DEUTSCHE
BUNDESBANK

The Inventory Cycle of the German Economy

Thomas A. Knetsch

Discussion Paper
Series 1: Studies of the Economic Research Centre
No 09/2004

Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-1
Telex within Germany 41227, telex from abroad 414431, fax +49 69 5601071

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax No +49 69 9566-3077

ISBN 3–935821–87–5

Abstract

Using aggregate data, the paper analyzes the importance of inventory investment for German business cycles since 1960. In contrast to U.S. experience, the traditional production-smoothing/buffer-stock model is not rejected by empirical evidence. Preliminary national accounts data of inventory investment have particularly poor quality. In order to be able to analyze recent stockbuilding trends in Germany, we propose a composite index aggregating information drawn from monthly production and sales statistics as well as from the Ifo business survey.

Keywords: inventory fluctuations, business cycles; data quality, composite index; Germany.

JEL classification: E22; C32.

Non-Technical Summary

The paper investigates the inventory cycle of the German economy and presents a composite index which is able to timely assess the "true" changes in inventories better than the preliminary releases of the national accounts.

On an aggregate level, stylized facts of the German inventory cycle are derived and compared with U.S. evidence. Destocking is shown to be a considerable phenomenon during German recessions since 1960, although it turns out to be less pronounced than in the United States. Furthermore, German data do not provide evidence against the traditional production-smoothing/buffer-stock hypothesis as is found by Blinder and Maccini [1991] for the United States, for instance. In Germany, the variance of (detrended) GDP does not exceed (detrended) final demand, and the correlation between the latter and changes in inventories is negative. The contradictory findings between Germany and the United States might be explained by structural differences such as the relative importance of trade inventories vis-à-vis manufacturers' stocks of finished goods and distinct levels of labor adjustment costs.

The quarterly series of real inventory investment (in seasonally adjusted terms) can be appropriately modeled by an autoregressive process including a break in mean around 1980. Whereas the autoregressive structure proxies the cyclical behavior of the series, the mean break might indicate the secular tendency to reduce stockholdings owing to improvements in information technology and just-in-time production. Exogenous variables such as the contemporaneous changes in total demand and imports improve the explanatory power of the regression. The estimates highlight the strong relation between imports and stockholdings of purchased material and supplies.

Unfortunately, preliminary data on inventory investment as published in the German national accounts are subject to sizeable revisions. Those data are not recommended for use in assessing the current stance of the inventory cycle and for forecasting purposes. A composite index of inventory fluctuations is therefore proposed. Apart from a production-sales index which is derived from monthly production and sales statistics by means of cointegration analysis, the index is based on Ifo survey information on the assessments of inventory stocks expressed by manufacturers as well as retail and wholesale traders. In order to amalgamate the occasionally distinct signals of the single indicators, a method building on canonical correlation analysis is applied. The four indicators are shown to possess a single codependent cycle which bears the whole forecasting content of the series for larger than one-step ahead predictions. This component can be represented by a weighted average of the single indicators which renders the proposed composite index of inventory fluctuations is simple, timely, and (virtually) free of revisions.

Nicht technische Zusammenfassung

Der Diskussionsbeitrag untersucht den Lagerzyklus der deutschen Volkswirtschaft und stellt einen Index vor, der frühzeitig eine Einschätzung der endgültigen Lagerbestandsveränderungen ermöglicht, die besser ist als die vorläufigen Daten der amtlichen Statistik.

Auf aggregierter Datenbasis werden stilisierte Fakten über den deutschen Lagerzyklus abgeleitet und mit der Evidenz für die USA verglichen. Es wird gezeigt, dass Lagerabbau ein Phänomen ist, welches für die Erkärung der deutschen Rezessionsphasen seit 1960 zwar bedeutsam ist, jedoch im Vergleich zu den USA weniger ausgeprägt zu sein scheint. Ferner findet sich in deutschen Daten keine Evidenz gegen die traditionelle Produktionsglättungs-/Pufferbestandshypothese, wie sie beispielsweise von Blinder und Maccini [1991] für die USA nachgewiesen wird. In Deutschland übersteigt die Varianz der zyklischen Komponente des BIP nicht die Varianz der zyklischen Komponente der Endnachfrage, und die Korrelation zwischen letzterer Größe und den Vorratsveränderungen ist negativ. Die sich widersprechenden Ergebnisse für Deutschland und die USA könnten mit strukturellen Unterschieden hinsichtlich der relativen Bedeutung von Handelslägern (im Vergleich zu den Fertigwarenlägern im Verarbeitenden Gewerbe) und aufgrund von unterschiedlich hohen Anpassungskosten beim Faktor Arbeit erklärt werden.

Die vierteljährliche Zeitreihe der realen Vorratsveränderungen (in saisonbereinigter Rechnung) kann in geeigneter Weise durch einen autoregressiven Prozess inklusive eines Stufenbruchs um 1980 modelliert werden. Während die autoregressive Struktur das zyklische Verhalten approximiert, könnte der Stufenbruch die langfristige Tendenz zum Lagerabbau abbilden, die in den Verbesserungen der Informationstechnologie und der Just-in-Time-Produktionsweise ihre Ursachen haben könnte. Exogene Variablen wie die zeitgleichen Veränderungen der Endnachfrage und der Importe verbessern den erklärenden Gehalt der Regression. Die Schätzungen betonen den engen Zusammenhang zwischen Importen und der Vorratshaltung von Vor- und Zwischenprodukten.

Leider sind die vorläufigen Daten zu den Lagerinvestitionen, wie sie in den deutschen Volkswirtschaftlichen Gesamtrechnungen veröffentlicht werden, sehr revisionsanfällig. Es ist mithin nicht empfehlenswert, diese Daten zur Einschätzung der lagerzyklischen Entwicklung und zum Zwecke der Prognose zu verwenden. Stattdessen wird ein zusammengesetzter Index vorgeschlagen. Neben einer Produktion-Umsatz-Relation, die mit Hilfe der Kointegrationsanalyse aus der monatlichen Produktions- und Umsatzstatistik des Verarbeitenden Gewerbes ermittelt wird, basiert der Index auf den Ergebnissen der Befragungen des Ifo-Instituts zur Beurteilung der Lagerhaltung, die im Verarbeitenden Gewerbe sowie im Einzel- und Großhandelsbereich durchgeführt werden. Um die Einzelindikatoren, welche gelegentlich unterschiedliche Signale aussenden, zu verschmelzen, wird eine Methode angewandt, die auf der Analyse der kanonischen Korrelationen aufbaut. Es zeigt sich, dass die vier Einzelindikatoren einen einzigen kodependenten Zyklus besitzen, welcher den gesamten Prognosegehalt für Vorhersagen über Horizonte von mehr als einer Periode in sich trägt. Diese Komponente ist darstellbar als gewichtetes Mittel der Einzelindikatoren, so dass der vorgeschlagene zusammengesetzte Index der Lagerbestandsveränderungen einfach, frühzeitig verfügbar und (praktisch) revisionsfrei ist.

Contents

List of Tables

List of Figures

The Inventory Cycle of the German Economy[1]

Inventory investment plays a very important role in short and mild cycles, ...

Victor Zarnowitz, JEL, 1985

1 Introduction

Reflections on current and future trends of inventories are well established in applied business cycle analysis and macroeconomic forecasting. Especially around cyclical turning points, the emphasis on inventory cycle movements contrasts sharply with the overall contribution of inventory investment in the system of national accounts. The importance of inventory fluctuations on short business cycles was already stressed by Abramovitz [1950]. Furthermore, with Metzler's [1941] inventory accelerator model, a theory had been developed which was able to explain the observed destabilizing character. In fact, Metzler's seminal work is still a key reference when studying the consequences of inventory fluctuations on business cycles.

In the last twenty-five years, however, the production-smoothing/buffer-stock hypothesis underlying this classical approach has been called in question. Research has been focused on the implications of the alternative (S,s) model for inventory behavior first and foremost at the plant level, but also at the aggregate level.[2] The debate on the empirical relevance of the competing approaches is dominated by evidence from the United States. Hence one objective of the present paper is to provide stylized facts of the inventory planning of German firms;[3] i.e. we report evidence on the impact of destocking on economic activity during recessions and analyze the correlation structure between GDP, final demand, and changes in inventories.

We will argue that evidence against the production-smoothing/buffer-stock model is less compelling for Germany than for the United States. Hence, fitting standard stock-adjustment equations is a reasonable strategy for modeling the dynamics of inventory investment. Although the regression results seem to be satisfying for the purpose of describing inventory fluctuations from a historical perspective, they are of rather limited

[1]Deutsche Bundesbank, Economics Department, Wilhelm-Epstein-Str. 14, D-60431 Frankfurt am Main, Germany, email: thomas.knetsch@bundesbank.de. A first draft of the paper was presented at the CIRET conference in honor of Victor Zarnowitz held at RWI Essen on June 27-28, 2003. The author would like to thank the participants of this conference as well as Jörg Breitung, Jörg Döpke, Hermann-Josef Hansen, Heinz Herrmann, Karl-Heinz Tödter and Gerhard Ziebarth for valuable comments and suggestions. Of course, the author is fully responsible for all remaining shortcomings. The paper expresses the author's personal opinion which does not necessarily reflect the views of the Deutsche Bundesbank.

[2]This branch of literature was perhaps initiated by Blinder [1981]. An overview is given in Blinder and Maccini [1991], for instance.

[3]Empirical work on inventory behavior using German micro data can be found in König and Seitz [1991] and Seitz [1993], for instance.

value for assessing the current stance of the inventory cycle or for predicting future developments. The main reasons are data limitations. More precisely, preliminary inventory investment figures as published in the German national accounts are unreliable. In order to overcome this unsatisfactory situation, we therefore propose constructing a composite index processing information on stockbuilding in manufacturing as well as in the retail and wholesale trade sectors. In Knetsch [2004], composite indices are shown to outperform the first announced official inventory investment figure in predicting the "true" inventory fluctuations of the German economy.

The remainder of the paper is organized as follows. In the subsequent section, we report some stylized facts of the German inventory cycle. In Section 3, we present regression results which model the dynamics of inventory investment. We also note reasons why the German national accounts data on inventory investment is prone to revision. In Section 4, we explain the construction of the proposed composite index of inventory fluctuations. Finally, Section 5 concludes.

2 Stylized Facts of the German Inventory Cycle

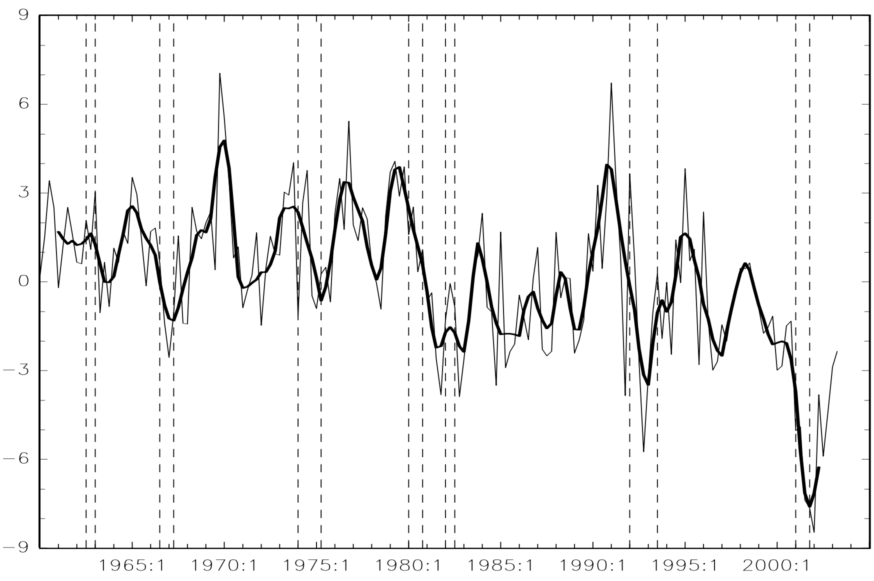
Several papers stress the importance of inventory fluctuations for business cycles in the United States. For instance, Blinder and Maccini [1991] calculate that the (purely arithmetical) contribution of destocking to reductions of real GNP during U.S. postwar recessions averages almost 90 per cent. This is one piece of evidence which leads macroeconomists to believe that inventories are a destabilizing factor in business cycles. However, when firms' motives for storing commodities are considered, inventories are thought to have a stabilizing character because rational firms (facing increasing marginal costs) strive to smooth production in the face of fluctuating sales. In a Keynesian model, Metzler [1941] shows that these apparently opposing views can be brought together assuming an output lag and an accelerator mechanism which is based on the idea that desired inventory stocks rise with sales.

In Table 1, we report the change in (real) inventory investment as a percentage of the change in (real) GDP during economic downturns in Germany since 1960.[4] For simplicity, recessions are dated using the mechanical rule that seasonally adjusted real GDP drops at least two quarters in a row. Since the time series of inventory investment is dominated by erratic fluctuations,[5] we also present results for a filtered series. We use an optimal

[4]From the first quarter of 1960 to the final quarter of 1990, data refer on West Germany. Note that, in contrast to data for Germany as a whole, the West German time series are measured according to the old accounting standards (ESA 79).

[5]Fluctuations over the very short term might be a result of the seasonal and calendar adjustment procedure applied. Since the aggregates of the production and the expenditure side of GDP are separately adjusted for seasonal and calendar effects, statistical discrepancies are almost certain to arise. By convention, the remaining seasonal and calendar effects are attributed to the series of inventory investment in order to meet the GDP accounting identity.

Figure 1: Series of inventory investment



Inventory investment is seasonally adjusted and measured in billions of 1995 euro. Source: National accounts published in August 2003. The original series is plotted by the solid line and the filtered series by the thick line. Vertical lines indicate the beginning and the end of the recession periods (technically defined).

low-pass filter which passes only cycles which are longer than $1\frac{1}{2}$ years; the filter lag length is 4.[6] The original and the filtered series of inventory investment are plotted in Figure 1.

From looking at both the plots and the results in Table 1, we conclude that there has been inventory disinvestment in (virtually) all economic downturns since 1960. On average, its arithmetical contribution to drops in real GDP is about 60 per cent. Destocking is therefore a considerable phenomenon during cyclical contractions in Germany, although it turns out to be less important than in the United States.[7]

Moreover, the filtered series seems to indicate that inventory fluctuations in Germany are dominated by oscillations whose average duration lies between three and four years. As in the United States, inventory investment is therefore central for explaining "Kitchin cycles".[8]

Next, we examine the volatility of production and sales as well as the correlation between sales and inventory investment. Sectoral and aggregate data for the United States

[6]For the construction of this type of filter, see Baxter and King [1999], for instance.

[7]The last recession seems to be an exception in this respect because, compared to the mild drop in GDP, destocking was extraordinarily strong.

[8]For a closer view on business cycle classification and the U.S. experience, see Moore and Zarnowitz [1986], for instance.

Table 1: Inventory investment during recessions

Recession[a]	Change in GDP[b]	Change in inventory investment (original)[c]		Change in inventory investment (filtered)[c]	
1962:4 – 1963:1	-4.62	0.94		-0.17	(3.6 %)
1966:4 – 1967:2	-3.44	-1.72	(50.0 %)	-1.31	(38.1 %)
1974:2 – 1975:2	-5.74	-2.41	(42.0 %)	-2.48	(43.2 %)
1980:2 – 1980:4	-4.37	-0.51	(11.6 %)	-1.92	(43.8 %)
1982:2 – 1982:4	-3.51	-2.59	(73.6 %)	-0.47	(13.5 %)
1992:2 – 1993:3	-11.45	-4.66	(40.7 %)	-1.90	(16.6 %)
2001:2 – 2001:4[d]	-1.56	-2.62	(167.9 %)	-3.88	(249.0 %)
Average			(64.3 %)		(58.3 %)

[a] Technical definition: at least two consecutive quarters of decline in seasonally adjusted real GDP.
[b] Billions of 1995 euro.
[c] Billions of 1995 euro; as a percentage of the change in real GDP in parentheses.
[d] Figures are preliminary, especially those of inventory investment.

indicate that the variance of production is higher than the variance of sales and that the covariance between sales and inventory investment is not negative.[9] For aggregate German data since 1960, as we will show right now, the results are less clear-cut, as they depend on the detrending procedure used.

For the whole economy, the identity between production, sales, and inventory investment can be stated as $Y_t \equiv X_t + \Delta N_t$ where Y_t is GDP, X_t final demand, and ΔN_t changes in inventories (all series in real terms). Dividing the equation by trend output Y_t^* gives $y_t = x_t + \Delta n_t$ with $y_t \equiv Y_t/Y_t^*$, $x_t \equiv X_t/Y_t^*$, and $\Delta n_t \equiv \Delta N_t/Y_t^*$. From this, we infer the following relation between second moments:

$$\mathrm{var}(y_t) = \mathrm{var}(x_t) + \mathrm{var}(\Delta n_t) + 2\,\mathrm{cov}(x_t, \Delta n_t).$$

There is no unique or commonly accepted measure of trend output. In Table 2, we therefore present the results of different procedures. Trend output is identified as a cubic deterministic trend, a Hodrick-Prescott filter with the (standard) smoothing parameter 1 600, a local linear trend of a structural time series model, and the random walk component of a multivariate Beveridge-Nelson decomposition.[10] Since the procedures used are representative of a wide range of conceptually different trend-cycle decompositions, common features can be considered to be stylized facts.

Table 2 shows that the variance of (detrended) GDP exceeds the variance of (detrended) final demand when trend output is measured by a cubic trend polynomial. While the

[9] See Blinder and Holtz-Eakin [1986] and Blinder and Maccini [1991], for instance.
[10] More details about the different detrending methods applied are given in Appendix A.1.

Table 2: Variances and correlations

Procedure measuring trend output	$\frac{\text{var}(\Delta \ln Y_t^*)}{\text{var}(\Delta \ln Y_t)}$	$\frac{\text{var}(x_t)}{\text{var}(y_t)}$	$\text{corr}(x_t, \Delta n_t)$
Cubic trend polynomial	0.049	0.88	−0.10
Hodrick-Prescott filter	0.050	1.02	−0.35
Smooth trend model	0.032	1.03	−0.29
Mult. Beveridge-Nelson	0.311	1.16	−0.41

The ratio $\text{var}(\Delta \ln Y_t^*)/\text{var}(\Delta \ln Y_t)$ is a measure of the persistence of the trend component; it is zero for a (log) linear trend and unity if the variances of the growth rates of the series and its trend component are equal.

opposite result appears for the multivariate Beveridge-Nelson trend, the variance ratio is close to unity in the case of the Hodrick-Prescott filter and the smooth trend model. With respect to the production-smoothing hypothesis, we cannot draw a unique conclusion, although the results indicate that procedures creating variable trend components tend to support this hypothesis most. In stark contrast to reported U.S. evidence, however, we find that the correlation between final demand and changes in inventories is negative, which is consistent with the role of inventories used as a buffer stock.[11]

The contradictory findings with respect to aggregate inventory behavior in the German and the U.S. economy may be explained by structural differences. The production-smoothing/buffer-stock hypothesis is well suited to manufacturers storing finished goods. For the United States, however, this "is the *smallest* component of total inventory investment", and moreover, "finished goods inventories held by manufacturers is the *least* volatile component of total inventory investment".[12] To understand aggregate inventory behavior in the United States, it is therefore more important to look at retail inventories and the manufacturers' storage of purchased material and supplies for which the alternative (S,s) model is said to be the more realistic approach.[13]

Unfortunately, sectoral data on inventory stocks are very limited in the German national accounts. Up to 1994 and on an annual basis, non-farm inventories are published separately for manufacturing and trade. Those data show that trade inventories rose from about 30 per cent of total non-farm inventories in 1960 to 37 per cent in 1994, but they are far lower than the more than 50 per cent reported for the United States. Furthermore, the

[11] Results for (West) Germany, which deviate from those presented here, have been reported in Fuyuda and Teruyama [1988] as well as in Ramey and West [1997]. Apart using from different data sets, they apply detrending procedures (growth rates in the former, linear trend in the latter case) which turn out to be less well-suited to extract cyclical components of the trending series under consideration.

[12] Quotations from Blinder and Maccini [1991], p.76; italics in original.

[13] In brief, the (S,s) approach to inventory behavior stresses the stock-out problem: Whenever inventory stocks are expected to reach a critical lower margin s, firms are going to replenish stockholdings up to the upper limit S.

volatility of the annual percentage changes in inventories is smaller in the trade sector than in manufacturing. At first glance, both pieces of evidence may confirm the view that the production-smoothing/buffer-stock model is more relevant to Germany than the United States. However, data on manufacturers' stocks contain both finished goods and raw materials, and the import content of inventory investment, which is relatively high in Germany, might indicate that stocks of raw materials are a considerable part of total inventories in manufacturing.

Another structural difference concerns the flexibility of labor. In his discussion of Blinder and Holtz-Eakin's paper, Abramovitz conjectured that evidence from Europe might support the production-smoothing/buffer-stock model. The idea is that firms smooth production when the cost of capital installment and labor recruitment outweighs the risk of potentially having old-fashioned goods in stock. Labor adjustment cost is higher in Germany than in the United States and firms should therefore have a greater incentive to smooth production. During recent years, however, the implementation of flexible working-time arrangements in Germany might have changed this pattern to some extent.

To sum up, inventory behavior in Germany differs from the U.S. experience in some important respects. Although inventory changes destabilize output during cyclical downturns, the arithmetical contribution of destocking to declines in GDP during recessions is less pronounced. Using aggregate data, we do not find evidence against the production-smoothing/buffer-stock model of inventory behavior in Germany.

3 Substance and Limitations of German National Accounts Data on Inventory Investment

This section consists of two parts. We start by modeling the dynamics of aggregate inventory investment using the standard concepts known from the literature. At the end of the sample, however, the national accounts data on inventory investment are prone to revision. In the second part, we highlight the poor data quality and present reasons for this.

3.1 Modeling the Dynamics of Inventory Investment

Inventory behavior has been modeled by stock-adjustment equations since Lovell [1961]. In order to model German inventory investment in this tradition, Döpke and Langfeldt [1997] specify an error correction mechanism between inventory stock, final demand and a short-run real interest rate measuring the opportunity cost of storing goods. Owing to a lack of original data, they construct a quarterly series for the stock using data on inventory investment from the national accounts. In older econometric work on this topic, changes in inventories are explained by lagged changes in GDP or final demand and, less frequently, by producer prices of finished goods.[14]

[14]See Maneval [1976] for an overview.

Table 3: Estimation results

Dep. Var.	ΔN_t		
Sample	1961:2 – 2001:4 (163 obs.)		
Model	(A)	(B)	(C)
const.	0.67 (0.26)	0.99 (0.23)	0.81 (0.22)
$S(80{:}1)$	−1.13 (0.35)	−1.04 (0.31)	−1.11 (0.29)
ΔN_{t-1}	0.47 (0.08)	0.58 (0.07)	0.58 (0.07)
ΔN_{t-2}	0.07 (0.08)	0.09 (0.07)	0.09 (0.07)
ΔN_{t-3}	−0.10 (0.08)	−0.11 (0.07)	−0.14 (0.07)
ΔN_{t-4}	0.30 (0.08)	0.20 (0.07)	0.22 (0.07)
ΔN_{t-5}	−0.20 (0.08)	−0.19 (0.07)	−0.17 (0.07)
ΔX_t		−0.26 (0.04)	
$\Delta(X_t + M_t)$			−0.25 (0.04)
ΔM_t			0.51 (0.07)
$\Delta S(91{:}1)$		40.5 (5.5)	38.0 (5.3)
R^2	0.43	0.59	0.63
DW	2.00	1.94	2.01
AIC	4.11	3.82	3.72
SC	4.25	3.99	3.91

Inventory investment is denoted by ΔN_t. The exogenous variables are the change in final demand ΔX_t and the change of imports ΔM_t. $S(80{:}1)$ and $S(91{:}1)$ indicate dummy variables which are 1 since 1980:1/1991:1 and otherwise 0. Standard errors are given in parentheses. R^2 is the determination coefficient, DW is the Durbin/Watson statistic and AIC is Akaike's and SC Schwarz's information criterion.

Since primary quarterly data on the aggregate inventory stock are not available for Germany, we abstain from specifying a stock-adjustment process explicitly. In Section 2, we have found that inventory fluctuations destabilize output during recessions and that there is no evidence against the production-smoothing/buffer-stock hypothesis. Since these results meet features of Metzler's inventory accelerator model, the time series of inventory changes should be well approximated by an autoregressive model whose characteristic polynomial has complex roots.[15]

By inspecting the plot in Figure 1, the inventory investment series seems to have a break in mean around 1980. While we observe an accumulation of inventory stocks in the 1960s and 1970s, there has been a general destocking trend during the last two decades. In fact, standard test procedures indicate a statistically significant structural break which can be located in the first quarter of 1980. On the one hand, it may be argued that this is evidence for the hypothesis that improvements in information technology and just-in-time production have allowed firms to melt down inventory holdings.[16] On the other hand, bearing in mind that national accounts data only possess a weak link to original inquiries on inventory stocks,[17] one should be cautious with such far-reaching interpretations.

For the modeling exercise of inventory investment, however, a mean break in the first quarter of 1980 ought to be taken into account. Hence, apart from the autoregressive (AR) structure, the univariate model contains a constant and a dummy variable which captures this break. As reported in Table 3, for the sample period from 1960 through 2001, an AR(5) polynomial serves as an appropriate baseline model. A more structural econometric specification, however, may contain the contemporaneous change of final demand as an exogenous variable which explains changes in inventories by the buffer-stock motive.[18] In fact, model (B) has greater explanatory power than the simple AR(5) model. This specification, however, does not distinguish between positive and negative changes of the inventory stock which stem from conceptually different sources. It is well known that the import content of stockholdings of raw material is quite large in Germany. Hence, it might be advantageous to separate the import-driven (positive) effect on changes in inventories from the demand-driven (negative) effect. In model (C), we therefore split final demand X_t into imports M_t and total demand $(X_t + M_t)$.[19] The impact of import changes to aggregate inventory investment is (in absolute value) twice as high as the effect of total demand. Furthermore, the estimate shows that 50 per cent of the goods imported in one quarter will be put on hold.

[15] The dynamics of output and inventory investment in the standard Metzlerian model can be represented by a second-order difference equation which induces cycles for all permitted parameter constellations.

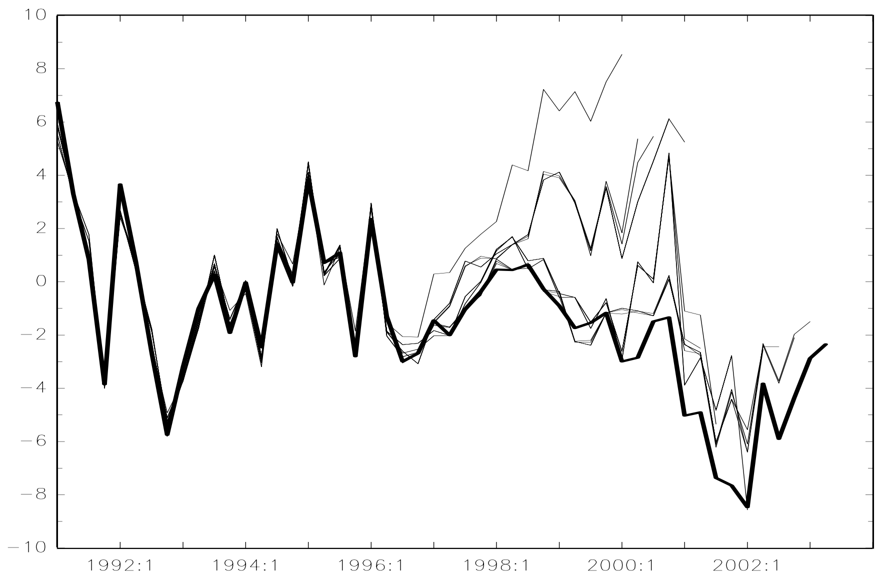
[16] For the United States, such aspects are discussed in Kahn, McConnell and Perez-Quiros [2002], for instance.

[17] To highlight this, it is worth quoting Ramey and West [1999]: "[T]he figures on the annual change [in inventories] looked suspicious: they [...] bore no obvious connection to the figures on the levels reported in the Statistische Bundesamt publication" (p.913).

[18] In addition, the model contains an impulse dummy capturing the shift in the exogenous variable owing to the German unification.

[19] Total demand is defined as the sum of private and public consumption, gross fixed capital formation and exports.

Figure 2: Data revisions with respect to inventory investment



The last 14 releases of seasonally adjusted changes in inventories (in billions of 1995 euro) are plotted with regard to the publications of national accounts from May 2000 through August 2003. The current release is plotted by the thick line.

3.2 The Susceptibility of Inventory Data to Revision

In the econometric analysis, we have tried to find an appropriate regression model in order to describe the dynamics of inventory investment in the German economy. Apart from taking such a historical perspective, applied business cycle research is also interested in assessing the current stance of the inventory cycle and, potentially, in forecasting future developments. In general, good forecasting performance does not only depend on well-specified models; above all, it relies on reliable data at the end of the sample.

Figure 2 highlights the fact that data on inventory investment are tremendously prone to revision. For instance, from the strong inventory accumulation during the last boom in 1999-2000, which was first reported in the national accounts, only a modest phase of destocking is left following several revisions.

The reasons for the poor quality of data on inventory investment are evident. Since the conversion to the European System of Accounts (ESA 95), data on inventory stocks have no longer been published in the German national accounts. Hence, a primary database is unavailable to the public. Moreover, new quarterly inventory investment figures are mainly determined as a residual when reconciling production and expenditure accounts of GDP. It is worth mentioning, however, that indicator information (which is more or less equivalent to what will be considered in the subsequent section) is used to cross-check the general adequacy of the figures obtained.[20] Nonetheless, mismeasurement on the production or the expenditure side of GDP first feeds into the preliminary inventory investment figures.[21]

After two years or so, when detailed statistical information (such as the results of the value-added tax statistics and the surveys about the cost structures of firms) have been incorporated into the system of national accounts, the inventory investment figures are more or less free of that kind of mismeasurement. Hence revised inventory investment data are assumed to still be a good proxy for the aggregate inventory fluctuations of the German economy.

The message of this section is clear: As far as preliminary data are concerned, the inventory investment figures turn out to be a product of a lack of statistical information rather than a measure of firm behavior. As long as their quality does not improve, the usefulness of national accounts data on inventory investment is quite limited as regards interpretation and suitability for predicting the inventory cycle of the German economy.

4 A Composite Index of Inventory Fluctuations

The objective of this section is to construct a composite index of inventory fluctuations in Germany which is simple, timely, and (largely) free of revisions. More precisely, as soon as the first official figure of inventory investment is announced, we would like to be equipped with an indicator-based estimate of this figure which is assumed to be closer to the "final" release.

We abstain from using the national accounts data because, in this case, we would have to fall back on preliminary data which possess no predictive power for the "final" data.[22] In order to produce an estimate of inventory fluctuations, one can rely on survey information instead. On a monthly basis, the Ifo institute publishes data on manufacturers', wholesale and retail traders' assessment of inventory stocks.[23] Moreover, it is possible to infer inventory fluctuations from monthly data on production and sales statistics. The idea is that the stock of finished goods must decrease if sales outweighs production and vice versa.

[20] In Braakmann [2003], the Ifo business survey on the assessment of inventory stocks is explicitly mentioned as an additional source considered by the Statistisches Bundesamt for the preparation of new national accounts data.

[21] On the problems of missing primary statistics and poor data quality, see also Remsperger [2003] and Grömling [2002].

[22] In Knetsch [2004], encompassing tests do not reject the hypothesis that, conditional on Ifo survey information, the first release does not possess any predictive power for the "final" figure of inventory investment.

[23] In the survey, firms report their view on whether inventory stocks are regarded as being too small, sufficient/normal (in seasonal terms), or too big. The individual qualitative answers are aggregated by weighting the proportion of positive and negative replies. For interpretational reasons, the scale of the aggregates are inverted because an increasing proportion of firms reporting too small inventory stocks indicates a rising expansive pressure on upstream sectors in the value-added chain and vice versa. Further details on the Ifo business survey are given in Oppenländer and Poser [1989].

First, we propose constructing a stable production-sales index measuring inventory fluctuations in the industrial sector. We then suggest amalgamating this index with the Ifo survey information in order to obtain an aggregate measure of inventory fluctuations in Germany.

4.1 A Production-Sales Index for the Industrial Sector

For the industrial sector, data on production and turnover are available on a monthly basis. The turnover index, however, measures a value and not a quantity. In order to obtain a series of sales, one can deflate the turnover index using the producer price index of industrial goods. Alternatively, in the flexible setup of a vector autoregression, one can consider a three-dimensional system with production, turnover, and producer prices.

The time series of these variables are trending over time while inventory fluctuations are stationary. Consequently, if some linear combination of production, turnover, and producer prices (all series in logs) ought to have explanatory power for inventory fluctuations, those series must be cointegrated. The first step is to test for cointegration.

For the subsequent analysis, we use a sample from January 1991 through December 2002. Standard information criteria indicate that lag order 3 is an appropriate choice for the vector autoregression under consideration. Table 4 presents results on Johansen's [1991] LR trace test as well as the values of the Hannan-Quinn (HQ) criterion which arise from estimates of the vector error correction models given pre-specified cointegrating ranks.[24] Johansen's test sequence indicates that the absence of cointegration is rejected at the 10% level. The HQ criterion reaches its minimum imposing one cointegrating relation onto the model. Hence we infer that the series of production, turnover, and producer prices are cointegrated.

As a result, a stable production-sales index can be defined using the cointegrating vector (standard errors in parentheses):

$$\ln IP_t - \underset{(0.02)}{0.83} \ln IT_t + \underset{(0.11)}{1.00} \ln PP_t \ \sim \ \mathrm{I}(0)$$

where IP_t is industrial production, IT_t industrial turnover, and PP_t the producer prices of industrial goods.

The coefficient attached to industrial turnover is negative, but significantly smaller than unity in absolute terms. Furthermore, producer prices cannot be omitted in the cointegrating relation. The hypothesis that the coefficients attached to industrial turnover and producer prices are the same in absolute terms is not rejected at usual significance levels (p-value: 20.3%).

Theoretical considerations would imply that the ratio between production and sales is stable. In the cointegration analysis, however, we find a linear combination between

[24] The idea of testing the cointegrating rank by using the HQ criterion can be found in Gonzalo and Pitarakis [1999].

Table 4: Cointegration rank tests

Rank	LR trace	HQ criterion
0	$28.50^{(\star)}$	−0.29
1	8.92	− **3.87**
2	0.00	−3.20

Johansen's LR trace statistic tests the hypothesis in terms of whether the cointegration rank is equal to (or smaller than) indicated. $^{\star\star}, ^{\star}, ^{(\star)}$ mean rejection at the 1%, 5% and 10% level respectively. The lowest value of the HQ criterion is printed in bold.

production, turnover, and producer prices which differs from this theoretical guess (possibly due to measurement errors). Nonetheless, the estimated relation may generally possess explanatory power for inventory changes in the industrial sector.

4.2 Constructing the Composite Index

Before we start constructing a composite index of inventory fluctuations, it is worth examining the extent of cyclical comovement between the "final" release of inventory investment and the indicator series at hand. Apart from the constructed production-sales index of the industrial sector, we use monthly information on manufacturers', retail and wholesale traders' assessment on inventory stocks, which is available from the Ifo business survey.[25]

For the subsequent analysis, the series are standardized which means that they possess zero mean and unit variance. Figure 3 depicts the graphs of the quarterly averages of the series. From visual inspection, it is fair to say that all indicators are more or less driven by fluctuations which are typically attributed to inventory cycle frequencies.[26] Of course, the production-sales index and the survey indicator of retail inventories are strongly affected by erratic variations. Hence, cyclical turning points can only be detected in the series on manufacturers' inventories and, in a perhaps less clear-cut way, in the series on wholesale traders' inventories.

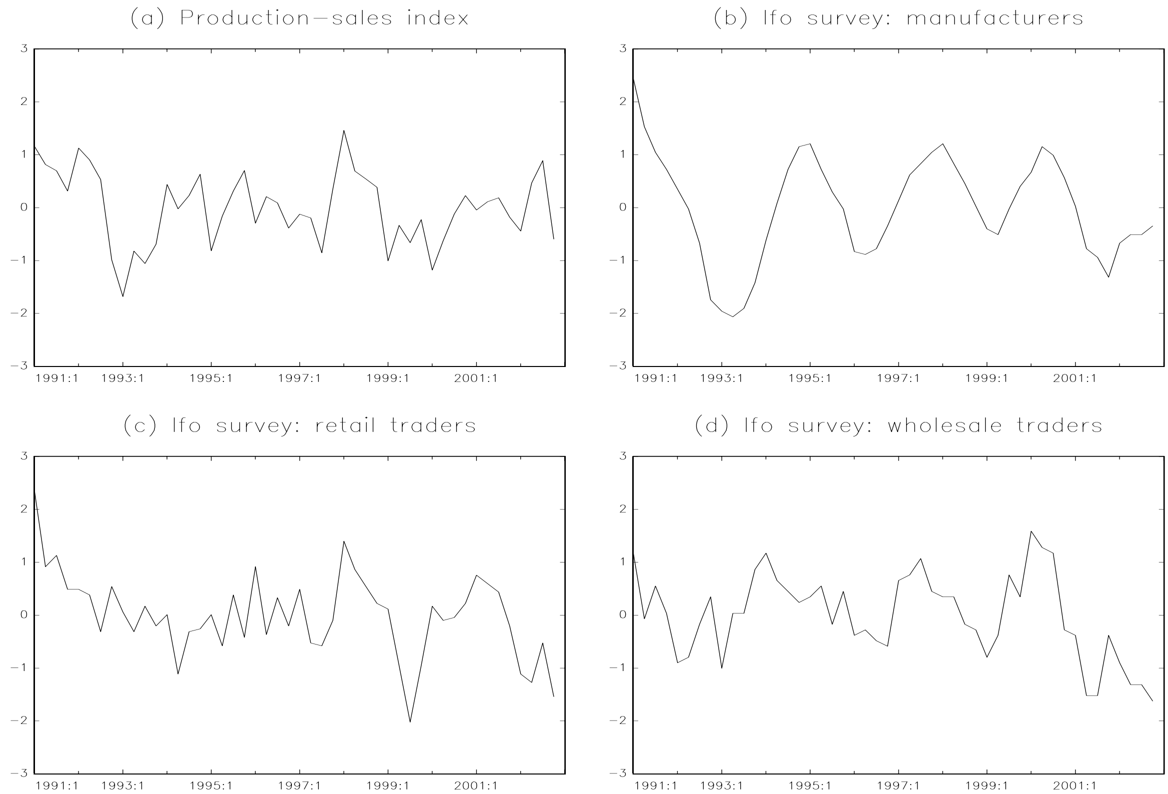
Next, it is interesting to know the pattern of cross-correlations between the indicator series and inventory investment. In order to detect possible phase shifts, we look at lead-lag structures. Since the reference is the "final release", national accounts data should be sufficiently revised. Consequently, Table 5 reports pair-wise cross-correlations compiled from the sample between the first quarter of 1991 and the final quarter of 2001.[27] The results show that survey data on manufacturers' assessment of inventory stocks comove

[25] Survey information on traders' inventories is available only for former West Germany.

[26] In Knetsch [2004], a more detailed analysis of the time series properties of the Ifo series (in a larger sample) is presented. This investigation also includes frequency domain approaches.

[27] Another reason for dropping the final observations is to avoid measuring artificial correlation because those are likely to be (at least) partially affected by the indicator information; recall the discussion in Section 3.2.

Figure 3: Indicator series of inventory fluctuations



Graph (a) shows the production-sales index constructed in Section 4.1; graphs (b) through (d) depict manufacturers', retail and wholesale traders' assessment of inventory stocks drawn from Ifo business survey. In all cases, quarterly averages of the standardized series are plotted.

most with the reference. Ifo data on inventories in the retail sector can also be seen as a coincident indicator, although cross-correlation is lower. While wholesale traders' assessment on inventories leads the reference cycle, the constructed production-sales index turns out to be coincident or slightly lagging.

To sum up, in order to obtain an overall impression of inventory behavior in Germany, it is worth considering all indicators at hand because each of them provides particular information from an original source. Since they all show a sufficiently strong comovement with the reference series, it is ensured that, when putting them together, we measure something which can be attributed to inventory fluctuations of the German economy.

Of course, when several indicators are in use, it is natural that they occasionally send different signals. To solve this problem, a composite index is usually constructed. The simplest aggregation method is to take the unweighted average. Since sectoral contributions to total inventory stocks are different, a weighted average appears to be more convincing.

Table 5: Cross-correlation between indicators and inventory investment

	lag		coin.	lead	
Indicator	-2	-1	0	$+1$	$+2$
production-sales index	0.20	**0.37**	**0.37**	0.15	0.02
manufacturers' inventory stock	0.21	0.39	**0.54**	0.37	0.17
retail traders' inventory stock	0.17	0.08	**0.32**	-0.01	0.05
wholesale traders' inventory stock	0.06	0.17	0.24	**0.37**	0.31

Correlations between the indicators and the respective lead or lag of the series of inventory investment are reported. The largest correlation is printed in bold.

Finding sectoral weights, however, is not straightforward because the indicators partially represent information from the same sector.

The analysis of cross-correlations provides a more fundamental argument against this kind of aggregation: Because of different cyclical features, comovement between the indicator series and the reference is either strong or loose. In order to design the weighting scheme of the composite index, we need a method of processing the cyclical properties of the indicator series in an efficient way.

Here, we use the concept of serial correlation common features in a vector autoregression which can be identified applying canonical correlation techniques.[28] The basic idea behind the methodology is as follows. According to Engle and Kozicki [1993], two stationary series possess a common cycle if there is a linear combination between the two which is not predictable (or white noise). Note that this concept is rather strong because cycles have to be exactly synchronized. The analysis of cross-correlations, however, has indicated that phase shifts exist between the indicator series. Hence, we apply the more general concept of codependent cycles, which allows for comovement between series which is not exactly synchronized.[29] Analytically, we search for independent linear combinations, known as codependence vectors, which have a moving-average structure of a small order q [MA(q)].

Using monthly data from January 1991 through December 2002, we set up a vector autoregressive model comprising the four indicator series at hand. Following standard information criteria, we choose lag order 4. In Table 6, we report the results of tests for codependence proposed by Vahid and Engle [1997].[30] There is one linear combination between the four indicators which is white noise. Hence, if we require series to be exactly synchronized, three different cycles will exist. Instead, if we allow for phase shifts, the existence of two MA(1) codependence vectors cannot be rejected at the 5% level. Hence,

[28] In Knetsch [2004], the application of this technique is shown to have an advantage over alternative approaches (such as factor models) in that it provides a weighting scheme which turns out to be rather insensitive to changes in the sample used for estimation.

[29] The idea of codependent cycles was introduced by Gouriéroux and Peaucelle [1992].

[30] Actually, they build on Tiao and Tsay's [1989] test statistic identifying so-called scalar component models in the general class of vector autoregressive moving-average models.

Table 6: Tests for codependent cycles

# codep. vectors	Degrees of freedom	Order of moving average	
		0	1
1	13	15.04	9.56
2	28	52.75**	27.31
3	45	128.06**	58.20$^{(\star)}$
4	64	553.47**	110.45**

The null hypothesis is that the number of codependent vectors is equal to (or larger than) the number indicated. Test statistics are asymptotically χ^2-distributed with the reported number of degrees of freedom. **,* ,$^{(\star)}$ mean rejection at the 1%, 5% and 10% level respectively.

there is a single codependent cycle in the system. Accepting the 10% level, however, we would identify two codependent cycles.

The codependence vectors can be estimated by using Vahid and Engle's generalized method of moments technique. Here, we present the results requiring that there are three codependence relations which are moving averages of order 1 (standard errors in parentheses):

$$PS_t - \underset{(0.11)}{0.28} MI_t, \qquad WI_t - \underset{(0.12)}{0.36} MI_t, \qquad RI_t - \underset{(0.12)}{0.10} MI_t$$

where PS_t is the production-sales index, while MI_t, WI_t, and RI_t represent the survey information on manufacturers', wholesale and retail traders' assessment on inventory stocks respectively.

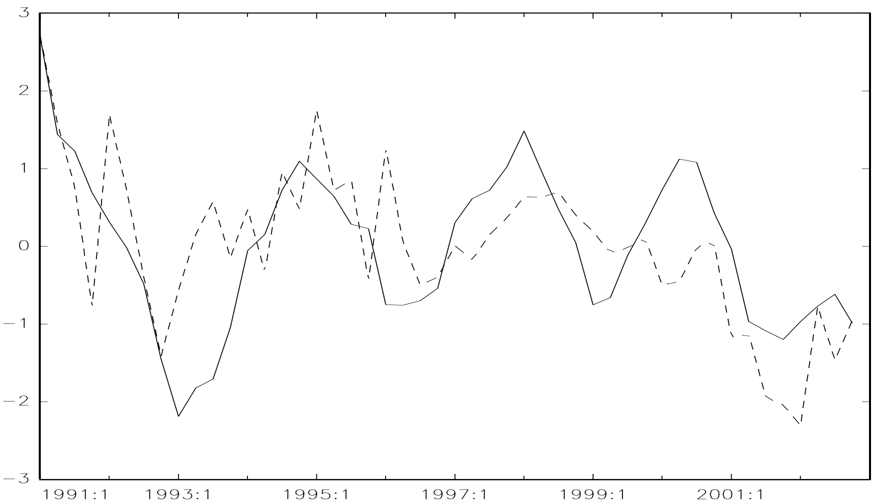
The estimated coefficient attached to MI_t in the third codependence vector is not significantly different from zero. Hence it turns out that the extent of co-cycling between retailers' inventory assessment and the remaining indicators is lowest. Note that this result mirrors the open question in terms of whether there are two or three MA(1) codependence vectors. If only two codependence vectors were identified, retailers' inventory assessment would be expected to form its own cycle.

In the case of three codependence vectors, however, a composite index can be simply constructed. As shown in Appendix A.2, there is a single linear combination between the indicators series which comprises the whole forecasting content at all horizons larger than 1. In analytical terms, it can be estimated by the orthogonal complement to the vector space spanned by the codependence relations. Appropriately normalized, the composite index of inventory fluctuations is represented by

$$CI_t \equiv 0.16PS_t + 0.21WI_t + 0.06RI_t + 0.57MI_t.$$

Since the indicator series are standardized and weights add up to unity, the coefficients represent the relative impact of each indicator on the composite index. Manufacturers' assessment of inventory stocks contributes to more than one-half of the composite index.

Figure 4: Composite index of inventory fluctuations



The composite index is plotted by the solid line and inventory investment (published in August 2003) by the dashed line. Both series are standardized.

Together with the impact of the production-sales index, information from manufacturing counts for almost three quarters. While the proportion of retail traders' inventory assessment is quite small, wholesale traders' assessment contributes to more than 20 per cent of the composite index.

In Figure 4, the composite index is plotted along with the reference, the revised time series of inventory investment. The composite index is strongly linked to its reference and shows a distinctly cyclical behavior where turning points can be easily located.[31] The composite index is an obvious choice to assess the current stance of the inventory cycle because the index is simple, available in a timely manner, and (virtually) free of revisions.[32] Furthermore, in contrast to single indicators, the composite index combines information from all sectors holding significant proportions of the aggregate inventory stock.[33]

[31]In the sample between the first quarter of 1991 and the final quarter of 2001, the contemporaneous correlation between the composite index and inventory investment is 0.55.

[32]Preliminary releases of monthly production and sales statistics are subject to revision. Owing to the small weight of the production-sales index, however, those revisions are expected to be of minor importance provided they are not due to conceptual changes. Since April 2003, the series of industrial turnover has been seasonally adjusted using the Census X-12-ARIMA procedure. Unfortunately, this conceptual change seems to disturb the stable production-sales relation and, consequently, the weighting scheme of the composite index.

[33]In fact, Knetsch [2004] presents evidence that simple forecasting models based on a composite index of that kind beat not only the first release of the national accounts statistics but also the Ifo series of manufacturers' inventory assessment in predicting the "final" release of inventory investment.

5 Conclusion

Economic downturns are cyclical phases during which firms reduce inventory stocks. In Germany, the arithmetical contribution of destocking to the reduction of GDP during recessions is considerable but less important than shown by U.S. evidence. The traditional production-smoothing/buffer-stock hypothesis of inventory behavior is generally compatible with aggregate data. A standard regression model building on Metzler's accelerator mechanism can explain inventory dynamics of the German economy.

Preliminary national accounts data on inventory investment are unreliable because the basis of primary information on aggregate inventory holdings available in a timely manner is rather weak. The first reported figure of quarterly inventory investment is more or less compiled as a residual in reconciling production and expenditure accounts of GDP.

In order to forecast recent trends of inventory investment, it is useful to rely on indicator information. The Ifo institute regularly asks manufacturers, wholesale traders and retail traders to assess inventory stocks. Moreover, from industrial production and sales statistics, an index measuring inventory fluctuations can be constructed. Using canonical correlation analysis, we propose a composite index of inventory investment which can be represented by a weighted average of the single indicators at hand.

The composite index combines the information on inventory behavior in Germany drawn from all sectors holding significant portions of the aggregate inventory stock. With stockholdings of purchased material and supplies, however, one important source of inventory fluctuations in the manufacturing sector is still left blank in the composite index.

Appendix

A.1 Methods Measuring Trend Output

It is well known that business cycle facts may be different when alternative trend-cycle decompositions are used. For the empirical practice, Canova [1998] therefore suggests applying a variety of detrending methods. In this appendix, we are going to sketch the statistical procedures used and present the estimation results. The Hodrick-Prescott filter is excluded from this description because its construction is obvious.

Polynomial Function of Time. A simple idea is to characterize trend output by a polynomial function of time. The log of output y_t is regressed on powers of time and the predicted values are taken as the trend. For the series at hand, the usual choice of a linear trend does not provide a sensible cyclical component, nor does a quadratic trend. Contrarily, with the cubic trend (including an intercept and a step dummy accounting for the unification break), a reasonable pattern of output cycle movements emerges.

Smooth Trend Model. Harvey and Jaeger [1993] find that, in the class of univariate structural time series models, the smooth trend model is evident for U.S. GDP. In this specification, output is decomposed into an integrated random walk trend

$$\tau_t = \tau_{t-1} + \beta_{t-1} \qquad \text{with} \qquad \beta_t = \beta_{t-1} + \zeta_t$$

and a cyclical component ψ_t which is described by the trigonometric process

$$\begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix} = \rho \begin{bmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{bmatrix} \begin{bmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix}$$

where $0 < \rho \leq 1$ is the dampening term and $0 \leq \lambda_c \leq \pi$ is the frequency (in radians) for which the spectrum of the stochastic cycle displays a peak. The mutually independent residual processes ζ_t, κ_t and κ_t^* are Gaussian white noise processes with variances σ_ζ^2 and σ_κ^2 respectively.

This type of model implies a stationary cycle around a trend which is integrated of order 2 [I(2)]. With estimated $\lambda_c \approx 0$, the specification turns out to fit the (break-adjusted) German GDP series quite well although ψ_t collapses to an AR(1) process ($\rho = 0.87$). As in the case of the United States, the resulting trend component is very close to the Hodrick-Prescott trend with the smoothing parameter 1 600.

Multivariate Beveridge-Nelson Decomposition. Beveridge and Nelson [1981] propose decomposing a nonstationary time series into a random walk with drift and a stationary cycle which comprises the forecastable future changes of the series. Although pretty consistent with the widely accepted I(1) property of (real) output, the univariate version does not convince practitioners because the estimation often produces a rather variable trend and a noisy cycle. In general, multivariate approaches create more persistent cycles provided that the information set consists of variables which help to predict output (see Evans and Reichlin [1994]). Trend output is determined by the common random walk trend of the system of variables.

We set up a vector autoregression of order 5 (AIC choice) consisting of private consumption c_t, investment in machinery and equipment i_t and GDP y_t (all series in logs). Standard tests for cointegration find evidence for two cointegrating relations which are estimated as follows (standard errors in parentheses):

$$\begin{array}{rcccc} c_t & - & \underset{(0.02)}{1.45 y_t} & + & \underset{(0.0005)}{0.0022\,t} & \sim & \mathrm{I}(0) \\ i_t & - & \underset{(0.08)}{1.27 y_t} & & & \sim & \mathrm{I}(0) \end{array} .$$

The matrix of loadings is restricted such that disequilibria of the first long-run relation are adjusted via y_t (0.19) and those of the second via i_t (-0.18). The five overidentifying restrictions imposed on the cointegrating space are not rejected at the 5% level (LR test statistic: 10.1).

The three series are driven by a single stochastic trend which can be obtained by rewriting the estimated vector error correction model in its common trends representation (see Stock and Watson [1989]).[34]

[34] The short-run dynamics of the vector error correction model are restricted by using a method which sucessively sets parameters equal to zero whose t-ratio is lower than the threshold value 1.41.

A.2 Codependent Cycle Analysis

Let x_t be a K-dimensional vector autoregression of finite order p:

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + ... + A_p x_{t-p} + \varepsilon_t$$

where A_1, A_2, ..., A_p are $(K \times K)$ parameter matrices and ε_t is a K-dimensional white noise process with zero mean.

Suppose that x_t is covariance-stationary. By the Wold decomposition theorem, x_t has a moving-average representation of infinite order.

According to the concept developed by Gouriéroux and Peaucelle [1992], x_t will possess codependent cycles if there is a $(K \times s)$-matrix γ with $0 < s < K$ such that $u_t \equiv \gamma' x_t$ is a moving average process of short order q [MA(q)].[35] Vahid and Engle [1997] show that the existence of codependence imposes a specific set of non-linear restrictions on the parameter matrices of the vector autoregression. In the MA(1) case, for instance, γ needs to fulfil the conditions

$$\gamma'(A_1 A_{i-1} + A_i) = 0, \text{ for } i = 2, ..., p\,, \quad \text{and} \quad \gamma' A_1 A_p = 0.$$

Codependence of order q implies that the process u_t is not predictable at horizons larger than q, i.e. $E(u_t \,|\, \Omega_{t-i-1}) = 0$ with $i \geq q$, where the information set contains the complete history of the process x_t, i.e. $\Omega_t \equiv \{x_t, x_{t-1}, x_{t-2}, ...\}$. Let the $(K \times (K-s))$-matrix $\gamma_\perp$ be the orthogonal complement of γ satisfying $\gamma_\perp' \gamma = 0$. Using the identity $I_K \equiv \gamma(\gamma'\gamma)^{-1}\gamma' + \gamma_\perp(\gamma_\perp'\gamma_\perp)^{-1}\gamma_\perp'$, we can write $x_t = Cu_t + D\eta_t$ where $C \equiv \gamma(\gamma'\gamma)^{-1}$, $D \equiv \gamma_\perp(\gamma_\perp'\gamma_\perp)^{-1}$, and $\eta_t \equiv \gamma_\perp' x_t$ is a $(K-s)$-dimensional vector process. Of course, $E(x_t \,|\, \Omega_{t-i-1}) = D\, E(\eta_t \,|\, \Omega_{t-i-1})$ with $i \geq q$.

In the case $s = K - 1$, η_t is a scalar process. Hence, at horizons larger than q, the forecast of each series in x_t is determined by the forecast of η_t (multiplied by some scalar). In other words, there exists a single linear combination between observable series which comprises the whole forecasting content of the process x_t at horizons larger than q.

References

Abramovitz, Moses [1950], *Inventories and Business Cycles*, New York: National Bureau of Economic Research.

Baxter, Marianne and Robert G. King [1999], *Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series*, Review of Economics and Statistics 81: 575-593.

Blinder, Alan S. [1981], *Retail Inventory Behavior and Business Fluctuations*, Brookings Papers on Economic Activity 1981, 2: 443-520.

[35]Note that in the original contribution x_t is assumed to be a moving average of finite but long order.

Blinder, Alan S. and Douglas Holtz-Eakin [1986], *Inventory Fluctuations in the United States since 1929*, in: Gordon, Robert J. (ed.), *The American Business Cycle: Continuity and Change*, Chicago and London: The University of Chicago Press: 183-236.

Blinder, Alan S. and Louis J. Maccini [1991], *Taking Stock: A Critical Assessment of Recent Research on Inventories*, Journal of Economic Perspectives 5: 73-96.

Braakmann, Albert [2003], *Qualität und Genauigkeit der Volkswirtschaftlichen Gesamtrechnungen*, Allgemeines Statistisches Archiv 87: 183-199.

Canova, Fabio [1998], *Detrending and Business Cycle Facts*, Journal of Monetary Economics 41: 475-512.

Döpke, Jörg and Enno Langfeldt [1997], *Die Vorratsveränderungen im Rahmen von Konjunkturprognosen*, Konjunkturpolitik 43: 344-377.

Engle, Robert F. and Sharon Kozicki [1993], *Testing for Common Features*, Journal of Business and Economic Statistics 11: 369-395.

Evans, George and Lucrezia Reichlin [1994], *Information, Forecasts, and Measurement of the Business Cycle*, Journal of Monetary Economics 33: 233-254.

Fukuda, Shin-ichi and Hiroshi Teruyama [1988], *Some International Evidence on Inventory Fluctuations*, Economics Letters 28: 225-230.

Gonzalo, Jesus and Jean-Yves Pitarakis [1999], *Dimensionality Effects in Cointegration Analysis*, in: Engle, Robert F. and Halbert White (eds.), *Cointegration, Causality, and Forecasting: A Festschrift in Honour of Clive W. J. Granger*, Oxford: Oxford University Press: 212-229.

Gouriéroux, Christian and Irina Peaucelle [1992], *Séries Codépendantes: Application à l'Hypothèse de Parité du Pouvoir d'Achat*, Revue d'Analyse Economique 68: 283-304.

Grömling, Michael [2002], *Vorratsveränderungen – Spielwiese für Statistik und Prognose?*, Wirtschaft und Statistik 12/2002: 1128-1134.

Harvey, Andrew C. and A. Jaeger [1993], *Detrending, Stylized Facts and the Business Cycle*, Journal of Applied Econometrics 8: 231-247.

Johansen, Søren [1991], *Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models*, Econometrica 59: 1551-1580.

Kahn, James A.; Magaret M. McConnell and Gabriel Perez-Quiros [2002], *On the Causes of the Increased Stability of the U.S. Economy*, Federal Reserve Bank New York: Economic Policy Review, May 2002: 183-202.

Knetsch, Thomas A. [2004], *Evaluating the German Inventory Cycle Using Data from the Ifo Business Survey*, Economic Research Centre of the Deutsche Bundesbank: Discussion Paper 10/2004; appears in: Sturm, Jan-Egbert and Timo Wollmershäuser (eds.), *Ifo Survey Data in Business Cycle and Monetary Policy Analysis*, Heidelberg: Physica, forthcoming.

König, Heinz and Helmut Seitz [1991], *Production and Price Smoothing by Inventory Adjustment*, Empirical Economics 16: 233-252.

Lovell, Michael [1961], *Manufacturers' Inventories, Sales Expectations, and the Acceleration Principle*, Econometrica 29, 3: 293-314.

Maneval, Helmut [1976], *Gibt es einen Lagerzyklus in der Bundesrepublik?*, ifo-Studien 22: 37-61.

Metzler, Lloyd A. [1941], *The Nature and Stability of Inventory Cycles*, Review of Economics and Statistics 3: 113-129.

Moore, Geoffrey H. and Victor Zarnowitz [1986], *The Development and Role of the National Bureau of Economic Research's Business Cycle Chronologies*, in: Gordon, Robert J. (ed.), *The American Business Cycle: Continuity and Change*, Chicago and London: The University of Chicago Press: 735-779.

Oppenländer, Karl H. and Günter Poser (eds.) [1994], *Handbuch der Ifo-Umfragen*, Berlin and Munich: Duncker und Humblot.

Ramey, Valerie A. and Kenneth D. West [1999], *Inventories*, in: John B. Taylor and Michael Woodford (eds.), *Handbook of Macroeconomics*, Volume 1, Amsterdam: Elsevier Science Publishers: 863-923.

Remsperger, Hermann [2003], *Das System der Volkswirtschaftlichen Gesamtrechnungen als Informationsquelle für die Geldpolitik in der EWU*, Allgemeines Statistisches Archiv 87: 133-146.

Seitz, Helmut [1993], *Still More on the Speed of Adjustment in Inventory Models: A Lesson in Aggregation*, Empirical Economics 18: 103-127.

Stock, James H. and Mark W. Watson [1988], *Testing for Common Trends*, Journal of the American Statistical Association 83: 1097-1107.

Tiao, George C. and Ruey S. Tsay [1989], *Model Selection in Multivariate Time Series*, Journal of the Royal Statistical Society B 51: 153-213.

Vahid, Farshid and Robert F. Engle [1997], *Codependent Cycles*, Journal of Econometrics 80: 199-221.

Zarnowitz, Victor [1985], *Recent Work on Business Cycles in Historical Perspective: A Review of Theories and Evidence*, Journal of Economic Literature 23: 523-580.

The following Discussion Papers have been published since 2003:

Series 1: Studies of the Economic Research Centre

January	2003	Testing mean-variance efficiency in CAPM with possibly non-gaussian errors: an exact simulation-based approach	Marie-Claude Beaul Jean-Marie Dufour Lynda Khalaf
January	2003	Finite-sample distributions of self-normalized sums	Jeong-Ryeol Kim
January	2003	The stock return-inflation puzzle and the asymmetric causality in stock returns, inflation and real activity	Jeong-Ryeol Kim
February	2003	Multiple equilibrium overnight rates in a dynamic interbank market game	Jens Tapking
February	2003	A comparison of dynamic panel data estimators: Monte Carlo evidence and an application to the investment function	Andreas Behr
March	2003	A Vectorautoregressive Investment Model (VIM) And Monetary Policy Transmission: Panel Evidence From German Firms	Joerg Breitung Robert S. Chirinko Ulf von Kalckreuth
March	2003	The international integration of money markets in the central and east European accession countries: deviations from covered interest parity, capital controls and inefficien-Cies in the financial sector	Sabine Herrmann Axel Jochem
March	2003	The international integration of foreign exchange markets in the central and east European accession countries: speculative efficiency, transaction costs and exchange rate premiums	Sabine Herrmann Axel Jochem

March	2003	Determinants of German FDI: New Evidence from Micro-Data	Claudia Buch Jörn Kleinert Farid Toubal
March	2003	On the Stability of Different Financial Systems	Falko Fecht
April	2003	Determinants of German Foreign Direct Investment in Latin American and Asian Emerging Markets in the 1990s	Torsten Wezel
June	2003	Active monetary policy, passive fiscal policy and the value of public debt: some further monetarist arithmetic	Leopold von Thadden
June	2003	Bidder Behavior in Repo Auctions without Minimum Bid Rate: Evidence from the Bundesbank	Tobias Linzert Dieter Nautz Jörg Breitung
June	2003	Did the Bundesbank React to Stock Price Movements?	Martin T. Bohl Pierre L. Siklos Thomas Werner
15	2003	Money in a New-Keynesian model estimated with German data	Jana Kremer Giovanni Lombardo Thomas Werner
16	2003	Exact tests and confidence sets for the tail coefficient of α-stable distributions	Jean-Marie Dufour Jeong-Ryeol Kurz-Kim
17	2003	The Forecasting Performance of German Stock Option Densities	B R Craig, E Glatzer, J Keller, M Scheicher
18	2003	How wacky is the DAX? The changing structure of German stock market volatility	Jelena Stapf Thomas Werner

1	2004	Foreign Bank Entry into Emerging Economies: An Empirical Assessment of the Determinants and Risks Predicated on German FDI Data	Torsten Wezel
2	2004	Does Co-Financing by Multilateral Development Banks Increase "Risky" Direct Investment in Emerging Markets? – Evidence for German Banking FDI	Torsten Wezel
3	2004	Policy Instrument Choice and Non-Coordinated Monetary Policy in Interdependent Economies	Giovanni Lombardo Alan Sutherland
4	2004	Inflation Targeting Rules and Welfare in an Asymmetric Currency Area	Giovanni Lombardo
5	2004	FDI versus cross-border financial services: The globalisation of German banks	Claudia M. Buch Alexander Lipponer
6	2004	Clustering or competition? The foreign investment behaviour of German banks	Claudia M. Buch Alexander Lipponer
7	2004	PPP: a Disaggregated View	Christoph Fischer
8	2004	A rental-equivalence index for owner-occupied housing in West Germany 1985 to 1998	Claudia Kurz Johannes Hoffmann
9	2004	The Inventory Cycle of the German Economy	Thomas A.Knetsch
10	2004	Evaluating the German Inventory Cycle Using Data from the Ifo Business Survey	Thomas A.Knetsch

Series 2: Banking and Financial Supervision

1	2003	Measuring the Discriminative Power of Rating Systems	B. Engelmann, E. Hayden, D. Tasche
2	2003	Credit Risk Factor Modeling and the Basel II IRB Approach	A. Hamerle, T. Liebig, D. Rösch

1	2004	Forecasting Credit Portfolio Risk	A. Hamerle, T. Liebig, H. Scheule

Visiting researcher at the Deutsche Bundesbank

The Deutsche Bundesbank in Frankfurt is looking for a visiting researcher. Visitors should prepare a research project during their stay at the Bundesbank. Candidates must hold a Ph D and be engaged in the field of either macroeconomics and monetary economics, financial markets or international economics. Proposed research projects should be from these fields. The visiting term will be from 3 to 6 months. Salary is commensurate with experience.

Applicants are requested to send a CV, copies of recent papers, letters of reference and a proposal for a research project to:

Deutsche Bundesbank
Personalabteilung
Wilhelm-Epstein-Str. 14

D - 60431 Frankfurt
GERMANY