

Ruschinski, Monika

Working Paper

Investigating the Cyclical Properties of World Trade

ifo Working Paper, No. 30

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Ruschinski, Monika (2006) : Investigating the Cyclical Properties of World Trade, ifo Working Paper, No. 30, ifo Institute - Leibniz Institute for Economic Research at the University of Munich, Munich

This Version is available at:

<https://hdl.handle.net/10419/73717>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

ifo Working Papers

Investigating the Cyclical Properties of World Trade

Monika Ruschinski

Ifo Working Paper No. 30

May 2006

An electronic version of the paper may be downloaded from the Ifo website www.ifo.de.

Investigating the Cyclical Properties of World Trade

Abstract

The world economy in the last two decades is clearly marked by the integration of emerging countries in the international division of labor. To better understand the “globalization” effect, it is helpful to analyze the pattern and structure of world trade volume in the past, in order to draw conclusions for future development. An unobserved components model is used for decomposing world trade volume into trend, cycle, seasonal and irregular components. The analyses show that the process of the world trade volume is driven by the well-known fluctuations in form of the “Kitchin” and “Juglar Cycle”. Furthermore, there is one more cycle with a period between 4 and 5 years which improves the estimation results significantly. The information of the cyclical behavior of the time series is used for projections.

JEL Code: F02, F17.

Keywords: World trade, economic integration, unobserved components model, forecasting.

Monika Ruschinski
Ifo Institute for Economic Research
at the University of Munich
Poschingerstr. 5
81679 Munich, Germany
Phone: +49(0)89/9224-1261
ruschinski@ifo.de

1 Introduction

The world economy in the last two decades is clearly marked by the integration of emerging countries in the international division of labor. In the 1980s, the Asian “tigers” in Singapore, Taiwan and Hong Kong developed rapidly and increasingly engaged in international trade. Other Asian countries such as South Korea, Malaysia, etc. followed. Since the mid-1990s, the Eastern European reform countries of Poland, Hungary, Russia, etc., along with upcoming nations like China and most recently India, have intensified activity in the world market. This effect is often measured in terms of world trade volume, which has strongly expanded in the past. For instance, the international transactions of goods have more than doubled from 4,139.9 billion US dollars in 1994 to 9,051.8 billion US dollars in 2004 (International Financial Statistics 2005).

To better understand the “globalization” effect, it is helpful to analyze the pattern and structure of world trade volume in the past, in order to draw conclusions for future development. Furthermore, world trade volume is often used as an explanatory variable in estimation equations of national exports of goods and services. Reliable forecasts of world trade volume can also improve national projections of, for example, the German or the US trade balance.

In this study, an unobserved components (UC) model is used for decomposing world trade volume into trend, cycle, seasonal and irregular components. This method was already effectively applied in analyzing GDP series of various countries (see, e.g., Watson 1986, Clark 1987, Harvey/Jaeger 1993, Gerlach/Smets 1998 for the EMU area, Kichian 1999 for Canada, Flaig 2001 for the US, Flaig 2002 for Germany and Flaig 2005 for the German Production Index) and in identifying the German inventory cycle (Langmantel 2005).

The advantage of this type of model is that it is explicitly based on the stochastic properties of the data and that it is very flexible in accommodating peculiar features of the time series as outliers or structural breaks (see, e.g., Harvey/Jaeger 1993 and Flaig

2002). This study shows that beside a stochastic trend, cycles also determine the time series. This information is useful for generating projections to future, and the derived models can provide a simple basis for time series forecasts compared to complex calculations of global macro models. Since projections of large macro models are not inevitably better, and these models are more costly to operate than structural time series models, the unobserved component model is introduced as an interesting alternative forecasting method.

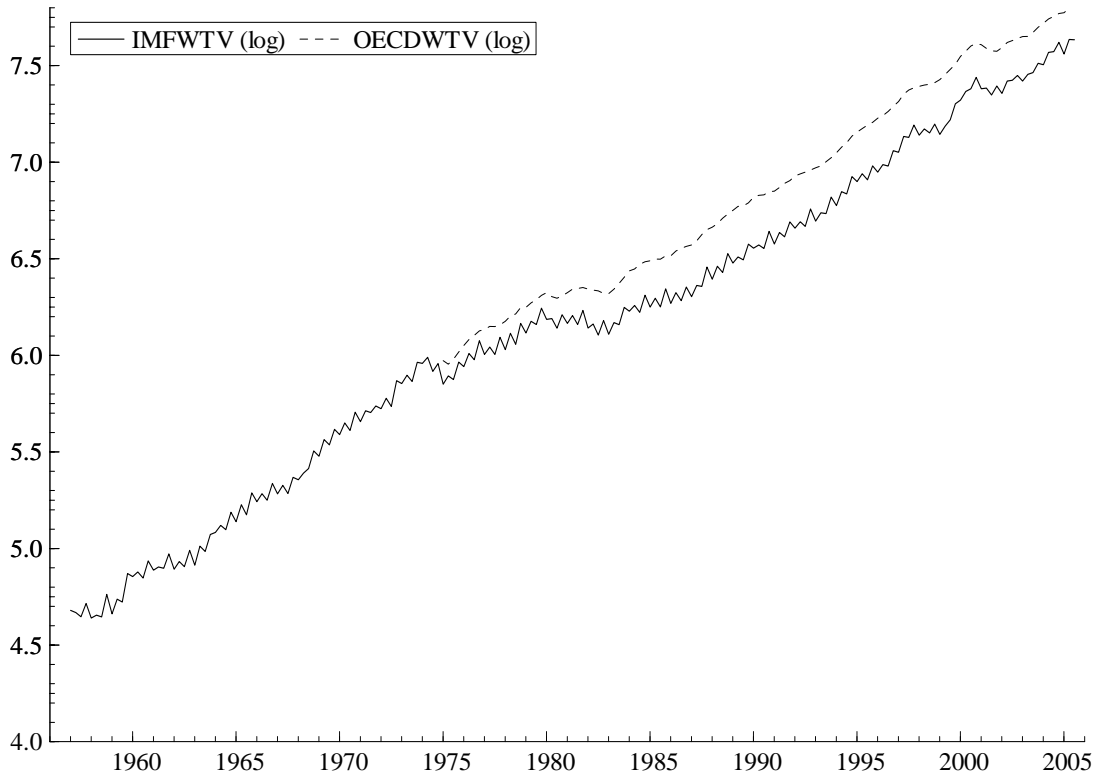
The organization of the paper is as follows: In section 2, the data basis and sources are described. In section 3, the econometric model and the alternative specification of the components are presented. Section 4 provides the empirical results of the estimations of the world trade volume and of the forecasting models. The final section contains a short summary and some concluding remarks.

2 Data

There are several time series with different survey periods from various sources that measure the development of world trade. We focus our research on two time series of official institutes. First, we examine the time series of the International Financial Statistics (IFS) from the International Monetary Fund (IMF) 2005: World, International Transactions, Exports (f.o.b.), in US dollars. The data covers the nominal flow of commodities and they are available monthly starting from 1957:1 to 2005:9. The deficiency of the data is that they are in nominal terms. Increases in prices, e.g. oil prices, expand the trade volume independent of the real exchange of goods. So we calculate a time series with data that is deflated with the export unit value index, 2000=100, IFS 2005.

Second, we consider a comprehensive series of world trade volume from the OECD which also includes services: OECD, Economic Outlook, Dec. 2005: World, Trade of Goods and Services, Volume, in US dollars of 2000, seasonally adjusted. This series is available in quarterly terms from 1975:1 to 2005:2. Figure 1 shows the time series in logs.

Figure 1: World Trade Volume (quarterly in logs) from IMF and OECD



A first look at Figure 1 shows that the two series proceed similarly. The fractions of goods and services in total world trade seem nearly stable since 1985. The advantage of the IMF series is the long time-horizon, which supports the structural time series analysis.

At first glance the data show an upward trend that is not constant over time. There was strong trade growth from 1963 until 1973 under the Bretton Woods System with an intensification of the division of labor between Europe, Japan and USA. The growth continued after the change of the exchange rate system, but the phase of expansion ended 1974 when the first oil crisis occurred. A sharp decline in world trade volume marked the subsequent world recession. It seems as if the world trade growth after the oil crises was slower than before and decelerated with the second oil price increase at the beginning of the 1980s. The decrease of world trade volume in 1983 displays the

following recession. Afterwards there was a long, stable increase in world trade which stopped in 1997 as the financial crisis of the Asian emerging countries dampened the international exchange. The millennium boom 2000 and the adjacent sharp decline which shows the recession especially of the USA in 2001 is also reflected in the time series. After 2002 trade volume expanded again continually.

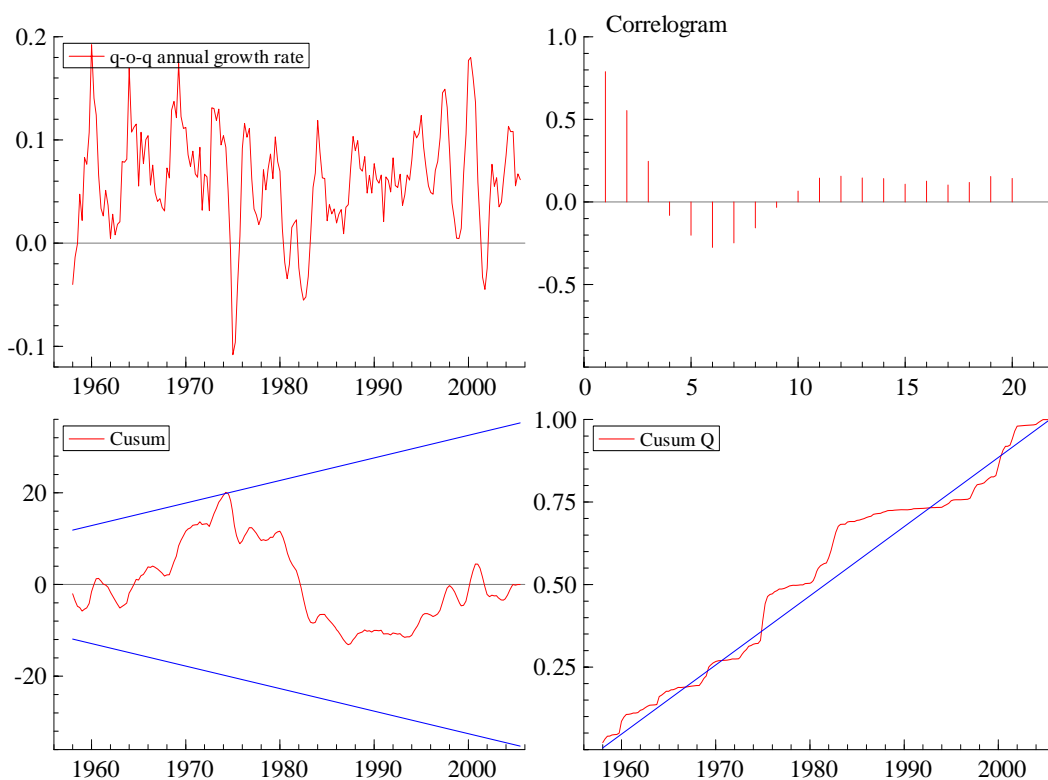
Since the selected time series show roughly the same behavior, the statistical description is nearly similar for the variables. Using the advantage of the long time-span of the IMF series, we concentrate only on that variable in the graphical and statistical presentation. In Figure 2 the quarter-on-quarter annual growth rate of the IMF World Trade Volume and the corresponding correlogram are displayed. In addition, the graphs for the Cusum and Cusum of squares tests are printed.

The quarter-on-quarter annual growth rate of the IMF World Trade Volume fluctuates around a mean of 6.2%. The CUSUM test indicates stationarity of the growth rate at a significance level of 10% (see Figure 2). The graph of the CUSUM test also confirms, that there are observable up and down swings in the growth rate of the trade volume. If we divide the sample into 10-year sub periods, it becomes apparent which phases under- and overperformed. From 1958 until 1967 the trade volume increased, on average (6.4%), whereas in the period from 1968 to 1977 it performed above average at 7.2%. Thereafter the growth slowed down from 1978 to 1987 with a mean of only 3.3%. The phase from 1988 to 1997 again shows above average performance with a mean of 7.5%. From 1998 until now the trade volume increased according to the overall mean (6.3%).

This analysis indicates that the trend of the time series is stochastic, which will be specified in the UC model in section 3. The CUSUM of squares test (CUSUM Q) detects no extraordinary changes in the variance of the growth rate. Only in the late 1970s and in the 1980s is there a noticeable deviation from the linear increase of the CUSUM Q. Overall, the growth rate of world trade volume is rather homoscedastic (see Figure 2). Of special interest is also the correlogram that displays the sample

autocorrelation function (ACF). The graph shows a cyclical autocorrelation in the world trade series. This fact, which is of major interest with regard to business cycle analysis and forecasting, needs further investigation. Therefore the UC model should consider one or more cycle components.

Figure 2: Descriptive Statistics of the q-o-q annual growth rate of the IMF World trade Volume



3 An Unobserved Components Model for World Trade Volume

The above-mentioned descriptive statistics of world trade volume provides information about the specification of the structural time series model. The results of the data description are straight forward: the time series exhibit a stochastic trend and the variance of the variables is determined by one or more cycles, which could be deterministic or stochastic. In addition, the IMF World Trade Volume, in contrast to the

OECD time series, is not seasonally adjusted. Therefore the model for this variable has to include a seasonal component.

In the following, we decompose the logarithm of world trade volume¹ y_t into the unobserved components trend μ_t , cycle ψ_t , season γ_t and the irregular ε_t (see Harvey 1989, Maravall 1997):

$$(1) \quad y_t = \mu_t + \psi_t + \gamma_t + \varepsilon_t, \quad \varepsilon_t \sim NID(0, \delta_\varepsilon^2), \quad t = 1, \dots, T.$$

The *stochastic trend* component μ_t is specified as:

$$(2) \quad \mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t, \quad \eta_t \sim NID(0, \delta_\eta^2),$$

$$(3) \quad \beta_t = \beta_{t-1} + \zeta_t, \quad \zeta_t \sim NID(0, \delta_\zeta^2).$$

where β_t is the slope of the trend μ_t . The irregular ε_t , the level disturbance η_t and the slope disturbance ζ_t are mutually uncorrelated. This specification is also called a *local linear trend* model (see e.g. Schlittgen/Streitberg 2001).

We specify the *stochastic cycle* ψ_t as the sum of M sub-cycles:

$$(4) \quad \psi_t = \sum_{i=1}^M \psi_{t,i}.$$

Each sub-cycle is specified as a vector AR(1) process (see, e.g., Flaig 2003):

$$(5) \quad \begin{bmatrix} \psi_{t,i} \\ \psi_{t,i}^* \end{bmatrix} = \rho_i \begin{bmatrix} \cos \lambda_i^c & \sin \lambda_i^c \\ -\sin \lambda_i^c & \cos \lambda_i^c \end{bmatrix} \begin{bmatrix} \psi_{t-1,i} \\ \psi_{t-1,i}^* \end{bmatrix} + \begin{bmatrix} \kappa_{t,i} \\ \kappa_{t,i}^* \end{bmatrix}.$$

where ρ_i , in the range $0 < \rho_i \leq 1$, is a damping factor; λ_i^c is the frequency, in radians, in the range $0 \leq \lambda_i^c \leq \pi$; $\kappa_{t,i}$ and $\kappa_{t,i}^*$ are two mutually uncorrelated NID disturbances with zero mean and common variance δ_κ^2 . Note that the period of the cycle is $2\pi / \lambda_i^c$. The variance of the cycle itself, δ_ψ^2 , is related to the variance of the disturbance term by

¹ In this case the components of the primal time series have a multiplicative relationship.

$\delta_\kappa^2 = (1 - \rho^2)\delta_\psi^2$. It follows that $\delta_\kappa^2 \rightarrow 0$ as $\rho \rightarrow 1$. In this case the stochastic cycle reduces to the deterministic, but stationary, cycle:

$$(6) \quad \psi_t = \psi_0 \cos \lambda_i^c t + \psi_0^* \sin \lambda_i^c t, \quad t = 1, \dots, T.$$

Since the calculated time series of the IMF World Trade Volume exhibits seasonal effects, a seasonal component is included in the UC model. In the case of the seasonally adjusted OECD time series, no seasonal component will be considered. The *stochastic season* γ_t can be modeled as a dummy variable approach or as a trigonometric seasonal cycle (see, e.g., Flaig 2003). The seasonal dummy approach is given by:

$$(7) \quad \gamma_t = -(\gamma_{t-1} + \gamma_{t-2} + \gamma_{t-3}) + \omega_t, \quad \omega_t \sim NID(0, \delta_\omega^2).$$

The trigonometric seasonal cycle approach starts from the idea that the seasonal effect at time t can be specified as the sum of two cycles with the seasonal frequencies $\pi/2$ (period of four quarters) and π (period of two quarters):

$$(8) \quad \gamma_t = \gamma_{t,1} + \gamma_{t,2}.$$

Each seasonal cycle can be described by a stochastic recursive formula (see Harvey 1989):

$$(9) \quad \begin{bmatrix} \gamma_{t,i} \\ \gamma_{t,i}^* \end{bmatrix} = \begin{bmatrix} \cos \lambda_i & \sin \lambda_i \\ -\sin \lambda_i & \cos \lambda_i \end{bmatrix} \begin{bmatrix} \gamma_{t-1,i} \\ \gamma_{t-1,i}^* \end{bmatrix} + \begin{bmatrix} \omega_{t,i} \\ \omega_{t,i}^* \end{bmatrix}.$$

$\lambda_i \equiv \pi i / 2$, $i=1,2$, denotes the seasonal frequencies and $(\omega_{t,i}, \omega_{t,i}^*)$ are two uncorrelated white noise random variables with common variance δ_ω^2 . For $i=2$ the component collapses to:

$$(10) \quad \gamma_{t,i} = \gamma_{t-1,i} \cos \lambda_i + \omega_{t,i}.$$

The *irregular component* ε_t reflects temporary shocks that are, as mentioned above, modeled as a white noise variable with the variance δ_ε^2 .

The model can be extended by intervention variables that capture outliers or structural breaks. An *outlier* can be thought of as an unusually large value of the irregular disturbance at a particular time. It can be captured by an impulse intervention dummy that takes the value one at the time of the outlier and zero elsewhere. A *structural break*, in which the *level* of the series shifts up or down, is modeled by a step intervention

variable, which is zero before the event and one after. This kind of break is identified by an unusually large value of the level disturbance. Analogically a large value of the slope disturbance indicates a *structural break* in the *slope*, which can be modeled by a staircase intervention, which is a trend variable taking values 1,2,3,...., starting in the period after the break.

Estimation of the model parameters is carried out by maximum likelihood in the time domain. The filtered and smoothed values of the unobserved components are generated by the Kalman filter. The estimations are done with STAMP 6.02. (see Koopman, Harvey, Doornik and Shephard 2000). For most of the initial values the default settings of STAMP are used.

4 Empirical Results

4.1 Estimation and Test Results

Starting from the above-mentioned analyses, local linear trend models with stochastic level and slope for the IMF and the OECD time series are estimated. Primarily we calculated the models without cycles, then we introduced in a second step a trigonometric cycle with one, two and three sub-cycles. Summary statistics are outlined in Table 1 and Table 2. In addition, we tested two variants of seasonal specification (trigonometric versus dummy variables) in the case of the IMF series.

The test statistics show that the best specification is a local linear trend model with three sub-cycles¹ (see Table 1 and Table 2). Since the results for the IMF series are similar for the two methods of seasonal adjustment, we display only the results for the model with three sub-cycles. Furthermore, we estimate models with fixed levels since this case of a smoothed trend plus cycle can often lead to a more attractive decomposition (see Koopman, Harvey, Doornik and Shephard 2000). The test results are robust. In the case of the OECD series, we prefer the smooth trend model to the local trend model (see Table 2). Since the residuals of the components (level, slope and irregular) don't

indicate any outlier or structural break of the underlying time series, intervention dummies aren't taken into account.

Table 1: Summary Statistics for the Local Linear Trend Model of IMFWTV (log)

IMFWTV (log)					
	logLik	AIC	SIC	LB	PEV
Trigonometric season					
No cycle	704.46	-7.44	-7.30	24.89	0.00054
1 Subcycle	710.88	-7.46	-7.28	14.74	0.00051
2 Sub-cycles	710.93	-7.43	-7.19	14.42	0.00051
3 Sub-cycles	714.28	-7.46	-7.18	11.35	0.00048
Dummy variable season					
3 Sub-cycles	714.98	-7.46	-7.18	11.34	0.00048
Smooth trend (dummy variable season)					
3 Sub-cycles	714.98	-7.47	-7.21	11.34	0.00048

Note: logLik denotes the maximized value of the likelihood function, AIC the Akaike information criterion and SIC the Schwartz information criterion. LB stands for the Ljung-Box-statistics with 18 lags and PEV for the prediction error variance. The estimation was calculated over the time-span from 1957:1 to 2005:3.

The analyses of the three sub-cycles indicate for both time series one cycle with a cycle period of 2.6 resp. 2.7 years, a second with 4.3 resp. 4.7 years, and a third one with 8.9 resp. 9.8 years (see Table A1 of the Appendix). Following the business cycle literature, the first cycle can be interpreted as a “Kitchin Cycle” (forty month cycle), which is also present in the inventory investment (see Langmantel 2005). The third cycle, of ca. 9 years, shows the properties of a “Juglar Cycle”, with a period between seven and ten years. The long “Juglar Cycle” is quite deterministic for both time series, since the damping factor ρ is converging to 1 (see Figure A1 and A2 of the Appendix). A matter

¹ Except the Schwartz information criteria, which weights strongly the degrees of freedom, all test results prefer the specification with three cycles.

of particular interest is the second cycle, with a period of 4.3 resp. 4.7 years, which is stochastic. This kind of cycle is not usual in business cycle analyses. In respect to forecasting issues, the consideration of this “unknown” cycle improves the estimation results.

Table 2: Summary Statistics for the Local Linear Trend Model of OECDWTV (log)

OECDWTV (log)					
	logLik	AIC	SIC	LB	PEV
No cycle	531.03	-8.80	-8.71	23.59	0.00014
1 Sub-cycle	541.28	-8.94	-8.77	12.16	0.00012
2 Sub-cycles	543.25	-8.92	-8.69	12.11	0.00011
3 Sub-cycles	543.66	-8.88	-8.58	11.85	0.00011
Smooth trend					
3 Sub-cycles	547.37	-9.01	-8.73	10.69	0.00010

Note: Notation see Table 1. The estimation with the OECD data was calculated over the time-span from 1975:1 to 2005:2.

The amplitudes of the three cycles for the IMF and the OECD series are listed in Table 3. The amplitudes for the “Kitchin Cycle” are quite similar for both series with 1% resp. 0.9% of the trend. The amplitude of the second cycle is nearly 0.5% of the trend for IMF series and 0.9% of the trend in the case of the OECD data. The long “Juglar Cycle” reveals the greatest amplitudes in both time series (see Table 3).

Table 3: Amplitudes of the three Cycles in Percent of the Trend (Approximately)

	IMFWTV (log)	OECDWTV (log)
Cycle 1 (~ 2.7 years)	0.99 %	0.85 %
Cycle 2 (~ 4.5 years)	0.54 %	0.85 %
Cycle 3 (~ 9.3 years)	1.48 %	2.79 %

4.2 Forecasting Results

The estimation results are used for forecasting issues. In a first step we calculate post-sample forecasts from 2003:1 to 2005:2 resp. 2005:3 for the two time series and analyze predictive tests. In Figure 3 to 4 one step predictions are presented. The prediction intervals are set at two root mean square errors (RMSE). As seen in Figure 3 the actual values of the IMFWTV (log) are all in the prediction interval and the residuals proceed inside the bandwidth of two RMSE. In Table 4 the predictive “failure” test (“post-sample Chow test”) and the cusum t-test for the two time series are outlined. Also the prediction tests for the OECDWTV forecasts are satisfactory (see Figure 4 and Table 4).

Figure 3: Post-sample Prediction Analysis of IMFWTV (log)

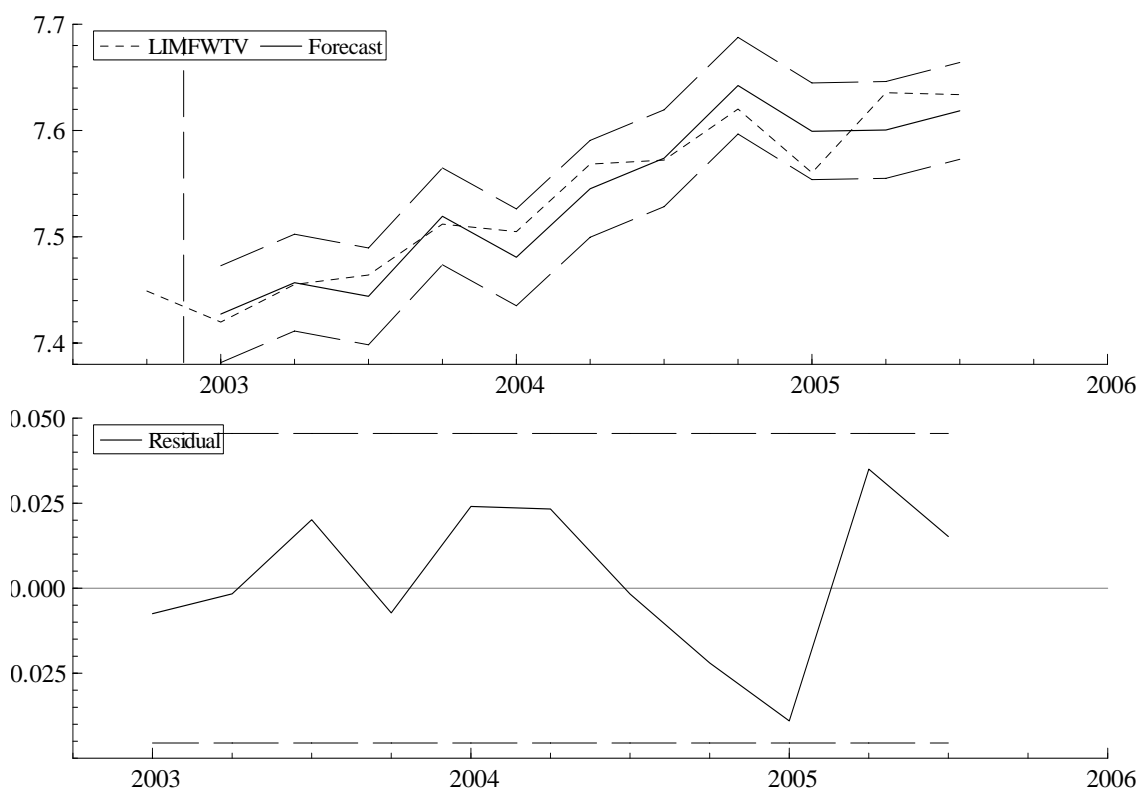


Figure 4: Post-sample Prediction Analysis of OECDWTV (log)

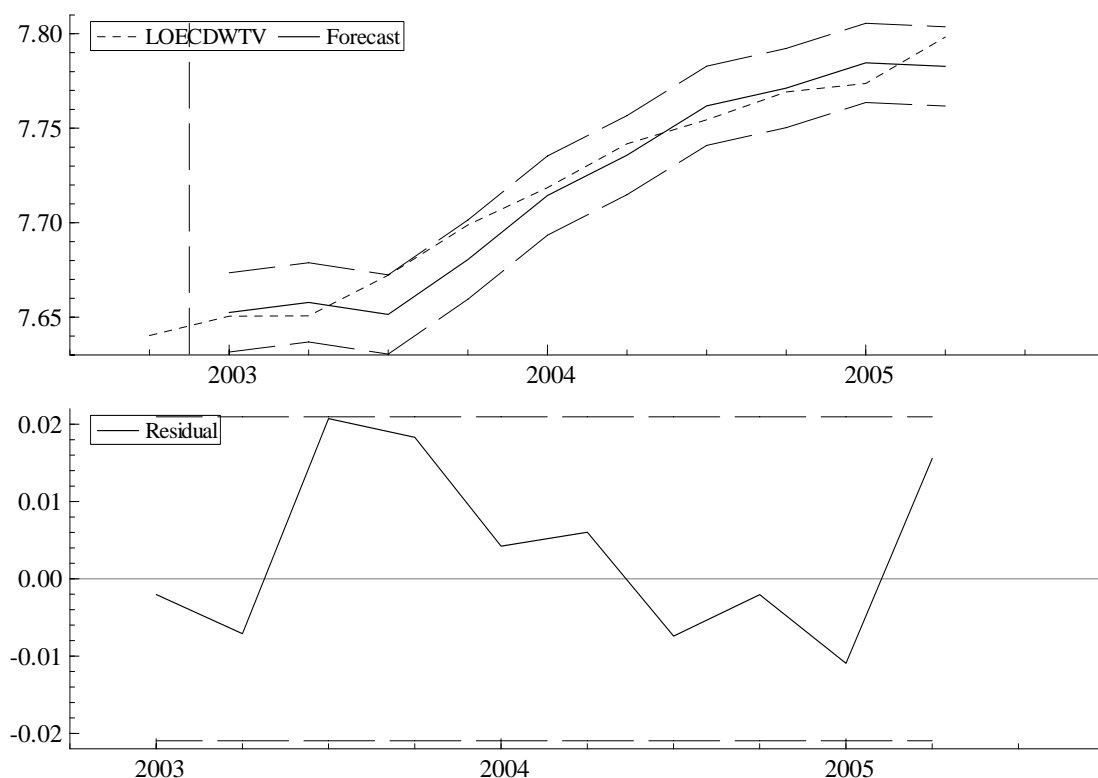


Table 4: Predictive Tests for IMFWTV (log), OECDWTV (log) and OEFWTV(log)

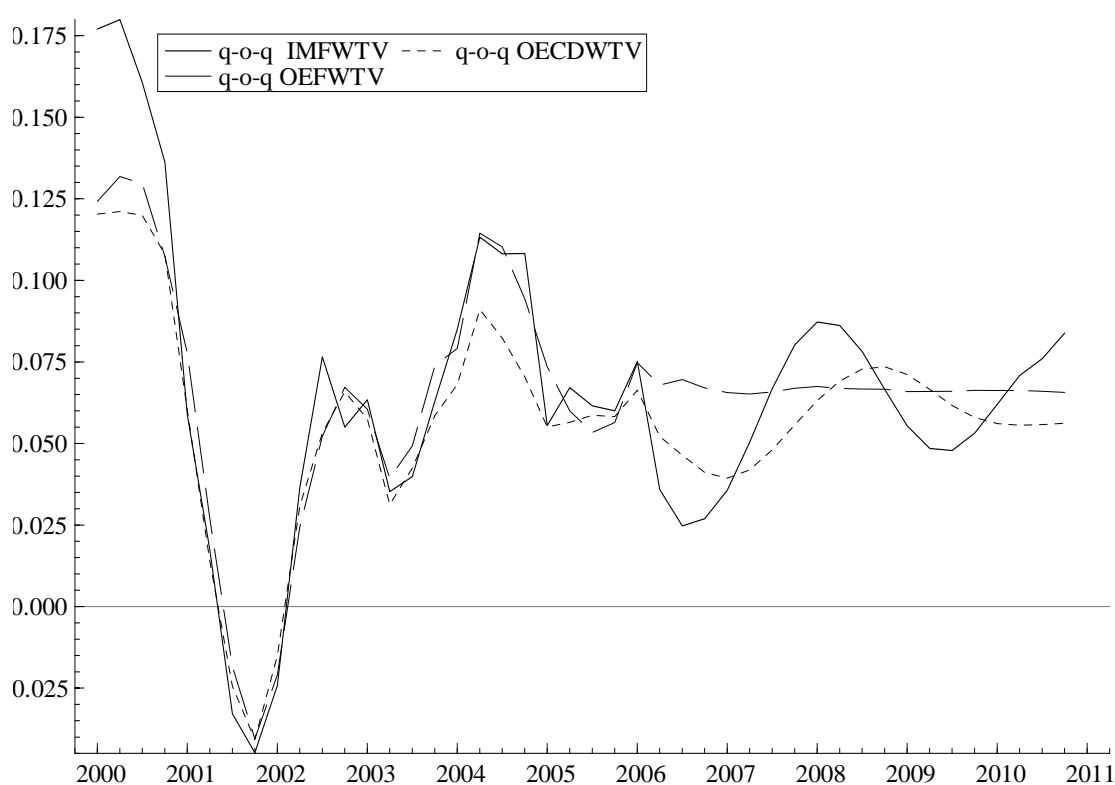
	IMFWTV (log)	OECDWTV (log)
Failure Chi2(11) test	9.848 [0.544]	11.785 [0.299]
Failure Chi2(10) test		
Cusum t(11) test	0.511 [0.692]	1.066 [0.311]
Cusum t(10) test		

Note: Probability value in square brackets.

In the next step forecasts from the end of the data period 2005:2 resp. from 2005:3 to 2010:4 are estimated. The forecasting of the univariate model is based on the information of the final state vector. The quarter-on-quarter annual growth rates from 2000:1 to 2010:4 for the two time series are represented in Figure 5. As a comparison, the estimated projections of a global macro model (Oxford Economic Forecasting

Model, Nov. 2005), which serves for forecasting issues, are also outlined. The graph reveals that the forecasts proceed divergently for the different data basis. The estimated cyclical behavior of the UC models clearly drives the forecast results. The projections of the OEF Global Model are based on linear extrapolations with constant growth rates in the future.

Figure 5: Forecasts of the Q-o-Q Annual Growth Rate of IMFWTV and OECDWTV with UC Models and OEFWTV with OEF Global Model



All series show a strong increase of world trade volume to the beginning of 2006. The IMF series marks a distinct upswing of the growth in world trade volume in the second and third quarter of 2006 with a recovery afterwards. The forecasts of the OECD data behave slightly differently. They show a smooth decrease of the q-o-q annual growth rates until 2007:2, whereas the average annual growth rate of 8.3% is clearly higher in 2006 than the growth rate of the IMF series at 5.3%. In Table 5 the average annual growth rates from 2005 until 2010 for the series are listed.

Table 5: Forecasts for the Annual Growth Rates of IMFWTV, OECDWTV and of the OEF Global Model

Period	IMFWTV	OECDWTV	OEF-Global-Model
2005	6.4 %	6.4 %	6.3 %
2006	5.3 %	8.3 %	7.2 %
2007	6.4 %	6.3 %	6.8 %
2008	6.8 %	7.2 %	6.9 %
2009	3.7 %	6.5 %	6.8 %
2010	6.1 %	4.5 %	6.8 %

The analysis reveals that all the measures of world trade volume show cyclical behavior. Both time series show a strong growth in the first quarter of 2006. The subsequent forecasting results and processes of the variables diverge distinctly. The projections are sensible in respect of the choice of the time series.

5 Conclusion

The study indicates that the method of structural time series model is useful for prognoses of world trade volume. The unobserved component model reveals that all measures of world trade volume display cyclical behavior. The analyses show that the process of the world trade volume is driven by the well-known fluctuations in form of the “Kitchin” and “Juglar Cycle”. Furthermore, there is one more cycle with a period between 4 and 5 years which improves the estimation results significantly. The information of the cyclical behavior of the time series is used for projections. A comparison with forecasting results of the OEF Global Model confirms the outcome of the unobserved component model. However, the long-term prognoses are sensible in respect of the underlying time series, which differ in the observation period, seasonal adjustment and calculation method.

Appendix A: Estimation Results

Figure A1: Components of IMFWTV (log)

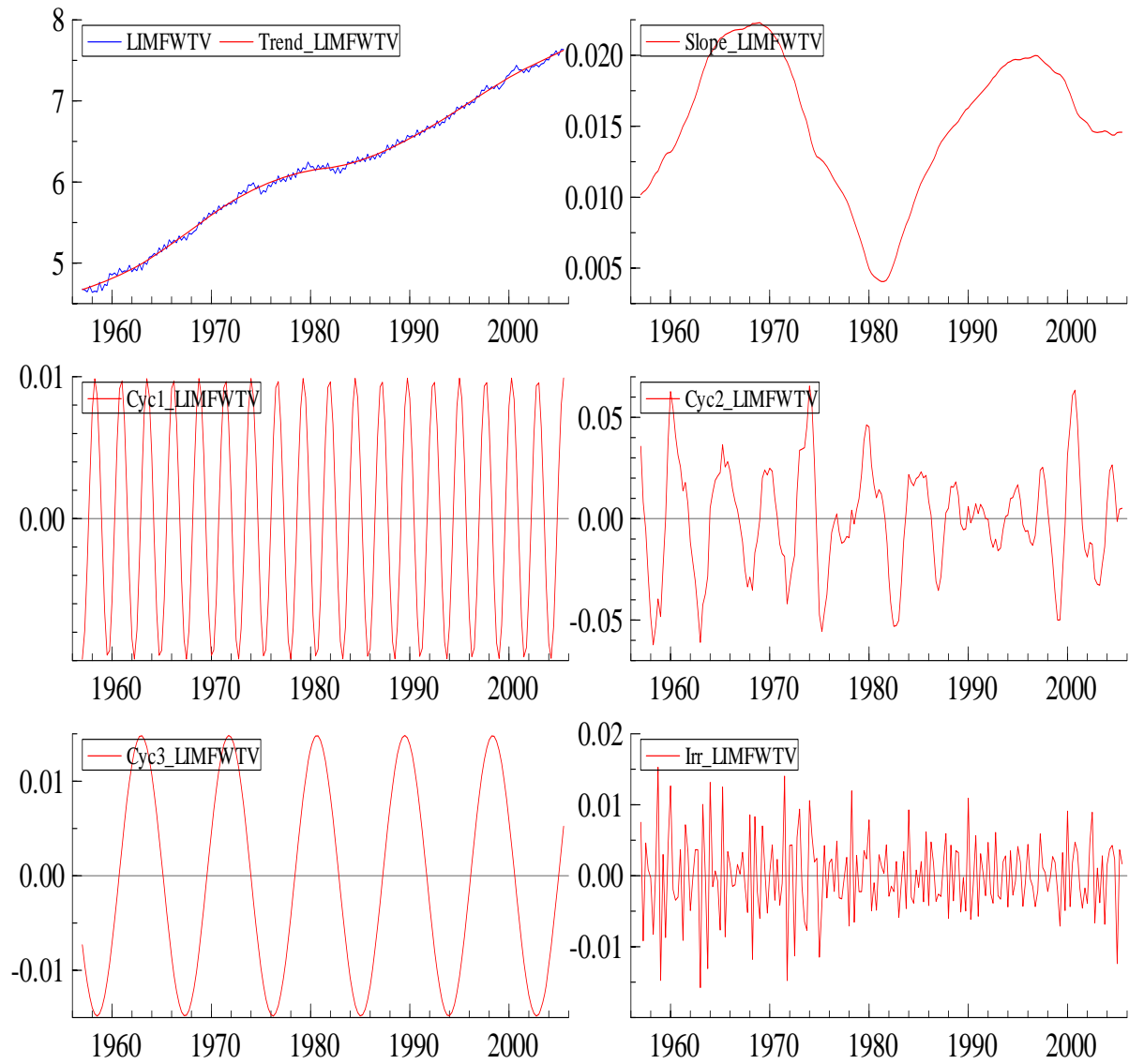


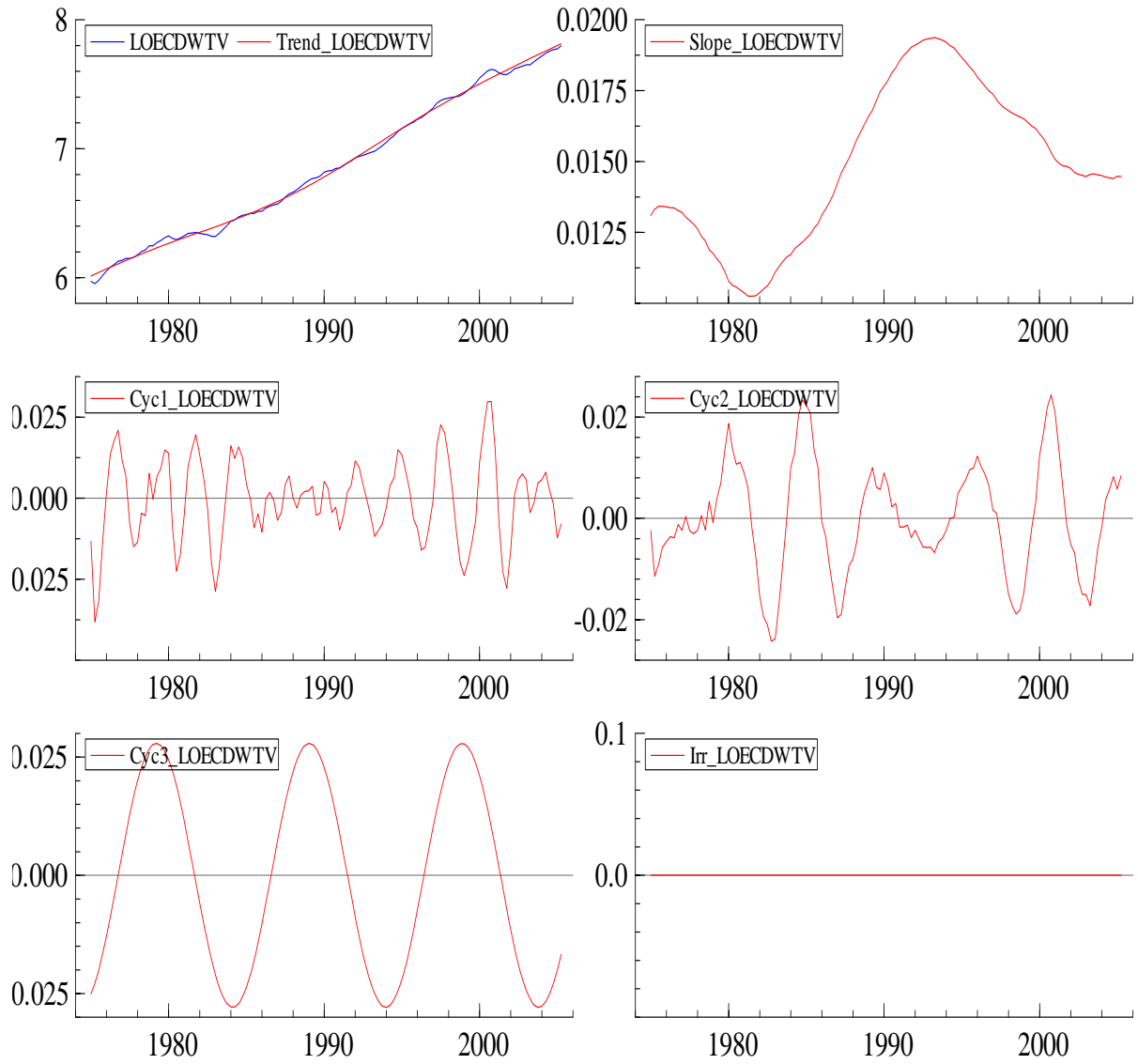
Figure A2: Components of OECDWTV (log)

Table A1: Estimation Results for the UC-Model of IMFWTV and OECDWTV

	IMFWTV	OECDWTV
Irregular δ_ε	0.0093	0.0000
Level δ_η	0.0000	0.0000
Slope δ_ζ	0.0014	0.0008
Seasonal δ_ω	0.0008	
Cycle 1 $\delta_{\psi 1}$ $\delta_{\kappa 1}$ ρ_1 λ_1^c Years= $2\pi / 4\lambda_1^c$	0.0078 0.0000 1.0000 0.5988 2.62	0.0015 0.0056 0.9277 0.5796 2.71
Cycle 2 $\delta_{\psi 2}$ $\delta_{\kappa 2}$ ρ_2 λ_2^c Years= $2\pi / 4\lambda_2^c$	0.0301 0.0117 0.9218 0.3651 4.30	0.0135 0.0043 0.9476 0.3298 4.76
Cycle 3 $\delta_{\psi 3}$ $\delta_{\kappa 3}$ ρ_3 λ_3^c Years= $2\pi / 4\lambda_3^c$	0.0121 0.0000 1.0000 0.1774 8.86	0.0204 0.0000 1.0000 0.1597 9.84
Sample	1957:1–2005:3	1975:1-2005:2

References

- Clark, P.* (1987), The Cyclical Component of U.S. Economic Activity, *Quarterly Journal of Economics*, Vol. 102, pp. 797-814.
- Flaig, G.* (2001), Trend and Cycles in U.S. Real GDP. Working Paper, No. 607, CESifo.
- Flaig, G.* (2002), Unobserved Components Models for Quaterly German GDP. Working Paper, No. 681, CESifo.
- Flaig, G.* (2003), Strukturelle Zeitreihenmodelle: Spezifikation, Schätzung und Anwendungen. *Wissenschaftliche Studien*, Heft 5, pp. 258-263.
- Flaig, G.* (2005), Time Series Properties of the German Production Index. *Allgemeines Statistisches Archiv*, in press.
- Gerlach, S., F. Smets* (1998), Output Gaps and Monetary Policy in the EMU Area, *European Economic Review*, Vol. 43, pp. 801-812.
- Harvey, A.* (1989), *Forecasting, Structural Time Series Models and the Kalman Filter*, Cambridge.
- Harvey, A., A. Jaeger* (1993), Detrending, Stylized Facts, and the Business Cycle, *Journal of Applied Econometrics*, Vol. 8, pp. 231-247.
- International Monetary Fund* (2005), *International Financial Statistics*, Washington.
- Kichian, M.* (1999), Measuring Potential Output within a State-Space Framework. Working Paper, No. 99, Bank of Canada.
- Koopman, S.J., A.C. Harvey, J.A. Doornik, N. Shephard* (2000), *Structural Time Series Analyser, Modeler and Predictor*. London.
- Langmantel, E.* (2005), Identifying the German Inventory Cycle: A Multivariate Structural Time Series Approach Using Survey Data, *Journal of Economics and Statistics*, Vol. 225, pp. 675-687.

Maravall, A. (1997), Unobserved Components in Economic Time Series. In: Pesaran, H., T. R. Wickens (eds.), *Handbook of Applied Econometrics – Macroeconomics*, Oxford, pp. 12-77.

Organisation for Economic Co-operation and Development (2005), *OECD Economic Outlook*, No. 78, Paris.

Oxford Economic Forecasting (2005), Global Model, Nov. 2005, Oxford.

Schlittgen, R., B. Streitberg (2001), *Zeitreihenanalyse*, München.

Watson, M. (1986), Univariate Detrending Methods with Stochastic Trends, *Journal of Monetary Economics*, Vol. 18, pp. 49-75.

Ifo Working Papers

- No. 29 Holzner, Chr., V. Meier, and M. Werding, Time Limits in a Two-tier Unemployment Benefit Scheme under Involuntary Unemployment, April 2006.
- No. 28 Eggert, W. and A. Haufler, Company Tax Coordination cum Tax Rate Competition in the European Union, April 2006.
- No. 27 Lachenmaier, S. and H. Rottmann, Employment Effects of Innovation at the Firm Level, April 2006.
- No. 26 Radulescu, D.M. and M. Stimmelmayer, Does Incorporation Matter? Quantifying the Welfare Loss of Non-Uniform Taxation across Sectors, March 2006.
- No. 25 Lessmann, Chr., Fiscal Decentralization and Regional Disparity: A Panel Data Approach for OECD Countries, March 2006.
- No. 24 Fuchs, Th., Industry Structure and Productivity Growth: Panel Data Evidence for Germany from 1971–2000, December 2005.
- No. 23 Holzner, Chr. and A. Launov, Search Equilibrium, Production Parameters and Social Returns to Education: Theory and Estimation, December 2005.
- No. 22 Sülzle, K., Stable and Efficient Electronic Business Networks: Key Players and the Dilemma of Peripheral Firms, December 2005.
- No. 21 Wohlrabe, K. and M. Fuchs, The European Union's Trade Potential after the Enlargement in 2004, November 2005.
- No. 20 Radulescu, D.M. and M. Stimmelmayer, Implementing a Dual Income Tax in Germany: Effects on Investment and Welfare, November 2005.
- No. 19 Osterkamp, R. and O. Röhn, Being on Sick Leave – Possible Explanations for Differences of Sick-leave Days Across Countries, November 2005.
- No. 18 Kuhlmann, A., Privatization Incentives – A Wage Bargaining Approach, November 2005.

- No. 17 Schütz, G. und L. Wößmann, Chancengleichheit im Schulsystem: Internationale deskriptive Evidenz und mögliche Bestimmungsfaktoren, Oktober 2005.
- No. 16 Wößmann, L., Ursachen der PISA-Ergebnisse: Untersuchungen auf Basis der internationalen Mikrodaten, August 2005.
- No. 15 Flaig, G. and H. Rottmann, Labour Market Institutions and Employment Thresholds. An International Comparison, August 2005.
- No. 14 Hülsewig, O., E. Mayer and T. Wollmershäuser, Bank Loan Supply and Monetary Transmission in Germany: An Assessment Based on Matching Impulse Responses, August 2005.
- No. 13 Abberger, K., The Use of Qualitative Business Tendency Surveys for Forecasting Business Investing in Germany, June 2005.
- No. 12 Thum, M. Korruption und Schattenwirtschaft, Juni 2005.
- No. 11 Abberger, K., Qualitative Business Surveys and the Assessment of Employment – A Case Study for Germany, June 2005.
- No. 10 Berlemann, M. and F. Nelson, Forecasting Inflation via Experimental Stock Markets: Some Results from Pilot Markets, June 2005.
- No. 9 Henzel, S. and T. Wollmershäuser, An Alternative to the Carlson-Parkin Method for the Quantification of Qualitative Inflation Expectations: Evidence from the Ifo World Economic Survey, June 2005.
- No. 8 Fuchs, Th. and L. Wößmann, Computers and Student Learning: Bivariate and Multivariate Evidence on the Availability and Use of Computers at Home and at School, May 2005.
- No. 7 Werding, M., Survivor Benefits and the Gender Tax-Gap in Public Pension Schemes – Work Incentives and Options for Reform, May 2005.
- No. 6 Holzner, Chr., Search Frictions, Credit Constraints and Firm Financed General Training, May 2005.