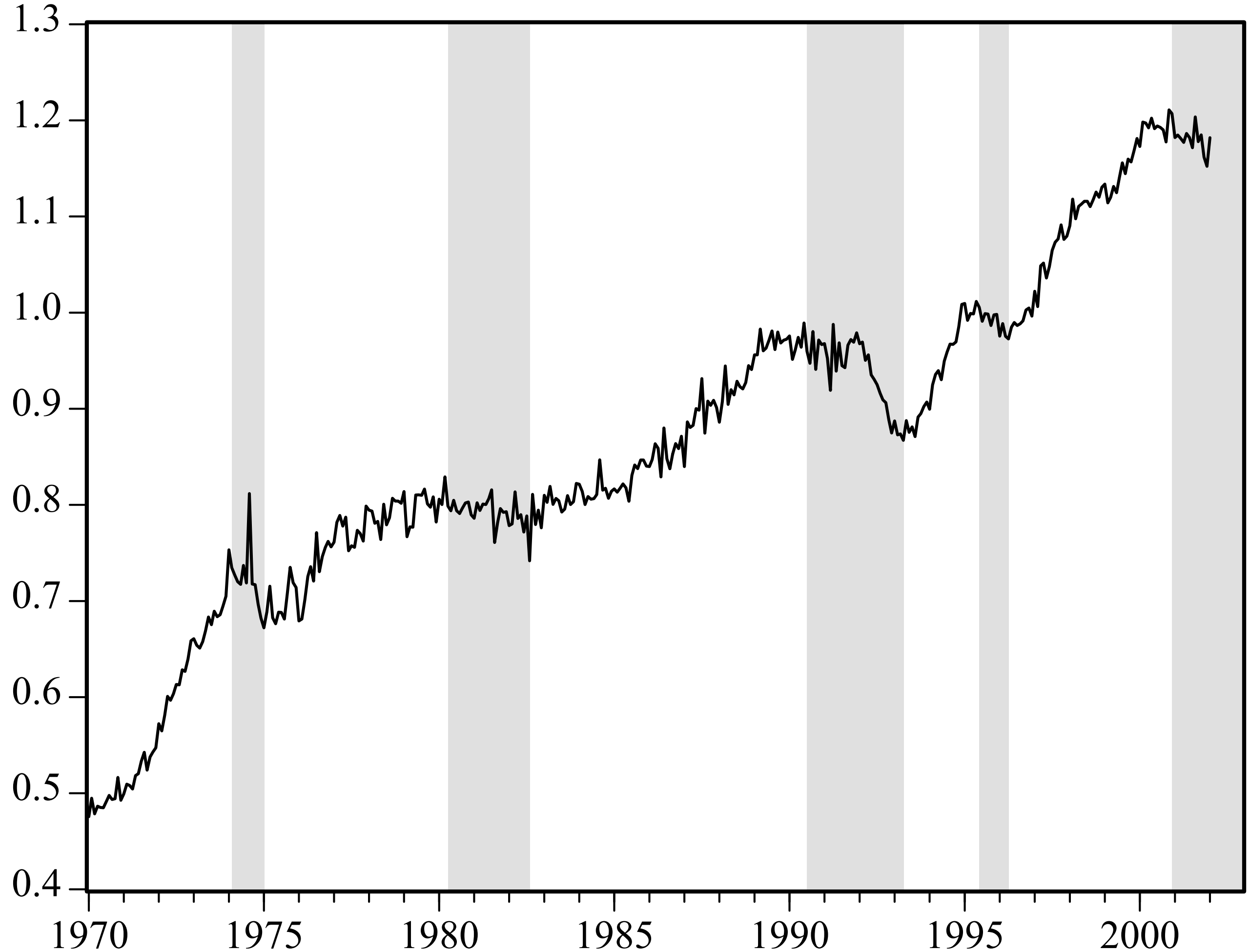

Figure 13
SWEDEN
Evolution of IIP and Estimated Recessions (Shaded)

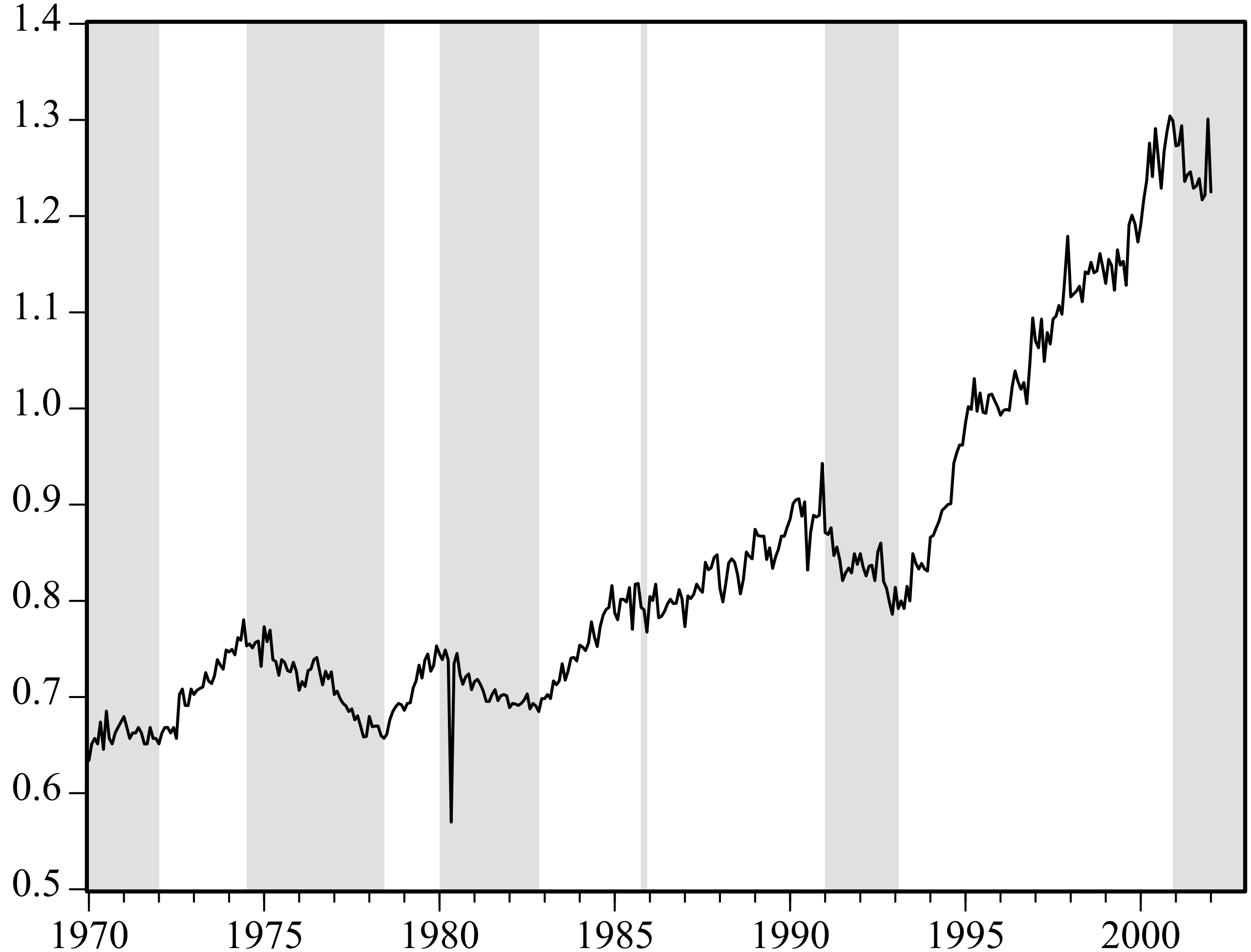

Figure 14
UNITED KINGDOM
Evolution of IIP and Estimated Recessions (Shaded)

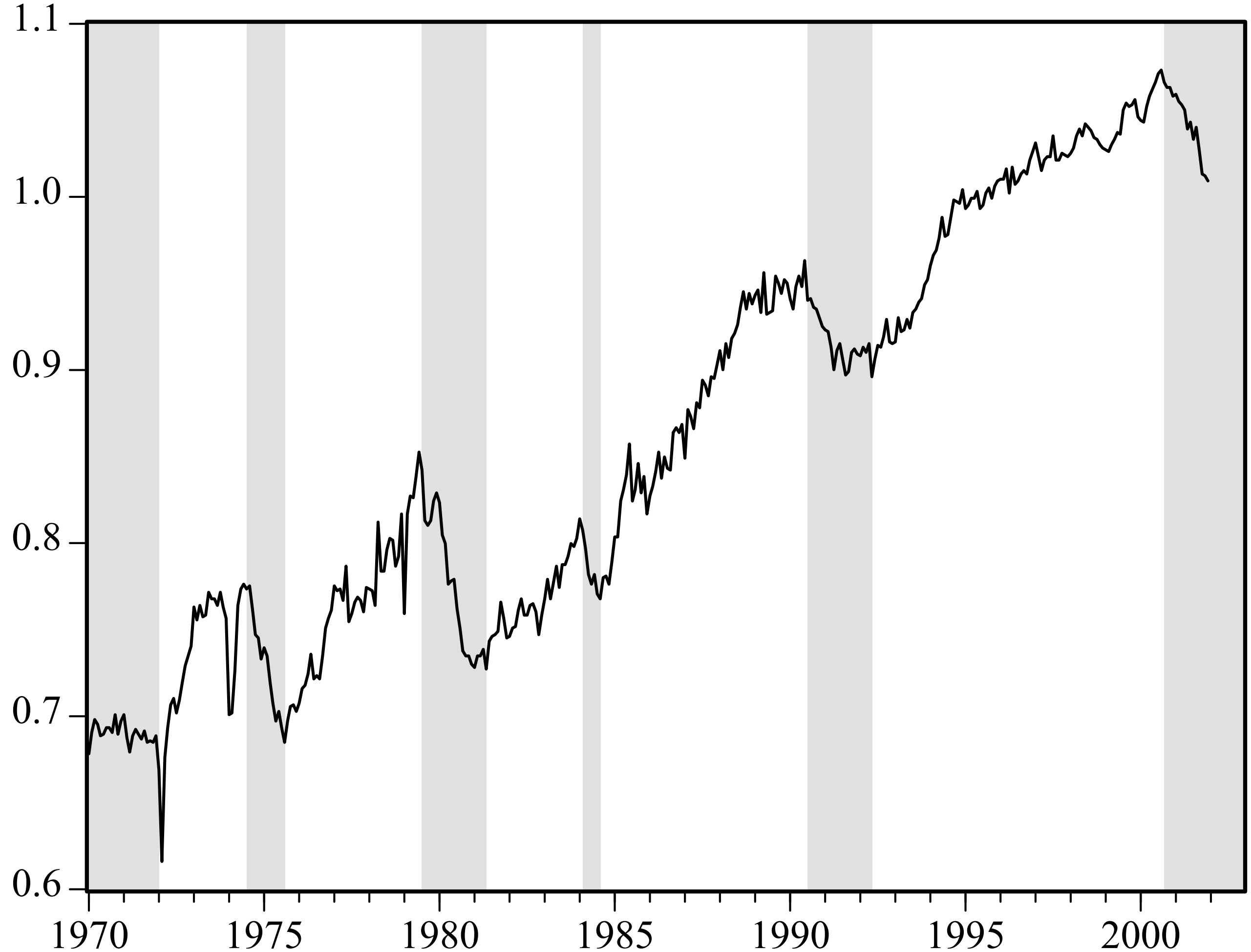

Figure 15
UNITED STATES
Evolution of IIP and Estimated Recessions (Shaded)

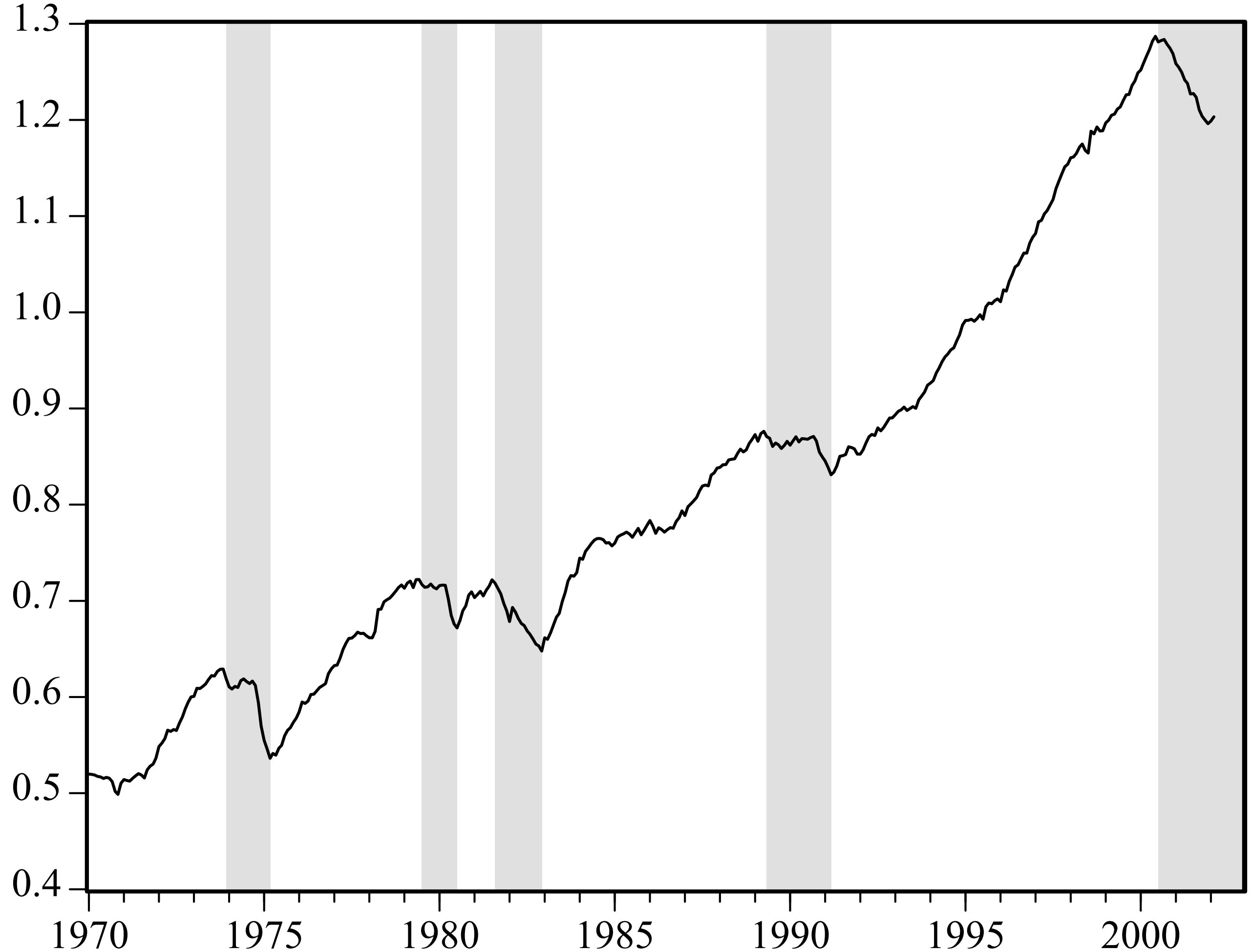

Figure 16: Corrected Contingency Coefficients with respect to France and Germany

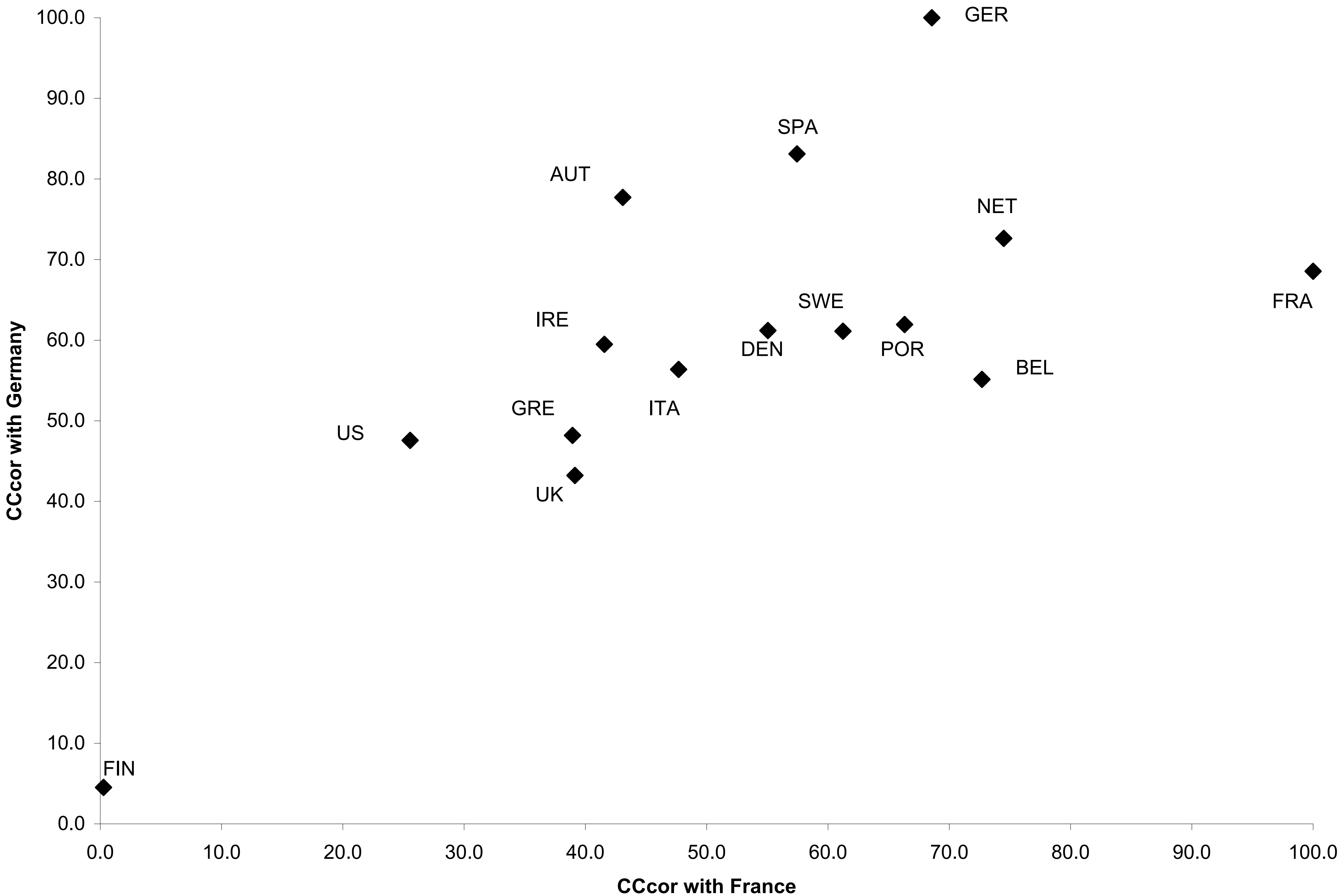

Figure 17: Corrected Contingency Coefficients with respect to UK and US