Business Cycle Stylized Facts and Inventory Behaviour: New Evidence for the Euro area

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Abstract

The purpose of this paper is for the first time to use Business Tendency Survey data, first, to identify new facts that are useful for the interpretation of the decline in the volatility of real activity in the Euro Area, and, second, to test the inventory management hypothesis as an explanation for the Great Moderation in Europe. We present stylized facts from the Business Tendency data on series for inventories, current production, current orders and expected production for the Euro area, emphasizing the decline in the volatility of the series. Further, we investigate whether the decline in inventory volatility can be attributed to an endogenous change in the persistence of shocks to the accumulation dynamics of inventories or to an exogenous change in the shocks hitting the inventory optimisation process. Our results at Euro level generally indicate that there is no evidence of a break in the inventory accumulation process. On the contrary, the impact of exogenous shocks on inventory volatility appears to be steadily declining over time, beginning from the mid eighties.

Keywords: Business cycle stylized facts, Inventory behaviour, European Business Tendency Survey data.

JEL Classification: C32, E32

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1. Introduction

In recent years a number of studies—see, for example, McConnell and Perez Quiros (2000), Blanchard and Simon (2001), and Stock and Watson (2003--have reported stylized facts concerning the most important US macroeconomic time series. The main findings concern the decline in volatility observed in US macroeconomic data since the mid 1980's. Despite the large amount of literature on this topic and efforts to explain the evidence, the debate on the causes of the 'Great Moderation' is still open. Blanchard and Simon (2001) attribute it to improvements in monetary and fiscal policy. Stock and Watson (2003) argue that the reduction in US output volatility should be attributed not only to better monetary policy but also to a decrease in the volatility of productivity shocks--the so-called 'Good Luck' hypothesis. McConnell and Perez Quiros (2000) propose an explanation for the reduction in US production volatility based on better inventory management practices within durable goods. More recent explanations--for example, Dynan et al. (2006)--focus on the role of financial markets in the propagation mechanism of the shocks.

Work has also proceeded to uncover stylized facts for the European Business cycle. A substantial literature has focused on topics such as the synchronicity of national cycles with respect to the Euro area business cycle--Camacho, Perez Quiros and Saiz (2008) and Stock and Watson (2005), convergence--Carvalho and Harvey (2005) and Canova, Ciccarelli, Ortega (2004), the time varying nature of international business cycles--Artis, Osborn and Perez (2006), the dating of cyclical chronology—Simpson, Osborn and Sensier (2001), Artis, Marcellino and Proietti (2004), and Giannone and Reichlin (2005), changes in the volatility of output growth and other characteristics of business cycles among European and G-7 countries--Agresti and Mojon (2001), Artis, Krolzig and Toro (2004), Stock and Watson (2005), and Giannone, Lenza and Reichlin (2008), among the others.

The purpose of this paper is for the first time to use Business Tendency Survey data, first, to identify new facts that are useful for the interpretation of the decline in the volatility of real activity in the Euro Area, and, second, to test the inventory management hypothesis as an explanation for the Great Moderation in Europe. In fact, unlike in the US, inventory data in Europe are not directly derived from specific quantitative surveys among firms, but are obtained as a residual in the form of inventory investment from the National Accounts. Hence, quantitative data exist on inventory investment, but not on inventory stocks. Studies that have explored the relationship between inventory investment and GDP in the Euro area include Dimelis (2001) and Chikan and Tartai (2003). But, to investigate issues such as the behaviour of inventories over the business cycle and whether advances in inventory management techniques can explain the Great Moderation, inventory stock data are needed. To fill this gap, in this paper we make use of inventory stock data from the Business Tendency Surveys (BTS).[1] These data are qualitative in the sense that firms are not asked to provide quantitative information about a variable of interest (say, the level of production), but rather to state whether this variable has increased, stayed the same, or decreased with respect to the previous month. On inventories, the qualitative nature of the data means that firms are asked to state whether inventory levels are above or below "normal" levels generally interpreted as desired levels of stocks.

In the first part of the paper, we provide new stylized facts on business cycles for the Euro Area--specifically, Italy, France, and Germany--and the United Kingdom in comparison with the US. We discuss the business cycle properties of the Business Tendency Survey data for the Euro Area in order to provide evidence of their suitability to be used to interpret business cycle stylized facts. Since inventories are associated with the production of goods, we perform our analysis using Industrial Production as a reference for business cycle movements. Our results indicate that the BTS data are strongly correlated with Industrial Production and that the findings of a decline in volatility hold for these data as well. This evidence allows us to make use of Business Tendency Survey data on inventories to draw inferences regarding the role of inventories at the aggregate level.

Next, the paper provides new evidence on the causes of the decline in output volatility in the Euro Area, investigating in particular the inventory management hypothesis. Whereas the hypothesis that better inventory management techniques brought about by computerization has been widely investigated as an

[1] Malgarini (2008) has used Business Survey data in an analysis of the reduction in volatility in Italy, but he does not consider other European countries, and does not investigate whether advances in inventory management techniques are responsible for the decline in volatility.

explanation for the Great Moderation in the US[2], few attempts have been made in this direction for Europe, essentially due to lack of reliable data on inventory stocks. To this end, we attempt to determine whether the decline in the volatility of Euro Area economic activity can be attributed mainly to an endogenous change in the persistence of shocks to the accumulation dynamics of inventory movements, or rather to a change in the shocks hitting the inventory optimisation process, such as, sales, interpreting the latter as exogenous. Rather than undertaking a search for the best empirical model of the inventory accumulation process, we use a standard specification based on an AR process also used by Stock and Watson (2005), allowing for a discrete break in 1984, in order to evaluate changes in inventory accumulation over time.

The results indicate that the inventory accumulation process at the European level, excluding the case of Italy, did not experience a break in 1984. Rather, the impact of external, exogenous shocks seems to have been declining over time, starting in the mid eighties, which has caused a decline in the volatility of the inventory accumulation process. In sum, it appears that inventories did not play a major role in causing the Great Moderation in Europe. Rather, the decline in the volatility of the inventory accumulation process seems to be due a decline in the volatility of exogenous shocks due to other forces, such as better monetary policy, "Good Luck", or changes in the role of financial markets.

The paper is structured as follows: Section 2 reports business cycle characteristics for Industrial Production for the Euro Area. Section 3 describes the data set and reports the main stylized facts for key series in the Business Tendency Surveys. Section 4 explores the possible role of inventory accumulation in explaining the Great Moderation using the Business Tendency Survey data. Section 5 concludes.

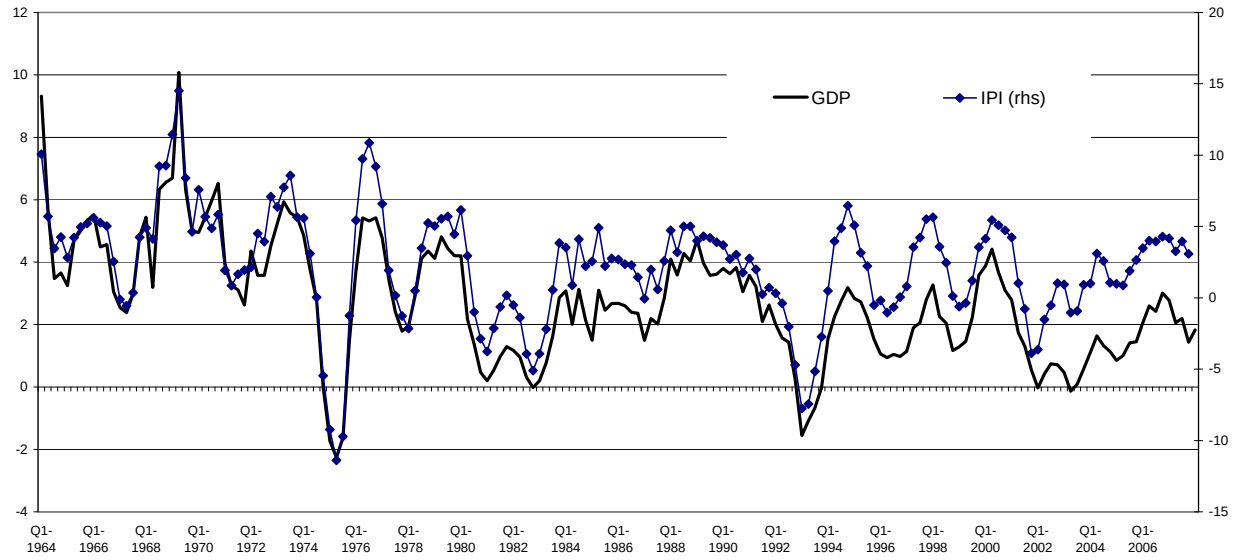
2. Stylised Facts about the Euro Area Business Cycle

2.1 Data Description

The data analysed cover the period 1963:1 – 2008:1 and were obtained from OECD statistical data base. For the real economy we use monthly seasonally adjusted values of the logarithm of the Industrial Production Index (IPI) for the United States, the United Kingdom, the three main Euro area countries (France, Germany and Italy), and a Euro Core indicator built by aggregating data from France, Germany and Italy[3]. The data set also includes cyclical indicators drawn from qualitative surveys such as those on inventories, current production and production expectations in European countries. All the data are available on monthly bases. Cyclical economic activity is generally measured in terms of GDP; however, the agriculture and service sectors do not usually display a well defined cyclical pattern[4] (see A'Hearn and Woitek, 2001), and are expected to hold far less inventory than industry. Moreover, GDP and industrial production growth rates are highly correlated. For the Euro Core, the contemporaneous correlation coefficient is equal to .9, and as Figure 1 indicates the cyclical patterns in the two series are very similar. Focusing on Industrial Production is also of interest because the business cycle characteristics of Industrial Production have not received much attention in the literature. For these reasons, in this paper we choose to concentrate the analysis on the industrial sector instead of on total GDP.

[2] For investigations of whether advances in inventory management techniques are responsible for the Great Moderation in the US, see Ahmed, Levin and Wilson (2004), Blanchard and Simon (2001), and Stock and Watson (2003) for VAR approaches, Maccini and Pagan (2009) for a partial equilibrium model approach, and Kahn, McConnell and Perez Quiros (2002), Khan and Thomas (2007), and Iacoviello, Schiantarelli and Schuh (2007) for general equilibrium model approaches.
[3] The three countries represent roughly 70% of the Euro Area total value added and the correlation between Euro Core and Euro Area industrial production is equal to .99.
[4] In the case of agriculture, cyclical fluctuations are mainly determined by environmental factors.

Figure 1--GDP and Industrial Production Growth: Euro Core



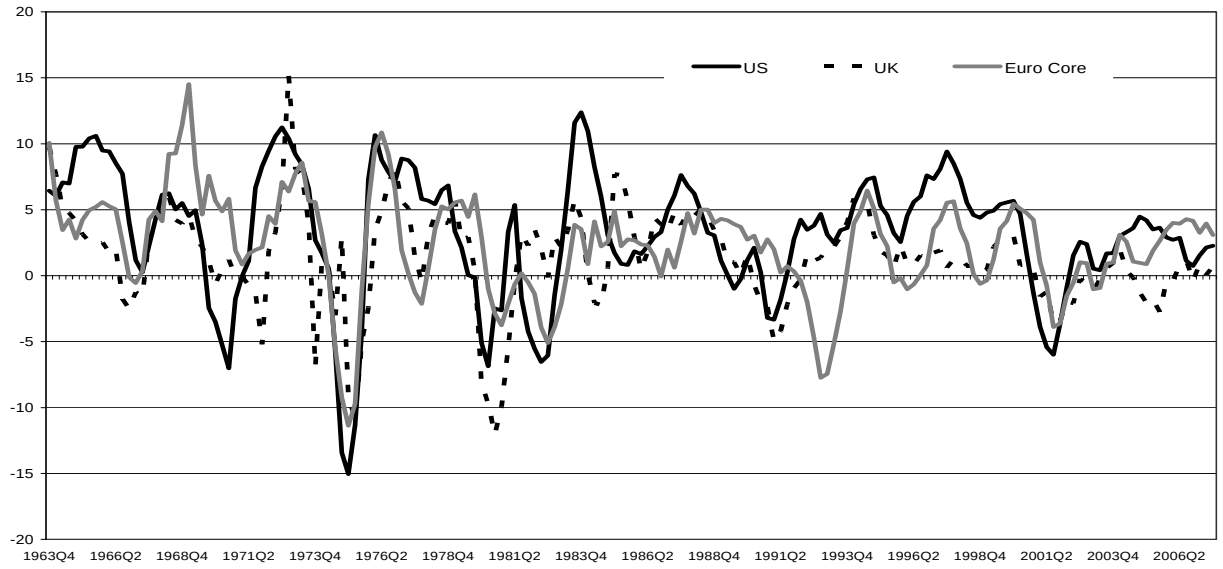
The Euro core, the UK and the US. Figure 2 shows the yearly growth rates for Industrial Production for the US, the Euro Core countries taken as a whole, and the UK. The average yearly growth industrial activity is higher in the US (3.3%) than in the Euro Core (2.8%) and the UK (2.5%). Similarly to what Agresti and Mojon (2001) have already found when looking at GDP data, the timing of cyclical patterns also seems to be quite close: in all the countries considered, industrial activity lapse into a deep recession after the first oil shock, followed by a recovery and a "double dip" at the beginning of the eighties. The subsequent recovery appears to be steeper in the US than in Europe.

Another important divergence emerges in the early nineties, when a recession took place in the US and the UK in 1991-92, but not in Europe, among other things because of the fiscal stimulus following German reunification. On the other hand, a recession occurred in Europe in 1992-93, but not the US and UK, due to the financial crisis that occurred in Europe that arose primarily from the failure of the exchange rate agreement. In the first half of the last decade, IPI growth was higher in the US than in Europe. However, European growth was catching up with that of the US in the last years of the sample, as a result of both a slowdown in the US and the resilience of growth in Europe. Over the entire period, US activity seems to be leading with respect to European fluctuations. On average, the volatility of business cycles seems to be higher in the US than in Europe, although it seems to slow down in all the countries towards the end of the sample.

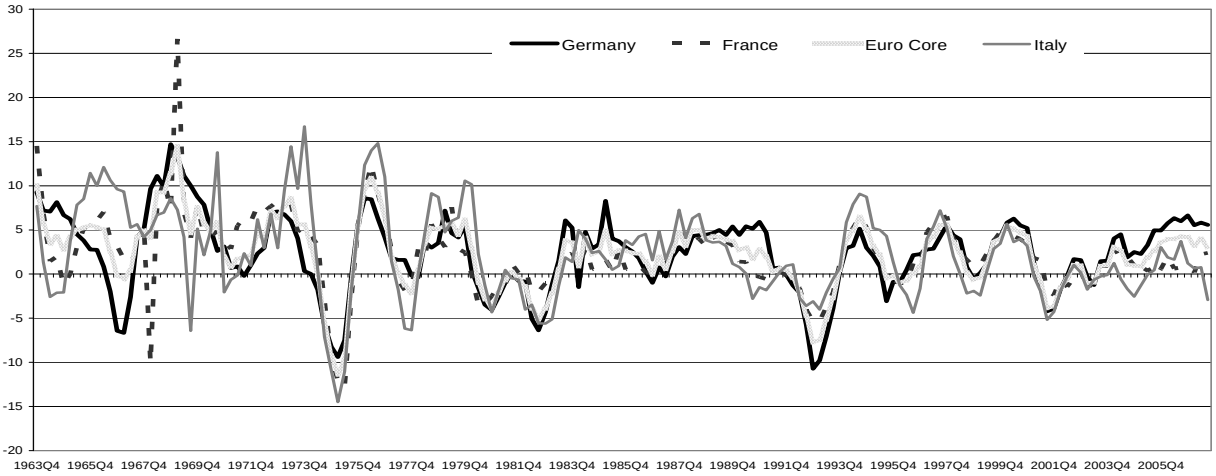
Euro Core countries. Figure 2 also displays the same analysis conducted on the three countries of the Euro Core. Industrial Production growth rates are on average remarkably similar among the three countries (2.2% in Germany, 2.4 % in France 2.2% in Italy). France shows a highly distinctive growth episode at the end of the sixties, which resulted from the political turmoil associated with the "French May" in 1968, when a wave of strikes hit the French economy and gave rise to severe contraction of Industrial Production in 1968:2, followed by a large "rebound" in the following year. Germany is also characterised by a country-specific cyclical episode at the beginning of the nineties, when as a result of the policy stimulus following reunification, the economy grew at a faster pace than in the rest of Europe. Italy instead exhibits a different cyclical pattern towards the end of the sample, with stagnation of Industrial activity which began at the end of 2000 and continued for more than 3 years thereafter, which contrasts with (moderate) growth registered in the rest of the Euro core. Cyclical patterns, however, seem largely consistent among the three countries considered. On average, the volatility of business cycles also seems to be quite similar in the three countries (without considering the sharp cyclical episode in France during the sixties). Finally, in this case too, towards the end of the sample volatility appears to slow down in all the countries considered in the analysis.

Figure 2 -- Industrial Production Growth

Euro Core, UK and US



Euro Core Countries (IT, FR, DE)



2.2 Main Business Cycle Characteristics

In order to gain a better understanding of the business cycles characteristics on the two sides of the Atlantic, we calculated the business cycle reference dates. To do so, we used the methodology proposed by Harding and Pagan, (2002). The dating algorithm is based on the “classical” business cycle definition and considers the (log) levels of Industrial Production, for which business cycle characteristics have not previously been reported. For each country, Table 1 provides various business cycles statistics, including the average duration of complete cycles, the periods of expansions and contractions, their amplitude and steepness (i.e. the amplitude divided by the duration). It also reports a measure of asymmetry of the fluctuations – the excess of cumulated movements (E) – which shows the deviation of the economy from a

constant expansion/contraction. A value of E close to zero indicates that the cyclical fluctuation is (almost) linear in its behaviour: during an expansion, a negative sign implies non linear behaviour, with a progressive intensification of gains (concave expansions), while a positive sign instead indicates a convex expansion, with a slowing down of output gains towards the end of the fluctuation. On the other hand, during a recession, a positive sign of E is interpreted as indicating a "convex recession", where output losses are particularly intense at the beginning of the fluctuation. Conversely, a negative sign is an indicator of a "concave recession", where losses are particularly intense towards the end of the fluctuation. Furthermore, turning points for each series are reported in the appendix.

The Euro core, the UK and the US. First we compare the main cyclical features for the aggregate Euro Core, the UK and the US. Duration of cycles is higher in the US than in the Euro Core and the UK; in particular, the duration of expansionary phases is much longer in the US than in Europe. What most distinguishes the Euro Core from the two English-speaking countries, however, is the amplitude and the steepness of the fluctuations, which are much lower in the Euro Core during both recessions and expansions. As a consequence, also the cumulative gains/losses are higher in the US and the UK than in the Euro Core. Finally, measures of excess expansion/recessions show that during contractions the shape of the fluctuations is slightly convex indicating somewhat more intense output losses at the beginning of slumps for all the areas considered. On the other hand, during expansions, strong evidence emerges of "concave" fluctuations, with a progressive intensification of output gains towards the end of the fluctuation.

Table 1-- Business Cycle Characteristics: Euro Core, UK and US

	US	UK	Euro Core	Germany	France	Italy
Number of cycles (peak to peak)	7.00	11.00	11.00	9.00	8.00	15.00
Number of cycles (trough to trough)	7.00	10.00	11.00	9.00	8.00	14.00
Average Duration - peak to peak	19.14	15.00	13.73	16.44	19.13	11.40
Average Duration - trough to trough	19.71	15.60	13 73	16.11	18.50	11.57
Average Duration - Recessions	4.25	4.64	3.67	4.80	5.67	4.33
Average Duration - Expansions	15.14	10.36	9.91	11.33	13.00	7.07
Amplitude - Recessions	-6.69	-5.15	-3.57	-5.35	-5.07	-4.79
Amplitude - Expansions	21.90	9.33	10.87	13.57	15.43	11.38
Steepness - Recessions	-1.57	-1.11	-0.97	-1.11	-0.89	-1.11
Steepness - Expansions	1.45	0.90	1.10	1.20	1.19	1.61
Triangle Approximation - Recessions	-14.21	-11.95	-6.55	-12.83	-14.37	-10.38
Triangle Approximation - Expansions	165.82	48.33	53.84	76.88	100.30	40.22
Excess - Recessions	1.77	1.47	0.81	1.56	1.64	1.29
Excess - Expansions	-9.50	-3.76	-4.34	-5.59	-6.53	-4.08

Euro Core countries. Turning to Euro Core countries, Germany and especially Italy exhibit a lower average duration of expansions and recessions. In the case of Italy, this is mainly due to short fluctuations towards the end of the sample. This finding is at odds with previous studies on the Italian manufacturing sector, according to which the Italian economy entered a long phase of stagnation after a peak at the end of 2000. Accordingly, the trough identified by the Harding-Pagan procedure at the end of 2001 (followed by new peaks and troughs quite close to each other in 2002-2005) may be interpreted as merely a "false start" and not as a proper cyclical fluctuation. If this is the case, the number of fluctuations for Italy is closer to what has been found for the other two countries of the Euro core. As for the amplitude and the cumulative gains of expansionary phases, these are larger in France with respect to Germany and Italy. Recessions are generally mildly convex, meaning that they are quite close to the linear approximation representation, with output losses that are generally slightly larger at the beginning of the fluctuation. Expansions are also convex, which indicates that also output gains are larger at the beginning of the fluctuation.

2.3 Volatility

Diminished business cycle volatility has been widely documented for the US. In what follows, we try to determine whether this is also a characteristic of Industrial Production for the Euro zone. More specifically, we investigate whether the volatility reduction can be attributed to the existence of structural breaks in the Data Generating Process (McConnell and Perez-Quiros, 2000) or to a long trend decline (Blanchard and Simon, 2001). In order to inspect the first hypothesis, table 2 reports standard deviations of the cyclical component for Industrial Production, in absolute terms and relative to the US over the period 1965-2006. Since our goal is to analyze changes in the economic fluctuations, we extracted the cyclical components of the data with a Band-Pass filter; more specifically, following Stock and Watson (2005), we employed the Baxter-King filter, with eight leads/lags and a pass-band of 6-32 quarters.[5] As in Kim and Nelson (1999), we also split the sample considering a break in 1984. Each sub-period standard deviation is then reported relative to the full sample, so that a value less than one indicates a period of relatively low volatility. Considering the whole period, volatility is lower in Europe than in the US; within the Euro Core, volatility is higher in Italy than in Germany and France. Moreover, in all the countries considered Industrial Production is much less volatile in the second part of the sample: volatility reduction is a widespread phenomenon involving both the English-speaking countries and those of the Euro Core.

Table 2 -- Volatility of Industrial Production, 1965-2006

	Standard deviation absolute term 1965:1 – 2006:1	Standard deviation Relative to US	Standard deviation Relative to 1965-2006	
		1965:1-2006:1	1965:1-1983:4	1984:1-2006:1
Euro Core	2.12	0.82	1.25	0.72
Germany	2.27	0.88	1.22	0.77
France	2.09	0.81	1.30	0.64
Italy	2.75	1.06	1.31	0.62
United Kingdom	1.91	0.74	1.34	0.56
United States	2.58	1.00	1.32	0.61

We then investigate the second hypothesis of a long-term trend decline by calculating the rolling standard deviations for Industrial Production. In this regard, figure 3 reports rolling standard deviations of the cyclical components extracted with the band pass filter for both the Euro core, the UK, the US, and the Euro core countries considered separately. For each geographical area, we analysed the volatility using a window of five years (as in Blanchard and Simon, 2001).

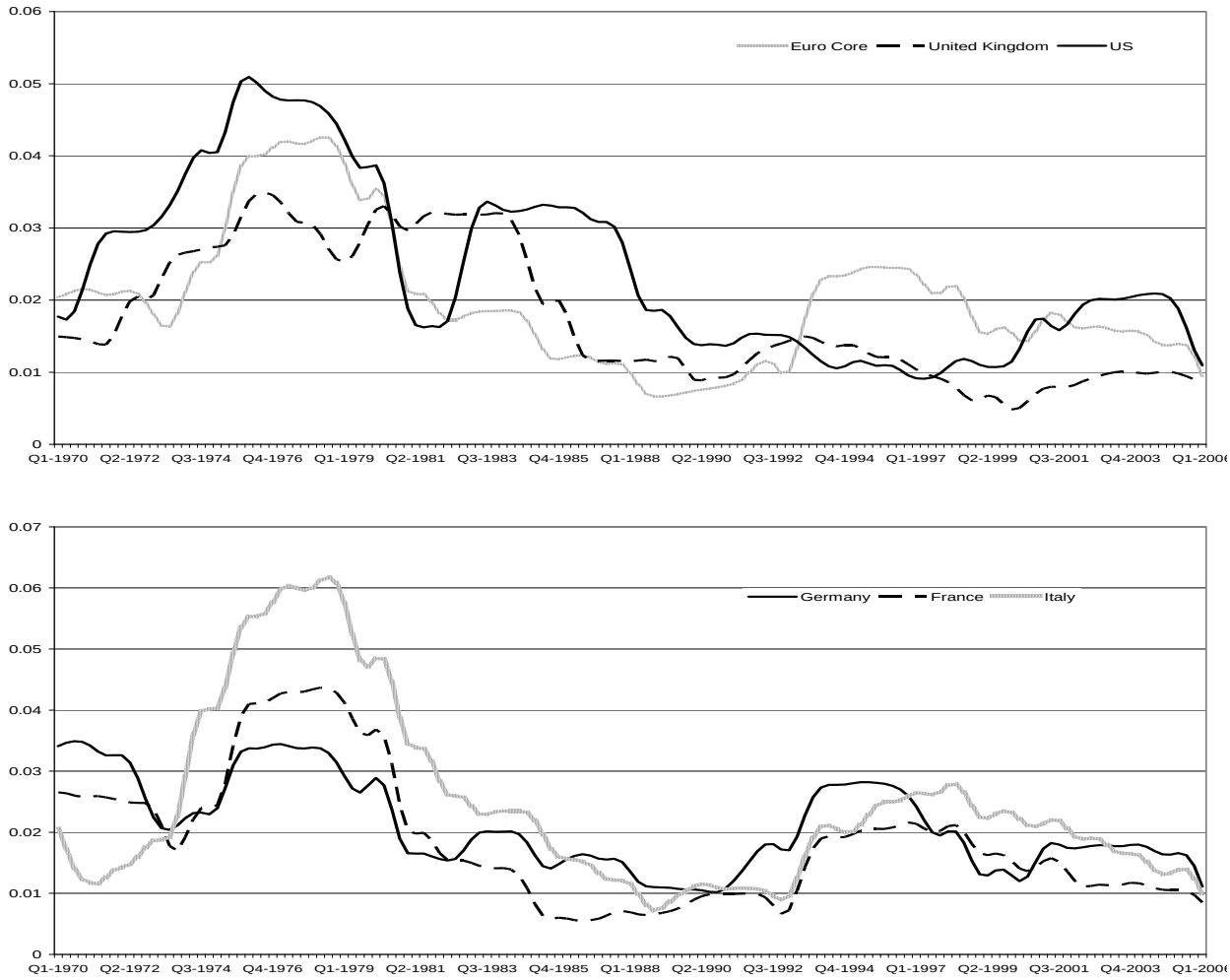
The Euro Core, the UK and the US. Standard deviation started declining in the mid-seventies in all the areas considered, eventually picking again in the US at the beginning of the eighties. However, volatility decreased again after 1983, and more sharply in 1985, reaching its lowest levels at the end of the decade. Some signs of resilience appeared in Europe at the beginning of the nineties, probably linked to the instability following the German reunification and the crisis of the European exchange rates agreements in the fall of 1992. Volatility starts however to decline again in the mid-nineties, stabilising at its lowest level of the last 40 years towards the end of the sample. All in all, the Euro Core seems to have been characterised by a significant rise in volatility at the beginning of the nineties, which eventually disappeared towards the end of the decade.

Euro Core countries. A possible explanation for the peculiar behaviour of business cycle volatility in Europe during the nineties is furnished by national data. In fact, after a decline in all the countries

[5] We also experimented with an HP filter with similar results.

considered in the period 1969-1992, volatility picked up in Germany (with possibly a break in the Data Generating Process) in the period 1992-1998, probably because of the shock associated with the reunification process. Indeed, the standard deviation started to fall again from 1999 onwards, reaching its lowest levels at the end of the sample, with values almost 1/3 of those of the mid-seventies. Finally, among the countries considered, Italy exhibits the most marked decline, which is possibly explained by some of the considerations already advanced about the "catching up" of Italian economy in the first part of the sample and its prolonged stagnation during the last decade.

Figure 3 – Rolling Standard Deviations



On the basis of the above statistical evidence, it is therefore not possible to discriminate clearly between the two different representations of the observed decline in volatility, i.e. those alternatively associated with a structural break occurring somewhere in the mid-eighties or with a change in the slope of the volatility trend. Consequently, to shed light on this issue, we decided to take a step forward by investigating the economic determinants of the Great Moderation. In fact, different explanations have been advanced in the literature as to the causes of volatility decline, alternatively linking it to changes in policy regimes, or "good luck", or structural breaks stemming from technological innovation regarding inventory management.

These potential explanations can be empirically tested using consistent data on Industrial Production, sales and stocks of finished goods inventories for the manufacturing sector. These data are available for the US, and they have been used by various authors to test the hypothesis that inventory accumulation plays a prominent role in shaping the main features of business cycles. However, although European official statistical institutes disseminate data on Industrial Production and – to some extent – sales, they do not do

so on inventory stocks. In fact, inventory investment data are available from national accounts. However, they are not derived from direct measurements from firms, but rather are calculated as a residual. Moreover, in the Eurostat (1999) definition they also include "acquisitions less disposal of valuables and of non-produced, non-financial assets". In short, the inventory data that are available in Europe are inventory accumulation or inventory investment data, not inventory stock data. But, inventory stock data are needed to investigate hypotheses regarding the role inventory management techniques have played in the Great Moderation. Consequently, no official quantitative inventory data are available in Europe with which to assess the contribution of inventory behaviour to business cycles movements. We thus use the qualitative information on inventories stemming from Business Tendency Surveys (BTS from now on) harmonised at the European level from the European Commission.

3. Cyclical Indicators—Business Tendency Surveys

Since the early sixties, the European Commission has used a harmonised system of monthly business surveys—referred to as Business Tendency Surveys--to track the cyclical fluctuations of the industrial sector in real time.[6] These surveys, which began in 1962, initially covered the larger member states and were then gradually extended to all the countries participating in the Union. Today, such surveys are autonomously conducted by partner institutes in each country on the basis of a harmonised questionnaire. The questions are qualitative, in the sense that firms are not asked to provide quantitative information on the phenomena of interest but instead to assess them "qualitatively" on a given variable. For instance, a question on the current level of production does not ask firms to indicate the amount or the value of production but to report whether it has "gone up", "stayed the same" or "gone down" with respect to the previous month. In this sense, qualitative data are a somewhat less precise measure of a given phenomena. However, they are particularly valuable in business cycle analysis both because they are timely and because they provide unique information about certain variables, such as firms' assessments of expected production and orders, and information on other variables, such as inventory stocks, which for Europe are not measured by standard quantitative statistics.

Questions usually allow three possible answers arranged on a Linkert scale. Firm-level data are then processed in terms of sample averages of survey answers, e.g. by calculating the percentages of replies that production has "gone up", "stayed the same" or "gone down". As a synthetic measure, for each question (q), the balance (B) of the replies is usually calculated as the difference between the percentages of positive (P) and negative (N) replies:

$$(1) \qquad B_q = P_q - N_q$$

The questionnaire asks, amongst other things, for information on present and expected levels of production and orders, and on inventories of finished goods. In particular, firms are asked to indicate whether inventories are above or below "normal" levels generally interpreted as the desired amounts of stocks. In what follows, we assess the degree of correlation of survey data with the industrial cycle, and we look more closely at survey data volatility, concentrating in particular on inventories volatility and its relationship with industrial activity fluctuations.

In this section of the paper, we report basic stylized facts regarding several key series, including current production assessments, expected production, inventories and orders, from the Business Tendency Surveys. We also relate these series to the cyclical characteristics of Industrial production.

3.1 Correlation with Industrial Activity

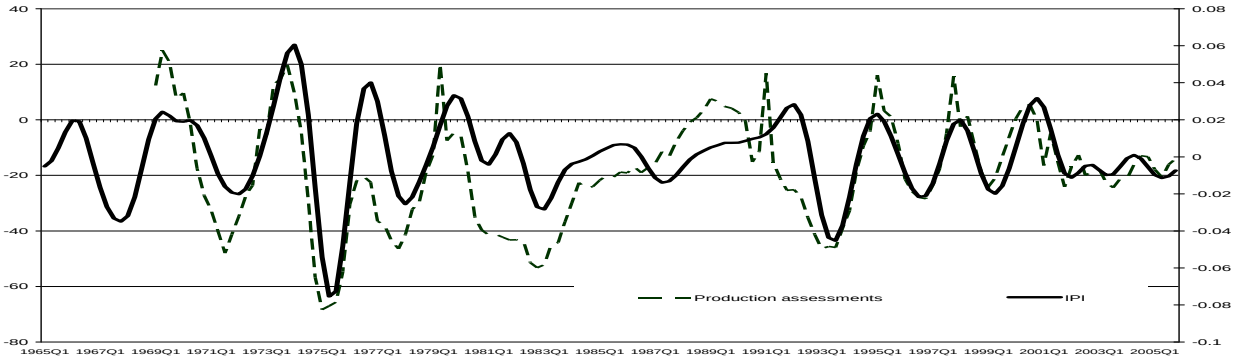
Business survey data are generally considered to be strongly correlated with economic activity, and as such they are widely used in Europe to evaluate business cycle evolution over time, especially for the industrial sector. In this respect, figure 4 compares the cyclical behaviour of Industrial Production with that of current production assessments derived from European Business Tendency Surveys in Italy, France, Germany and in the Euro Core. The Euro Core indicator is, as always, obtained by combining the balances on production assessments in Italy, France and Germany using value added shares as weights.

[6] See European Commission, 2002.

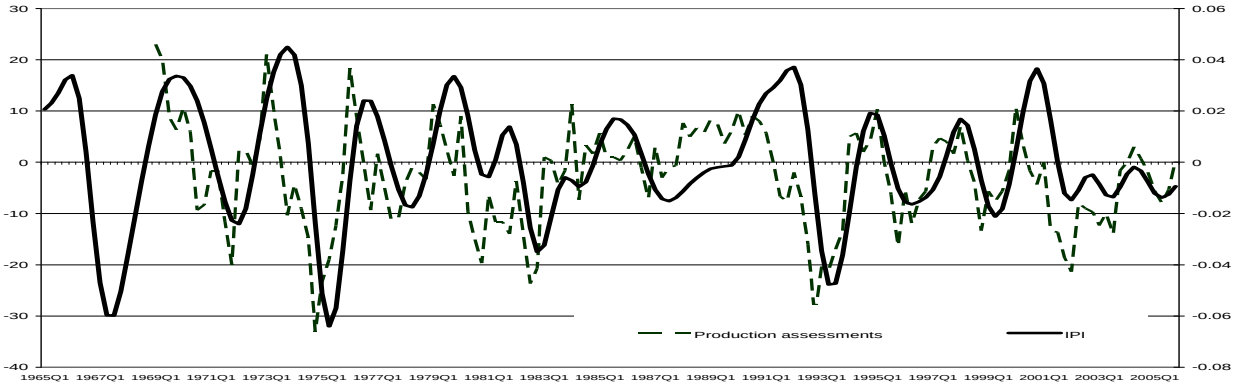
Firm assessments of current production levels and actual Industrial Production show a strong correlation throughout the sample, both for the Euro Core aggregate and for individual European countries. This finding is crucial for our analysis: if survey data are really able to match the real economy evolution, we can use them to investigate the “inventory hypothesis” as an explanation of the Great Moderation of European countries.

Figure 4 - Industrial Production and Current Production Assessments

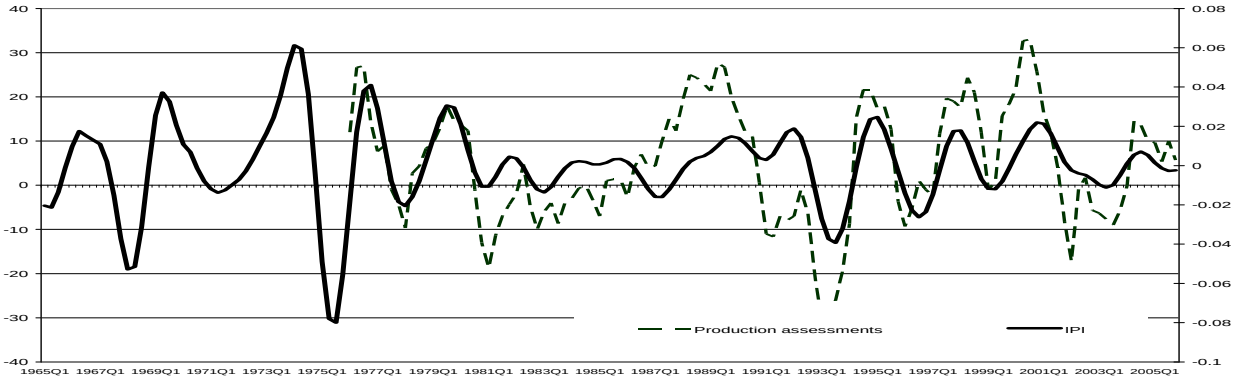
Euro Core



Germany



France



Italy

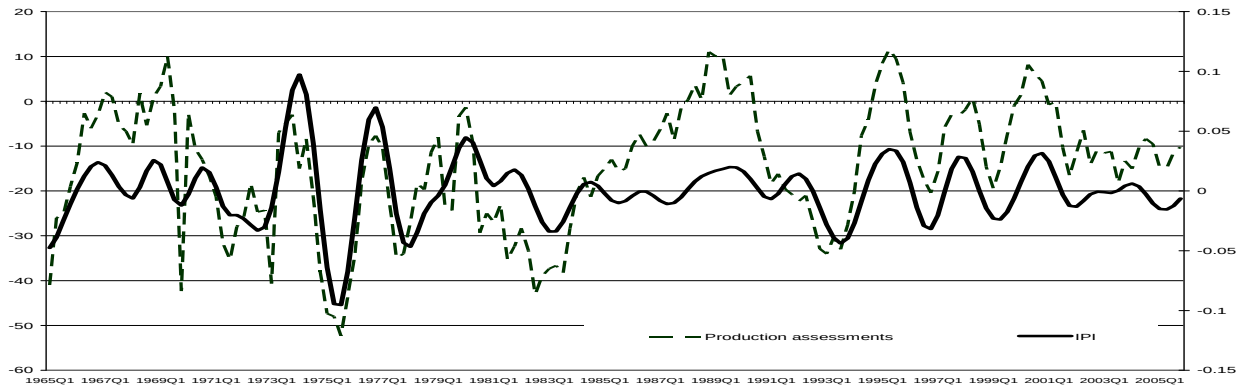
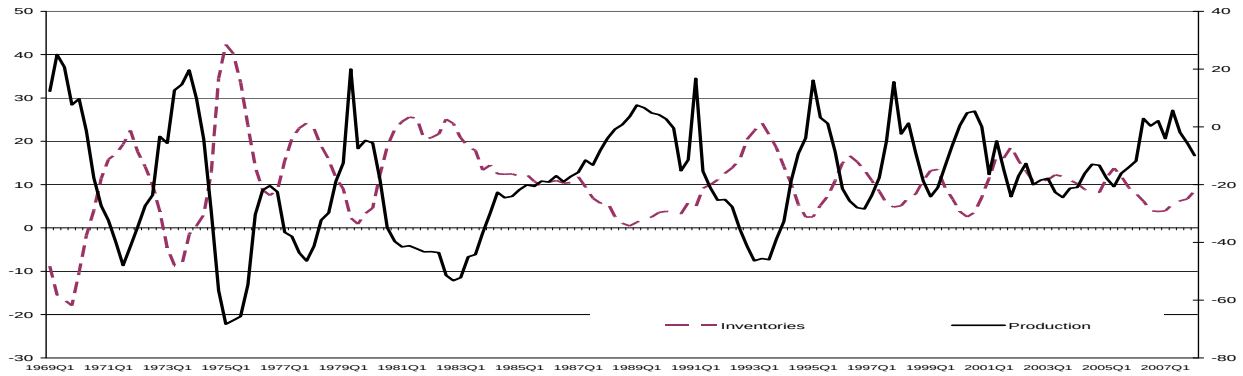


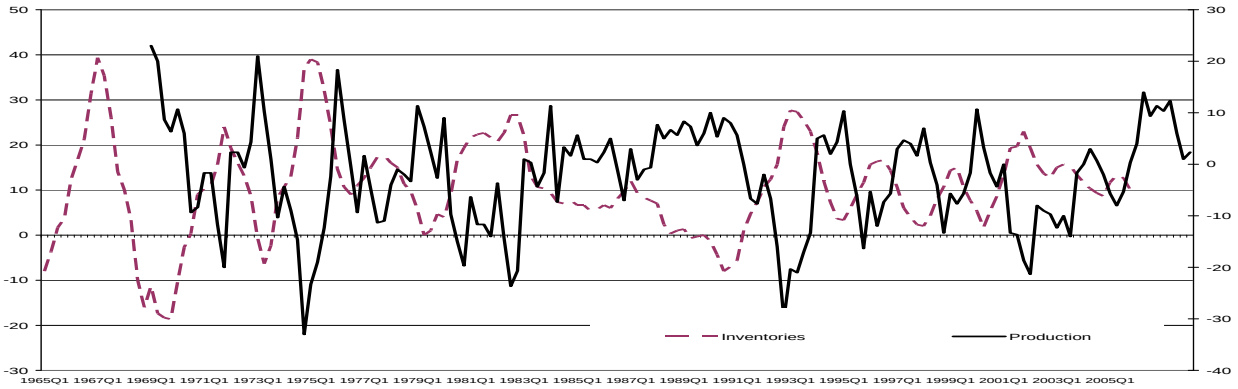
Figure 5 separately reports the balance for the inventory question and those referred to as current production assessments. Inventories balances are usually positive, a somewhat unexpected result given that one would expect inventories to be “normal” in the long run. Correlation of inventory movements with those of production assessments (which we have just shown to be strongly correlated with actual industrial activity) is quite high, albeit negative. That is, inventories move counter-cyclically, a finding in contrast with most studies in the literature but which can be explained by considering the exact nature of the question on inventory accumulation: in fact (see also on this section 4 below) the survey questionnaire asks whether the current level of inventories is above, equal or below a “normal” level, usually interpreted as the desired level of stocks. When production is rising, inventories may fall if sales turn out to be unexpectedly high, which may happen when the economy is in a boom, or vice versa when the economy is in a slump.

Figure 5 – Inventories and Current Production Assessments

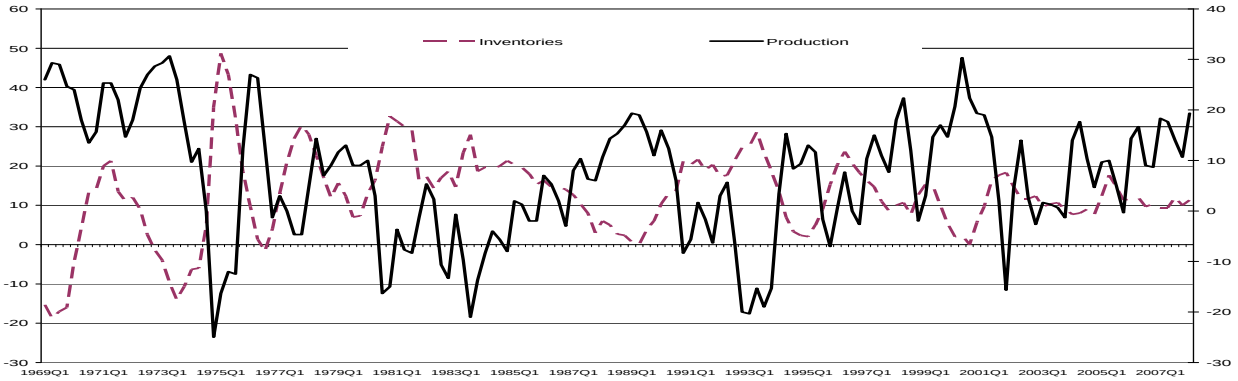
Euro Core



Germany



France



Italy

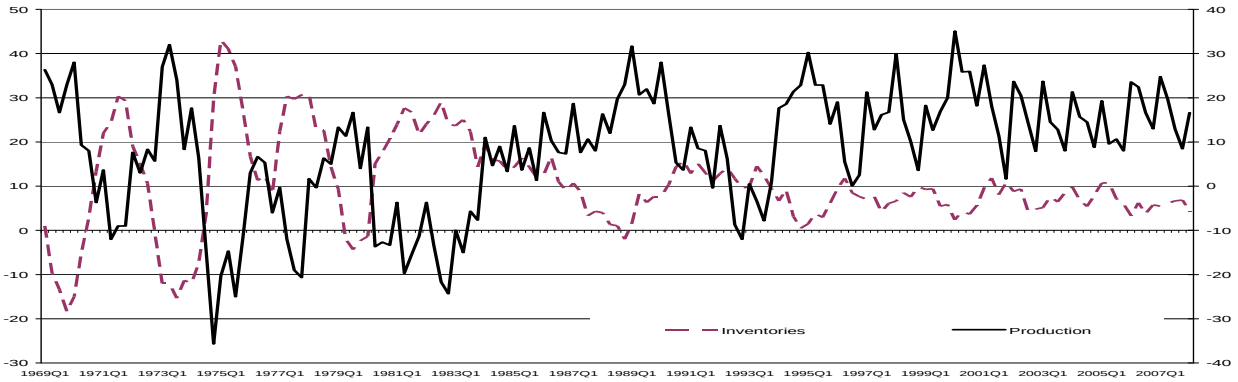


Table 3 reports cross correlations among survey data and (the cyclical component of) Industrial Production. Besides data on firms' assessments concerning current production and inventories, here we also consider assessments on the current level of orders and expectations about future production trends.[7] Cross correlations among Industrial Production and assessments on current orders, production and inventories generally peak at a lead of one period : for example, the cross correlation function among

[7] The European Commission provides a "Confidence Indicator" for the Industrial Sector using the balances on the expected level of production and the assessments on the current level of orders and inventories. The choice of the series is based on considerations concerning the potential leading characteristics of the data and their performance in tracking industrial cyclical activity. See on this European Commission, 2002.

current orders and Industrial Production in the Euro Core reaches a peak at lead of one period with a coefficient equal to 0.72, indicating that current orders derived from Business Tendency Surveys in the Euro Core as a whole lead actual Industrial Production by one quarter[8]. Correlation coefficients are generally rather high for the Euro Core, being above .7 in absolute terms for assessments on current production and inventories as well as on current orders and slightly below that threshold for expected production, which has a two period lead over industrial production. Correlations are generally a bit lower for all series for the individual countries. Inventories are confirmed to be counter-cyclical, a result already obtained by previous studies for the Italian economy (Cesaroni, 2007 and Malgarini, 2008). Overall, the results show that survey data are closely correlated with the cyclical behaviour of Industrial Production. The existence of common cyclical components among survey data and Industrial Production for Italy has, in fact, already been found

Table 3 -- Cross Correlations between Business Survey Data and Industrial Production, 1965-2006

					Current orders (t-k)				
	k	-4	-3	-2	-1	0	1	2	3	4
Germany		0.30	0.50	0.67	0.74	0.70	0.53	0.28	-0.02	-0.29
France		0.19	0.34	0.49	0.57	0.55	0.42	0.19	-0.06	-0.30
Italy		0.17	0.40	0.59	0.66	0.60	0.38	0.10	-0.18	-0.39
Euro core		0.21	0.45	0.63	0.72	0.66	0.47	0.19	-0.12	-0.37
					Current production (t-k)				
	k	-4	-3	-2	-1	0	1	2	3	4
Germany		0.44	0.61	0.69	0.64	0.44	0.12	-0.21	-0.46	-0.59
France		0.14	0.35	0.55	0.67	0.63	0.45	0.17	-0.13	-0.40
Italy		0.00	0.20	0.42	0.58	0.60	0.45	0.20	-0.08	-0.30
Euro core		0.17	0.42	0.63	0.73	0.68	0.48	0.20	-0.10	-0.34
					Expected production (t-k)				
	k	-4	-3	-2	-1	0	1	2	3	4
Germany		0.50	0.63	0.67	0.58	0.36	0.04	-0.28	-0.52	-0.63
France		0.31	0.49	0.58	0.53	0.36	0.10	-0.16	-0.36	-0.44
Italy		0.25	0.43	0.53	0.51	0.39	0.15	-0.09	-0.30	-0.40
Euro core		0.43	0.59	0.66	0.59	0.38	0.08	-0.22	-0.46	-0.57
					Inventories (t-k)				
	k	-4	-3	-2	-1	0	1	2	3	4
Germany		-0.41	-0.61	-0.75	-0.77	-0.66	-0.43	-0.12	0.20	0.45
France		-0.12	-0.42	-0.65	-0.74	-0.63	-0.36	-0.01	0.32	0.54
Italy		-0.16	-0.40	-0.57	-0.62	-0.53	-0.31	-0.04	0.21	0.38
Euro core		-0.26	-0.51	-0.70	-0.76	-0.65	-0.41	-0.08	0.24	0.49

[8] Questions on current orders and production refer to the level in the month at which the interview is performed with respect to the recent past; in this sense, it is possible that the opinion on the current level of activity anticipates the actual performance. Moreover, it should be considered that the data are available on a monthly basis, while the analysis presented here is based on quarterly data: in this sense, it is possible that frequency conversion affects the result, enhancing the leading properties of the survey indicators.

using spectral methods (see Cesaroni, 2007). Hence, a careful study of volatility of survey data may yield interesting insights into the role of inventories in the Great Moderation.

3.2 Volatility of Business Survey Data

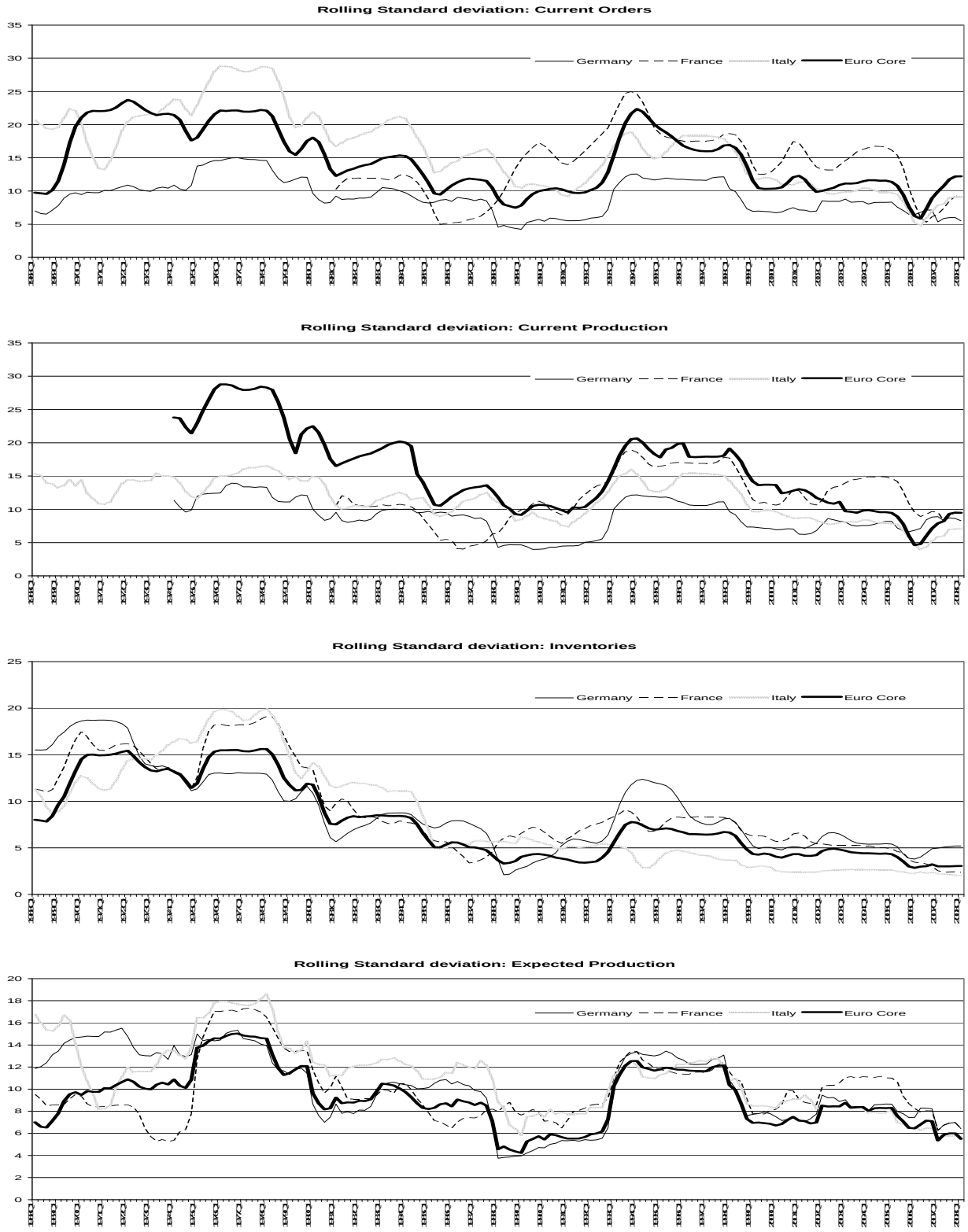
In the previous section we found that survey data are strongly correlated with industrial activity and that survey-based information on inventory accumulation moves counter-cyclically. Table 4 analyses the volatility of qualitative survey data, again splitting the sample into two sub-periods with a break in 1984. Volatility reduction is also evident in such data. For all the series concerning Euro Core taken as a whole, volatility is lower in the second part of the sample. The same results are also found looking at the data for each country, the only exception being current assessments of production and orders in France – for which, however, the sample starts at a later date (January and March 1976 respectively).

Table 4 – Volatility of Business Survey Data

	Current Orders			**Current Production**		
	Standard deviation 1963-2008	Standard deviation relative to 1963-2006 1963-1983	1984-2008	Standard deviation 1963-2008	Standard deviation relative to 1963-2006 1963-1983	1984-2008
Euro Core	17.35	1.13	0.82	19.26	1.26	0.70
Germany	19.13	1.15	0.83	9.93	1.16	0.88
France	16.66	0.67	1.04	13.17	0.87	1.04
Italy	19.48	1.23	0.66	14.15	1.10	0.75
	Production Expectations			**Inventories**		
	Standard deviation 1963-2008	Standard deviation relative to 1963-2006 1963-1983	1984-2008	Standard deviation 1963-2008	Standard deviation relative to 1963-2006 1963-1983	1984-2008
Euro Core	10.47	1.18	0.79	9.24	1.34	0.54
Germany	11.22	1.21	0.78	10.69	1.28	0.67
France	12.58	1.15	0.64	10.88	1.33	0.59
Italy	14.05	1.10	0.64	10.73	1.37	0.39

Fig. 6 provides the usual analysis of the evolution of volatility over time, computing rolling standard deviations on a window of five years. In this case too, the results obtained on survey data confirm those already derived by looking at variables more commonly used to measure cyclical fluctuations. For all the series considered, volatility decreased in the eighties, picked up again during the nineties and then fell in the last decade. Volatility reduction is stronger for inventories, and as a result the standard deviation of inventory assessments is clearly at its lowest level in the last part of the sample for all the countries and for the Euro Core taken as a whole. The latter result may suggest that inventories have played a significant role in explaining the Great Moderation: the hypothesis is that the so-called ICT revolution may have implied a better capacity for the firms to change production levels in response to shocks on final demand, resulting in a diminishing volatility of inventory accumulation (McConnel and Perez Quiros, 2000). In order to test this hypothesis, in the next section we investigate whether the fall in inventory volatility may be attributed to a change in the inventory accumulation process or to a change in the variance of the shocks. Moreover, we also investigate whether changes in inventory volatility are linked to a structural break in the series or to a long trend decline.

Figure 6 - Rolling Standard Deviations of Survey Data



4. Inventories

In the rest of the paper we concentrate on the hypothesis that a large part of the 'Great Moderation may have been due to changes in industrial organisation, involving in particular the use of information and communication technologies for inventory management. The so-called ICT revolution has brought more rapid and effective access to information. In turn, it may have helped firms change their production levels more quickly in response to external shocks. In other words, new technologies can be considered to have made it easier for firms to adjust production to demand, for example via shorter lead times in ordering or hiring decisions. A number of important consequences may ensue in this case. First, if firms are able to adjust production rapidly to market needs, the accumulation/decumulation of undesired stocks of finished products become less probable; as a consequence, the volatility of stocks should decline more than that of output. Moreover, if the technological shocks affecting inventory behaviour have a major effect on overall volatility reduction, one can also expect that reduction in inventories volatility will give rise to that observed for production.

According to the above findings, inventory volatility declined steadily in the period considered. However, it is not clear at this stage whether the reduction in inventory volatility may be simply a consequence of a reduced volatility of demand and industrial activity in general, or whether it should be considered an autonomous factor directly influencing (and not being influenced by) business cycle volatility. In fact, inventory balances indicate the extent to which – according to firms – inventories diverge from their "normal" levels. No further indication is given in the survey about the exact meaning of "normal" inventory levels. However, in 2006, ISAE, the Institute which carries out BTS in Italy, asked its sample of Italian firms to indicate whether a "normal" level of inventories could be interpreted as a level "adequate to the current needs of the firm". More than 95% of the sample responded in the affirmative to the question, confirming that the "normal" level can be interpreted as the "desired" level of stocks. Using respectively N_t and N^* to denote the current and desired level of stocks, we can therefore state that if $\frac{N_t}{N^*} > 1$ firms will report that inventories are above "normal"/desired levels, which implies that the balance of the inventory question will be greater than zero. In this sense, the balance of the question on inventory holdings can be interpreted as a qualitative measure of the divergence between the actual and desired level of stocks.

Accordingly, considering the simple identity among production, inventories and sales,[9] and assuming that the desired level of inventories will depend positively on the level of sales,[10] we have that the $\frac{N_t}{N^*}$ ratio will be higher, the higher is the level of current stocks and the lower the level of sales. In turn, the volatility of the above ratio (i.e., the volatility of the inventory balance) will depend upon:

- Volatility of sales: the more sales are volatile, the more the desired level of stocks is volatile.
- Ability of firms to adjust the desired level of stocks to the current level of sales: the more firms are able rapidly to adjust their production levels to the current level of sales, the less they need to adjust the current to the desired level of stocks, resulting in a decreasing volatility of the $\frac{N_t}{N^*}$ ratio.
- Ability of firms to adjust the actual to the desired level of stocks: the more firms are able to obtain the desired level of stocks, the less they need to "fine tune" the current to the desired level of inventories, resulting again in a decreasing volatility of the $\frac{N_t}{N^*}$ ratio.

Hence the observed lower volatility of the actual/desired inventory ratio may be due either to:

1) lower standard deviation of shocks hitting the inventory optimisation process (i.e. shocks pertaining mainly to the behaviour of sales)

[9] At time t, production (Y) equals sales (X) plus/minus accumulation/decumulation of stocks (N), i.e. $Y_t = X_t + \Delta N_t$

[10] For a discussion of the model, see Maccini and Pagan, 2009.

2) lower persistence of shocks in the inventory accumulation process.

In the latter case, we may interpret this change as first evidence of technological innovation affecting the choice of the optimal level of stocks and /or of the process of adjusting the actual to the desired level of stocks. In order to disentangle the two hypothesis, we can assume that the actual/desired inventory ratio (i.e. the BTS balance) follows an autoregressive process (AR) given by:

$$\frac{N_t}{N^*_t} = \beta + a(L)\frac{N_{t-i}}{N^*_{t-i}} + \varepsilon_t \qquad (2)$$

where a*(L)* is a polynomial in the lag operator *L,* ε_t is the error term of the regression and β Beta is a constant term taking into account the fact that on average the balance of the inventory question is greater than zero.

Following Stock and Watson (2005), we evaluate changes in the inventory accumulation process over time by estimating (2) and allowing for a discrete break at the beginning of 1984. A decrease in the sum of AR coefficients implies a decrease in the persistence of shocks on the deviation of inventory accumulation from the desired level; on the other hand, a decrease in the standard error of the regression (SER) implies a decrease in the magnitude of exogenous shocks hitting the process of inventory accumulation. The order of the autoregressive process was chosen so as to maximise the likelihood function, provided that residuals were well behaved according to the usual tests[11]. To check the stability of the results, we also use recursive methods estimating the recursive coefficients of AR parameters and standard errors. This second approach allows us to shed further light on the hypothesis of a structural break as an explanation of reduced volatility versus that of a long trend decline (Blanchard and Simon, 2001).

Table 5 presents the results assuming a structural break common to all the countries considered in the analysis. During the "Great Moderation", the persistence of shocks to the inventory accumulation process increased slightly with respect to the previous decades, so the inventory management hypothesis cannot be an explanation for the Great Moderation. On the other hand, innovations to the current/desired inventory ratio decreased substantially in all the countries considered. However, the Chow breakpoint test indicates that the decrease in the volatility of shocks can not be imputed to a particular point in time: in fact, the test is able to identify a statistically significant structural break in the mid-eighties only in the case of Italy. Figure 7 then shows the sum of recursive AR coefficients and recursive innovation standard errors for Italy, France, Germany and the Euro Core. The sum of autoregressive coefficients is fairly stable over time, confirming the result already obtained with standard OLS estimation. In the second panel, we have then calculated the Standard Error of a recursive regression on a window of five years for the period 1970-2007. For each country, the standard error of the regression displays a persistent decline over the last two decades, reaching quite low levels in the last decade. According to these findings, there is evidence that the decline in the standard error of the regression is mostly linked to a long term trend rather than to a specific break in the stochastic process.

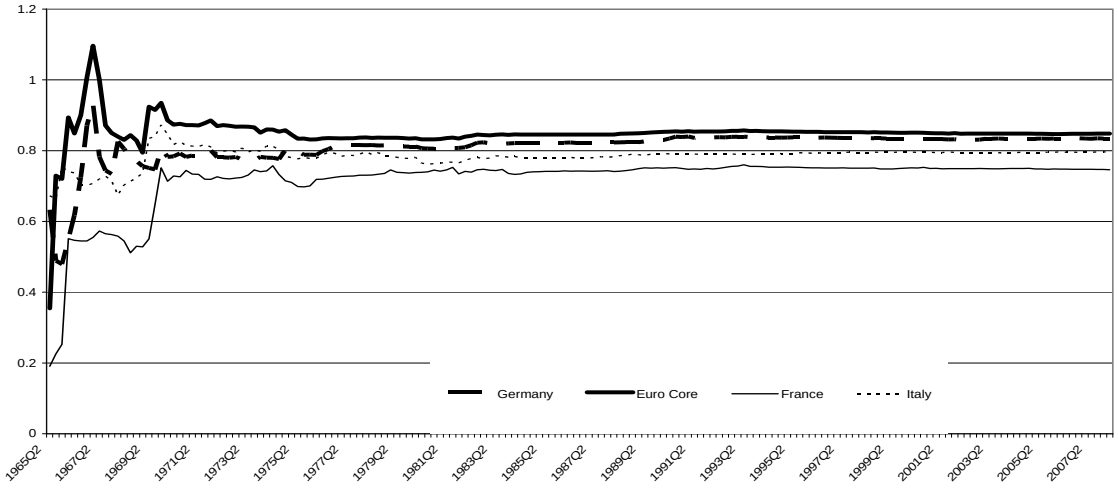
Table 5 – Autoregressive Parameters for the Current/Desired Inventory Ratio

	Sum of AR coefficients		SER		Stability test (Chow breakpoint test, p-value)
	1963-1983	1984-2008	1963-1983	1984-2008	
Euro Core	0.84	0.85	3.68	1.68	0.73
Germany	0.82	0.87	4.20	2.05	0.48
France	0.74	0.99	5.54	2.57	0.40
Italy	0.74	0.82	5.19	2.48	0.00

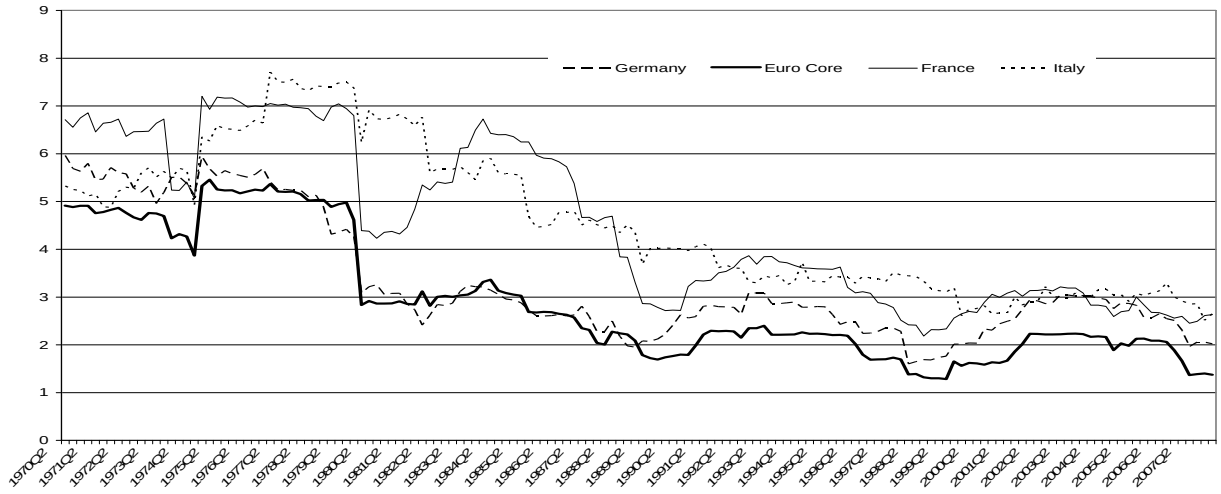
[11] The specification search resulted in the estimation of an AR(4) for Germany, an AR(3) for Italy and an AR(2) for France and the Euro Core .

Figure 7 – Recursive Least Square Analysis

Recursive Coefficients



Rolling Standard Error of the Recursive Regression



5. Conclusions

The analysis in the first part of the paper presents stylized facts on business cycles using for the first time Business Tendency Survey data as well as data on Industrial Production. The analysis confirms that fluctuations in Industrial Production have been on average longer, more ample and steeper in the US and the UK with respect to the main countries of the Euro Area (Germany, France and Italy). Nevertheless, the US, the UK, as well as the main countries of the Eurozone, all display a remarkable reduction of business cycle volatility from the mid-eighties onwards.

Most importantly, the presentation of the stylized facts for the Business Tendency Survey data reveal a number of interesting observations. First, current production assessments from the BTS data are highly correlated with Industrial Production for the sample period, so that the survey data are able to match movements for the industrial sectors of the Euro Core and for individual countries. This is important for subsequent empirical work with the BTS data. Second, inventory balances tend to move counter-cyclically with current production assessments. Third, rolling standard deviations of all the series in the BTS data reveal a decline in volatility in real activity since the mid-eighties.

The second part of the paper has been devoted to the investigation of one of the possible explanations for the Great Moderation, namely the explanation associated with better inventory management methods made possible by the use of more advanced technologies. This issue has been often addressed in the literature with reference to the US, but it has been seldom considered for Europe, mainly because of a lack of official and reliable data on inventory stocks. In this regard, our contribution has been that of introducing into this kind of literature the use of qualitative data drawn from Business Tendency Surveys harmonised at the European level by the European Commission.

In particular, a possible interpretation of BTS data on inventories is that they represent the divergence between the actual and the desired level of stocks. The latter is usually found to depend upon the level of sales and the technology used to adjust stocks to their desired level. Hence, the volatility of inventories is influenced by both exogenous and endogenous factors: the former are mainly linked to the volatility of sales, and therefore to factors that may influence volatility on the demand side of the economy; the latter are instead linked to technology used in the inventory accumulation process, including those which enable the better forecasting of sales (with the consequent adjustment of the desired level of stocks to that of sales) and the better adjustment of the actual to the desired level of stocks.

In this regard, our analysis has shown that there is no evidence of a break in the inventory accumulation process at the European level; rather, there is evidence that the impact of external, exogenous shocks has gradually declined over time, starting since the mid eighties. Consequently, our results do not support the view that inventories have played a role in explaining the Great Moderation in the Euro Area. Rather, an explanation for the Great Moderation in the Euro Area appears to lie with other forces, such as, better monetary policy, "Good Luck", or changes in the role of financial markets, an analysis of which is left for future work.

In summary, the main contribution of this paper is to demonstrate that the Business Tendency Survey data can be extremely useful both to present stylized facts on business cycle activity in the Euro area and to test interesting hypotheses, such as, whether inventory management advances were responsible for the Great Moderation. Further research is clearly advisable, making more thorough use of BTS data, including those on the expectations of economic agents concerning such key variables as orders, demand and production. In particular, such data are potentially valuable for the econometric estimation of optimization models of inventory behaviour and to test interesting hypotheses regarding movements in inventories, demand and production. In fact, in the Euro Area, information that is available in the BTS data, scuh as on inventory stocks and expected production, is not available elsewhere and can be derived only by means of public opinion surveys such as the one carried out in Europe by the European Commission.

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