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The present crisis and German crisis patterns

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Abstract

This paper analyzes the main cyclical features of the present crisis in light of the FRG’s cyclical experience. The starting point is a four-phase classification (lower turning point (LTP), upswing (UP), upper turning point (UTP) and downswing (DOWN) of the cycle by linear multivariate discriminant analysis (LDA) and dynamic linear discriminant analysis (DLDA)). After examining the stability of the discriminant analysis with both LDA and DLDA, we find that compared to previous German cycles, the financial crisis 2008ff had particular and unique consequences. First, the cycle stopped prematurely the UTP-phase, skipping the DOWN-phase and discharging immediately into a crisis, or the LTP-phase. While there had been extreme short LTP phases before, the complete absence of a phase is a new experience for Germany. All in all, the tenth cycle (2002-I to 2008-III) does not exhibit any particularities and certainly not the characteristics of a cycle stopped by stabilization requirements or an oil price shock. In contrast, the UTP-phase was unusually smooth. This is underlined by the rather good LDA and DLDA classification results for the tenth cycle and the LTP of the eleventh. All in all, while for the U.S. the financial crisis and its aftermath are seen as a “perfect storm” (Ray Fair), for Germany it was a “shock” that quickly propagated and led the economy into a crisis that was hardly imaginable. Whether the lack of previous distortions and maladjustments will lead the country quickly out of crisis once world trade finds its way back to its previous path to expansion remains to be seen. Reactions identified here would not contradict such expectations.

Key Words: German business cycle, four-phase scheme, linear discriminant analysis, dynamic discriminant analysis

JEL Classification: E29, E32, O52

1. Introduction

The global financial crisis 2008ff is the deepest and longest global crisis, and for many countries it is the worst national recession since World War II.[1] While the crisis has not yet ended, a number of crucial questions have arisen already. What caused or triggered the crisis in the financial sector and in the real sector in the U.S. and elsewhere? How did these impulses propagate through the national and international economies? To what extent were these impulses reinforced by a change of macroeconomic behaviour and what were its effects? In the end, responses to these questions should answer more general questions such as "How could the crisis happen at all – hadn't we been assured that the business cycle is under control" (Lucas 2003)? How could the crisis spread so fast and so broadly over the world and through national economies? How could it affect countries such as Japan or Germany so seriously and so much more than justified by their trade links? Are we confronted with a new mode of cycles or cyclical behaviour or is the present experience in line with previous experiences?

A final answer to most of these questions will have to wait, in particular those for the comparative role of impulses and propagation in the present crisis. What can be examined now is the question of whether the present crisis means the start of a new cyclical pattern of crisis. In which aspects it differs from Germany's cyclical experience can be addressed now and this is what the present paper addresses. For this we employ a four-phase scheme to classify the German business cycle. Its origin and features have been laid out before (Heilemann, Münch, 1999; Heilemann, Schuhr, 2008) and current details will be presented below.

In this paper we examine,

– to which degree the LDA and DLDA classification results for the period 2008-I to 2009-IV are in accordance with previous results and how the past cycle 2002-I to 2008-III might have changed German cyclical experience;

– which variables/parameters might have contributed to the changes of the picture of the German cycle. While the scheme employed does not allow causal analyses in the strict sense, LDA and DLDA allow some answers to these questions.

The literature on these questions is somewhat split. The general literature has been presented before (Heilemann and Münch, 1999) including references to the Burns and Mitchell (1947) reference cycle scheme and its possibilities and limitations (Zarnowitz and Moore, 1986). More specific approaches such as that of Meyer and Weinberg (1975, 1976) which established a predecessor of the present scheme have not been taken up again except by the present authors. Recently the business cycle and its classification enjoyed a kind of renaissance. Now not only the IFO Institute (see Abberger, Nierhaus, 2010) but also Statistics Netherland (Ruth, Schouten, Wekker, 2005), the German Statistical Office (Statistisches Bundesamt, 2010), Eurostat (Eurostat, 2010) and the EC (Gayer, 2010) report this kind of information. While they share with the present scheme the idea of a four-phase-cycle, they are basically production oriented and they do not share a broader, multivariate understanding of the cycle and do not include explicitly in their pictures inflation, the labour market or the monetary sector. In addition, most of these approaches do not look back much and have a history that is too short to examine their stability.

The next section of the paper (2) gives an overview of the methodology employed, which is of linear multivariate discriminant analysis (LDA) and a dynamic linear multivariate discriminant analysis

[1] For details and comparisons with previous post WW II crises see Reinhart, Rogoff, 2009, 248ff.

(DLDA), the classification scheme, and the final dating of the four phases of the German business cycle from 1955 to 2009. Section 3 looks at the results of various classification exercises to explore the role of the present crisis for classification, its consequences for the picture of Germany's cyclical experience, and the role played by the classificators. Section 4 summarizes the findings and evaluates their implications for the present crisis and for German business cyclical analysis in general.

2. The classification scheme

The basic purpose of the cycle scheme, its hypotheses, and its empirical foundations have been laid out in detail before (Heilemann, Münch, 1999) so we can be brief on these matters.

The reference system necessary for LDA was a four-phase cycle scheme composed, in our terms, by "upswing" (UP), "upper turning point" (UTP), "downswing" (DOWN), and "lower turning point" (LTP) [2] (see Haberler, 1937, pp. 257ff). The taxonomy does not require every cycle to include all phases. The scheme was developed from the two-phase (upswing/downswing) classification of the Deutsche Bundesbank (1991ff) and extended to a four-phase scheme by classifying the two quarters before and after the upper and lower turning points as UTP or LTP. The accuracy of this *a priori*-classification was tested by LDA and DLDA, which classify an observation into one of a set of given groups—stages or phases of the business cycle (a formal description of LDA and DLDA is given in the Appendix).

Table 1 Classification of (West) German business cycle into a four-stage scheme (1955-II to 2009-IV)

	Cycle		Starting quarter of phases[1]							
			Lower turning point		Upswing		Upper turning point		Downswing	
2	[1955-II] – 1958-II	[21]	…	…	…	…	1955-II	(4)	1956-II	(9)
3	1958-III – 1962-IV	(18)	1958-III	(4)	1959-III	(3)	1960-II	(5)	1961-III	(6)
4	1963-I – 1966-IV	(16)	1963-I	(1)	1963-II	(6)	1964-IV	(3)	1965-III	(6)
5	1967-I – 1971-I	(17)	1967-I	(4)	1968-I	(6)	1969-III	(2)	1970-I	(5)
6	1971-II – 1974-I	(12)	1971-II	(4)	1972-II	(2)	1972-IV	(2)	1973-II	(4)
7	1974-II – 1982-I	(32)	1974-II	(7)	1976-I	(13)	1979-II	(4)	1980-II	(8)
8	1982-II – 1994-I	(48)	1982-II	(6)	1983-IV	(27)	1990-III	(6)	1992-I	(9)
9	1994-II – 2001-IV	(31)	1994-II	(1)	1994-III	(23)	2000-II	(5)	2001-III	(2)
10	2002-I – 2008-III	(27)	2002-I	(7)	2003-IV	(17)	2008-I	(3)	-	(0)
11	2008-IV – [2009-IV]	[5]	2008-IV	[5]	…	…	…	…	…	…
All	1955-II – 2009-IV	219 (∅25)		39 (∅4)		97 (∅12)		34 (∅4)		49 (∅5)

Authors' computations. – 1) In parentheses: cycle/phase lengths in quarters.

The selection of the discriminators is based on economic theory and general knowledge of the German business cycle. Since the goal of the scheme is to translate macroeconomic forecasts into

[2] We use the well established term „turning point" even though UTP and LTP denote phases.

cycle terminology, we restricted the list of candidates to variables predicted in macroeconomic forecasts. We examined with LDA the classificatory contribution of more than 100 variables in the sample period of 1955-II to 2004-IV. Finally, with three discriminant functions we identified eight variables[3] explaining the *a priori* classification. As usual with this way of classification, a few and, in most cases, small modifications of the *a priori* dating of the phases were necessary. Boundary periods of cycle phases were iteratively re-assigned according to the classifications by LDA until the number of misclassifications at the boundaries was minimized. The final or *a posteriori* dating of the cycles is very similar to the Bundesbank's classification (based on trend deviation of industrial production) and also to that of the Economic Cycle Research Institute (2010) (based on filtering time series) (Table 1).

Table 2 LDA and DLDA classification results

Final phase[1,2]	No. of cases	Predicted phase[1] by LDA and DLDA[3]							
		LTP		UP		UTP		DOWN	
		Cycle 7 to 11 (1974-II to 2009-IV)							
LTP	26	22	(21)	2	(2)	0	(1)	2	(2)
UP	80	1	(3)	72	(72)	7	(5)	0	(0)
UTP	18	0	(0)	0	(1)	18	(17)	0	(0)
DOWN	19	1	(1)	0	(0)	0	(1)	18	(17)
Sum	143	24	(25)	74	(75)	25	(24)	20	(19)
Error rate: 9.1% (11.2%)									
		Cycle 7 to 9 (1974-II to 2001-IV)							
LTP	14	10	(10)	1	(2)	0	(0)	3	(2)
UP	63	0	(1)	58	(57)	5	(5)	0	(0)
UTP	15	0	(0)	1	(1)	14	(14)	0	(0)
DOWN	19	0	(1)	0	(0)	0	(1)	19	(17)
Sum	111	10	(12)	60	(60)	19	(20)	22	(19)
Error rate: 9.0% (11.7%)									
		Cycle 9 to 11 (1994-II to 2009-IV)							
LTP	13	11	(12)	1	(0)	0	(0)	1	(1)
UP	40	0	(0)	40	(40)	0	(0)	0	(0)
UTP	8	0	(0)	0	(0)	8	(8)	0	(0)
DOWN	2	0	(0)	0	(0)	0	(0)	2	(2)
Sum	63	11	(12)	41	(40)	8	(8)	3	(3)
Error rate: 3.2% (1.6%)									

Authors' computations.– 1) LTP: Lower turning point. UP: Upswing. UTP: Upper turning point. DOWN: Downswing. – 2) Phases according to the classifications in Table 1. – 3) DLDA classifications in parentheses.

[3] The number of variables used for the classification has occasionally been slightly changed. The present set of variables differs from the previously used set by excluding real private consumption, real investment in construction, private consumption deflator, and government deficit. The set is in use at the RWI since 2005. (Rheinisch-Westfälisches Institut für Wirtschaftsforschung, 2005, pp. 26ff.) The differences to the previously used set, however, are small (Heilemann, Schuhr, 2008).

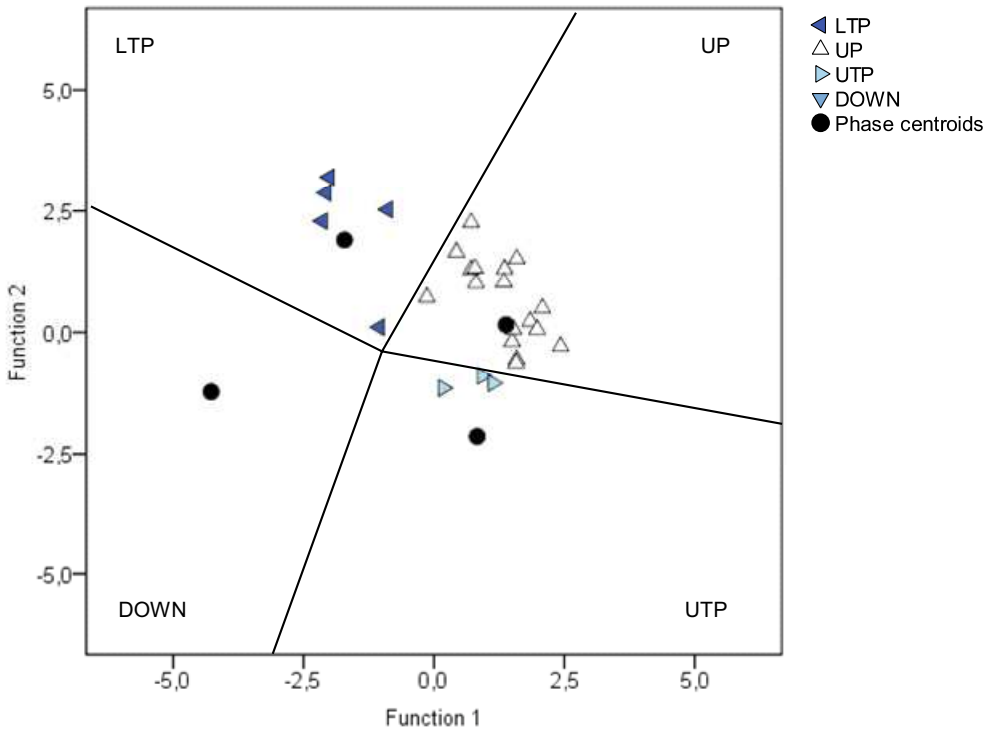
Table 3 Standardized canonical discriminant functions (1974–2009)

Variable		Coefficients of discriminant functions[1] 1	2	3	*F*-Value[3]	T^2-Value[4]
Wage and salary earners[2]	a	.61	-.30	.38	53.83	1.16
	b	.68	-.41	.13	56.47	1.58
	c	1.13	.01	-.55	9.82	.50
Real GNP[2]	a	-.10	-.83	-.10	41.82	.90
	b	.08	-.79	-.27	30.60	.86
	c	-1.83	.46	-.29	15.69	.80
Real investment in plant and equipment[2]	a	.75	.29	-.25	59.68	1.29
	b	.42	.54	.47	45.89	1.29
	c	1.92	-.10	.66	30.22	1.54
Net exports as percent of GNP	a	.48	.49	.74	11.53	.25
	b	.36	.52	.32	7.81	.22
	c	.58	.59	1.29	.91	.05
GNP price deflator[2]	a	1.02	1.44	-.07	13.58	.29
	b	.56	1.50	.89	19.75	.55
	c	1.61	-1.25	-.40	5.20	.26
Unit labour cost[2]	a	-.10	-.33	.42	20.71	.45
	b	.06	-.39	-.22	17.02	.48
	c	-1.48	.72	1.21	8.03	.41
Short term interest rate	a	-1.57	-1.21	.05	33.63	.73
	b	-1.24	-1.03	.24	33.84	.95
	c	-1.68	1.11	-.10	7.74	.39
Real long term interest rate	a	1.12	.76	.14	3.95	.09
	b	.89	.82	.44	2.12	.06
	c	2.57	-.14	.99	3.45	.18

	Function[1]	Eigen-value	Percent of variance	Canonical correlation	Test of function(s)	Wilks` λ	χ^2	Degree of freedom	Significance	Mult. T^2-Value[5]
a	1	4.24	72.7	.90	1 to 3	.07	361.9	24	.00	5.83
	2	1.49	25.6	.77	2 to 3	.37	136.7	14	.00	
	3	.10	1.6	.30	3	.91	12.5	6	.05	
b	1	4.55	71.8	.91	1 to 3	.06	292.1	24	.00	6.34
	2	1.67	26.4	.79	2 to 3	.33	113.9	14	.00	
	3	.12	1.9	.33	3	.89	11.6	6	.07	
c	1	5.36	74.4	.92	1 to 3	.05	170.5	24	.00	7.21
	2	1.56	21.6	.78	2 to 3	.30	66.9	14	.00	
	3	.29	4.1	.48	3	.77	14.4	6	.03	

Authors' computations. – 1) Results for period a: 1974-II to 2009-IV, b: 1974-II to 2001-IV, c: 1994-II to 2009-IV. – 2) Rates of change in percent. – 3) *F*-to-enter-statistic. – 4) Univariate measure of separation. – 5) Multivariate measure of separation.

Figure 1 Canonical discriminant functions and classifications[1,2] (2003–2009)



Authors' computations. – 1) LTP: Lower turning point. UP: upswing. UTP: Upper turning point. DOWN: Downswing. – 2) Discriminant scores for the quarters 2003-IV to 2009-IV. The discriminant functions based on data from the sample period 1974-II to 2009-IV.

The total error rate, the share of quarters misclassified by LDA in the sample period 1974-II to 2009-IV, is 9 percent (LTP: 15 percent; UP: 10; UTP: 0; DOWN: 5) (Table 2). The accuracy of LTP and UP classification corresponds to our experience with the results of quantitative measures of macroeconomic forecasts; those for the two other phases are surprising. Although in-sample tests are rather weak in general and in classification in particular, in a number of other tests (different sample periods, "leave one cycle (phase) out," etc.) the results proved to be rather robust (Heilemann, Münch, 1999; Heilemann, Schuhr, 2008). This holds with respect to accuracy of classification as well as to selection and classification weight of variables. A more detailed look at the accuracy of the classifications will follow in the next section.

The variables used for classification[4] and the estimation results for the three discriminant functions 1974-II to 2009-IV—the sample period covers only full cycles except the last—are shown in Table 3.[5] The sample period had to be shortened not only for stability reasons,[6] but mostly because of the general revision of NA. Although the LDA sample starts only in 1974-II, previous classification results for the period 1955-IV to 1974-I did not change. As before, the bulk of explanation in the three discriminant functions is borne by the first and second function, which are supposed to discriminate between the "upswing periods" (UP, UTP) and, in traditional terms, the "downswing periods" (DOWN

4 Previous analyses were based on twelve variables.

5 Estimations were made with the SPSS 17 routine DISCRIMINANT. Table 3 presents results for the sample period 1974-II to 2009-IV and for two sub-sample periods (1974-II to 2001-IV and 1994-II to 2009-IV).

6 The stability of various versions of our scheme for Germany has been widely analyzed (Heilemann, Schuhr, 2008; Heilemann, Münch, 1999).

and LTP) (Mayer, Weinberg, 1975). The explanatory contribution of the third function is as it was in previous estimations—very low—and has been kept to facilitate comparisons with previous results.

The eight variables employed were still rather successful in separating the four cyclical phases. Concentrating on the sample period 1994-II to 2009-IV, the explanatory power of the first discriminant function measured by the eigenvalue ratio, is with 74.4 percent, rather high and much ahead of the second (21.6 percent). The third function with 4.1 percent is considerably lower, but Wilk's λ and the corresponding χ^2 value indicate that the function still contributes significantly to the separation of groups. The parameters of six of the eight variables are statistically significant even in this short sample period (F-values to enter, T^2).

3. The crisis 2008ff

The classification results have a number of explicit and implicit economic implications. However, their analysis and interpretations are limited for two reasons: first, methodical reasons suggest a cautious interpretation of parameter estimates or weights of the discriminant functions and second, similar economic reasons. Despite using growth rates or ratios, most variables are significantly correlated for definitional reasons (GDP and investment) or functional reasons (unit labour cost and prices). Even more restrictive is that the eight variables employed for classification do not include all variables usually employed to render a picture of the cycle. While for classification the specification of the discriminant is usually sufficient as the results have documented in the present case, the analysis would have benefitted if the discriminant functions had included exports and not just "net exports."

3.1 Duration, intensity, predictability

In summer 2010 the 2008ff crisis in Germany is far from being over in the sense that the pre-crisis level of activity has been reached. It is clear already now that it will be Germany's deepest and longest crisis. The crisis started in the U.S. in December 2007.[7] Though Germany's macro-economic activity came under stress in summer 2008 with a temporary jump of oil prices and by the ECB' s increase of interest rates, it took until autumn for policy and the business sector realized the dangers coming from the steep decline of world trade. The UTP and hence the tenth cycle[8] came to a premature end, passing over the DOWN-phase and entering directly the LTP. While the classification scheme allows missing phases or "incomplete" cycles, this is the first time in Germany's cyclical history that a phase was completely missed.[9] The start of LTP may be disputed. While LDA let the LTP start completely undisputed[10] in 2008-IV (Table 5), DLDA classifies 2008-IV as UTP and let LTP start only in 2009-I. However, the DOWN-phase is also missed. The same conclusion results from "predictions" for 2008-I to 2009 based on other samples (not shown here) while they are by a small margin in favour of dating the onset of crisis in 2009-I.

Of course, quarterly data do not tell the whole story. However, looking at the quarterly data (Figure 4, Appendix) and their phase averages (Table 6, Appendix) reveals that this time the culprits were the

7 See NBER URL: http://www.nber.org/cycles/sept2010.html. Retrieved 2010-9-23.

8 Cycles and phases can be separated for analytical purposes by statistical means, but from an economic perspective they are not independent of each other.

9 A second case could have been the LTP in 1994-II which is classified as UP by LDA and DLDA (Table 5 and 6.)

10 As signalled by the probabilities for other "in-the-sample" classifications based on both the sample periods 1974-II to 2009-IV and 1994-II to 2009-IV as well as for other "out-of-the-sample" classifications based on the sample 1994-II to 2007-IV.

steep decline of net exports and real investment.[11] Unit labour cost, inflation or interest rates—the usual harbingers of a stabilization crisis—were of uncritical magnitudes as a comparison with the "oil crises" (seventh cycle) reveals. It fits into this picture that the tenth cycle was the third longest cycle. It ended prematurely as the short length of the UTP-phase and the missing down-phase signal.

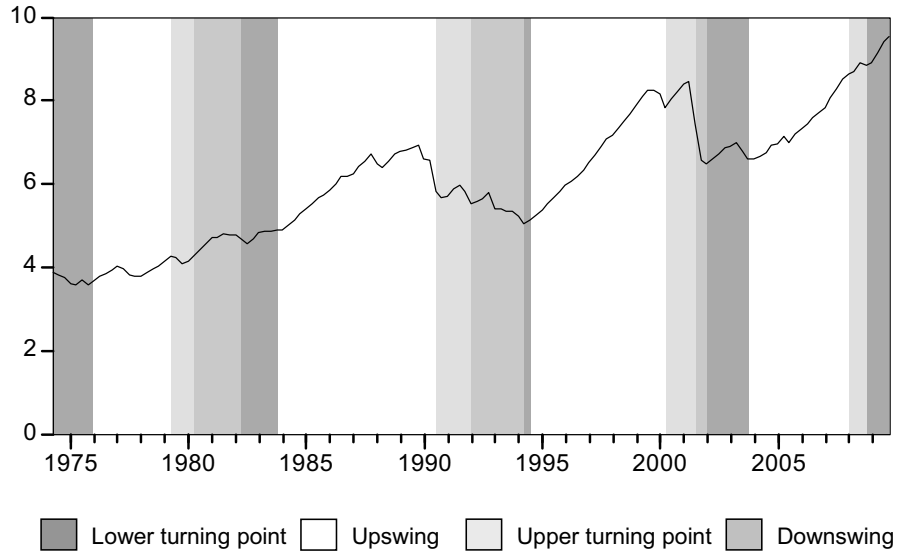
As the DLDA exposes, the separation power of the set of discriminant variables is unusually high in the periods 2008-I ff (Figure 2). The continuous rise of the separation measure since the 1980s reflects initialization difficulties. However, with respect to the tenth cycle, several features confirm the findings:

- the Upswing phase does not show any signs of "exhaustion" as in the previous two cycles;
- neither does the very brief UTP-phase show any signs of decline, and, most important,
- the LTP-phase shows an unusual increase of the measure. It does not hint at a missing downswing phase but points at a more complex picture of the contributions of the discriminant variables than in a typical LTP-phase.

Examining the univariate DLDA results renders a differentiated picture (Figure 3). The Indispensability measures clearly back the results of the multivariate analysis, with unit labour cost being the sole exception. However, looking at the separating power, with the exception of net exports and real long term interest rates, all variables show a loss of separating power.

How does the crisis or, more general, the tenth cycle affect the overall picture of (West) Germany's cyclical experience? Looking at Tables 2 and 3 the answer is not much, which is somewhat surprising. The classification errors of the various samples do not differ from that of previous samples; the same holds for the discriminant functions. Of course, given the small number of new observations, expectations should be modest. However, also the leave-one cycle-out tests yield the highest influence for the eighth cycle – including German Unification – while the tenth cycle ranks fourth.

Figure 2 Dynamic multivariate measure of separation (1974–2009)



Authors' computations.

[11] See also Projektgruppe Gemeinschaftsdiagnose [Joint Diagnosis] 2010. Stocks should be added here. However, in establishing the present scheme they could not be identified as a significant classifier.

Table 4 LDA and DLDA[1] classification errors (1974–2009)

Cycle[3]	Quarter	Phase[2]		A posteriori phase probabilities[2]			
		final[3]	predicted	LTP	UP	UTP	DOWN
7	1975-IV	LTP	UP	.2475	.7525	.0000	.0000
		(LTP)	(UP)	(.0593)	(.9402)	(.0005)	(.0000)
8	1982-II	LTP	DOWN	.0286	.0000	.0000	.9714
		(LTP)	(DOWN)	(.0252)	(.0000)	(.0000)	(.9748)
	1982-III	LTP	DOWN	.0459	.0000	.0000	.9541
		(LTP)	(DOWN)	(.2657)	(.0000)	(.0000)	(.7343)
	1983-III	LTP	UP	.4006	.5962	.0029	.0003
	1984-II	UP	LTP	.7294	.1370	.0712	.0623
		(UP)	(LTP)	(.5089)	(.4819)	(.0058)	(.0035)
	1989-I	UP	UTP	.0001	.4210	.5789	.0000
		(UP)	(UTP)	(.0000)	(.3636)	(.6364)	(.0000)
	1989-II	UP	UTP	.0000	.2882	.7117	.0000
		(UP)	(UTP)	(.0000)	(.1986)	(.8014)	(.0000)
	1989-III	UP	UTP	.0019	.3839	.6142	.0000
	1989-IV	UP	UTP	.0005	.2152	.7844	.0000
		(UP)	(UTP)	(.0000)	(.3757)	(.6243)	(.0000)
	1990-I	UP	UTP	.0000	.2793	.7207	.0000
		(UP)	(UTP)	(.0000)	(.2717)	(.7283)	(.0000)
	1990-II	UP	UTP	.0000	.1653	.8347	.0000
		(UP)	(UTP)	(.0000)	(.3321)	(.6679)	(.0000)
	1990-III	(UTP)	(UP)	(.0000)	(.6205)	(.3795)	(.0000)
9	1994-II	(LTP)	(UP)	(.2559)	(.6544)	(.0390)	(.0506)
	2000-I	UP	UTP	.0000	.3106	.6894	.0000
	2001-III	(DOWN)	(UTP)	(.0454)	(.0006)	(.6475)	(.3065)
	2001-IV	DOWN	LTP	.8880	.0150	.0049	.0921
		(DOWN)	(LTP)	(.8875)	(.0021)	(.0395)	(.0708)
10	2003-IV	(UP)	(LTP)	(.8951)	(.1049)	(.0000)	(.0000)
	2004-I	(UP)	(LTP)	(.6548)	(.3442)	(.0011)	(.0000)
	2008-IV	(LTP)	(UTP)	(.3353)	(.0022)	(.6622)	(.0003)

Authors' computations. –1) DLDA classification results in parentheses. – 2) LTP: Lower turning point. UP: upswing. UTP: Upper turning point. DOWN: Downswing. – 3) Cycles and phases according to the classifications in Table 1.

Table 5 LDA and DLDA Out-of-the-Sample-Classifications for 2008–2009

Cycle[2]	Quarter	Phase[1]		A posteriori phase probabilities[1]			
		final[2]	predicted by LDA[3] or DLDA[4]	LTP	UP	UTP	DOWN
	2008-I	UTP	UP (UTP)	.0040 (.0015)	.7947 (.0732)	.2011 (.9254)	.0001 (.0000)
10	2008-II	UTP	UP (UTP)	.0023 (.0002)	.7275 (.0783)	.2702 (.9215)	.0001 (.0000)
		UTP	UTP (UTP)	.0076 (.0009)	.4596 (.0114)	.5240 (.9878)	.0088 (.0000)
	2008-IV	LTP	UP (UTP)	.3518 (.3353)	.4923 (.0022)	.1040 (.6622)	.0519 (.0000)
	2009-I	LTP	LTP (LTP)	.9487 (1.000)	.0501 (.0000)	.0002 (.0000)	.0009 (.0000)
11	2009-II	LTP	LTP (LTP)	.9704 (1.000)	.0296 (.0000)	.0000 (.0000)	.0000 (.0000)
	2009-III	LTP	LTP (LTP)	.9760 (1.000)	.0240 (.0000)	.0000 (.0000)	.0000 (.0000)
	2009-IV	LTP	LTP (LTP)	.6651 (.9983)	.3347 (.0016)	.0002 (.0001)	.0000 (.0000)

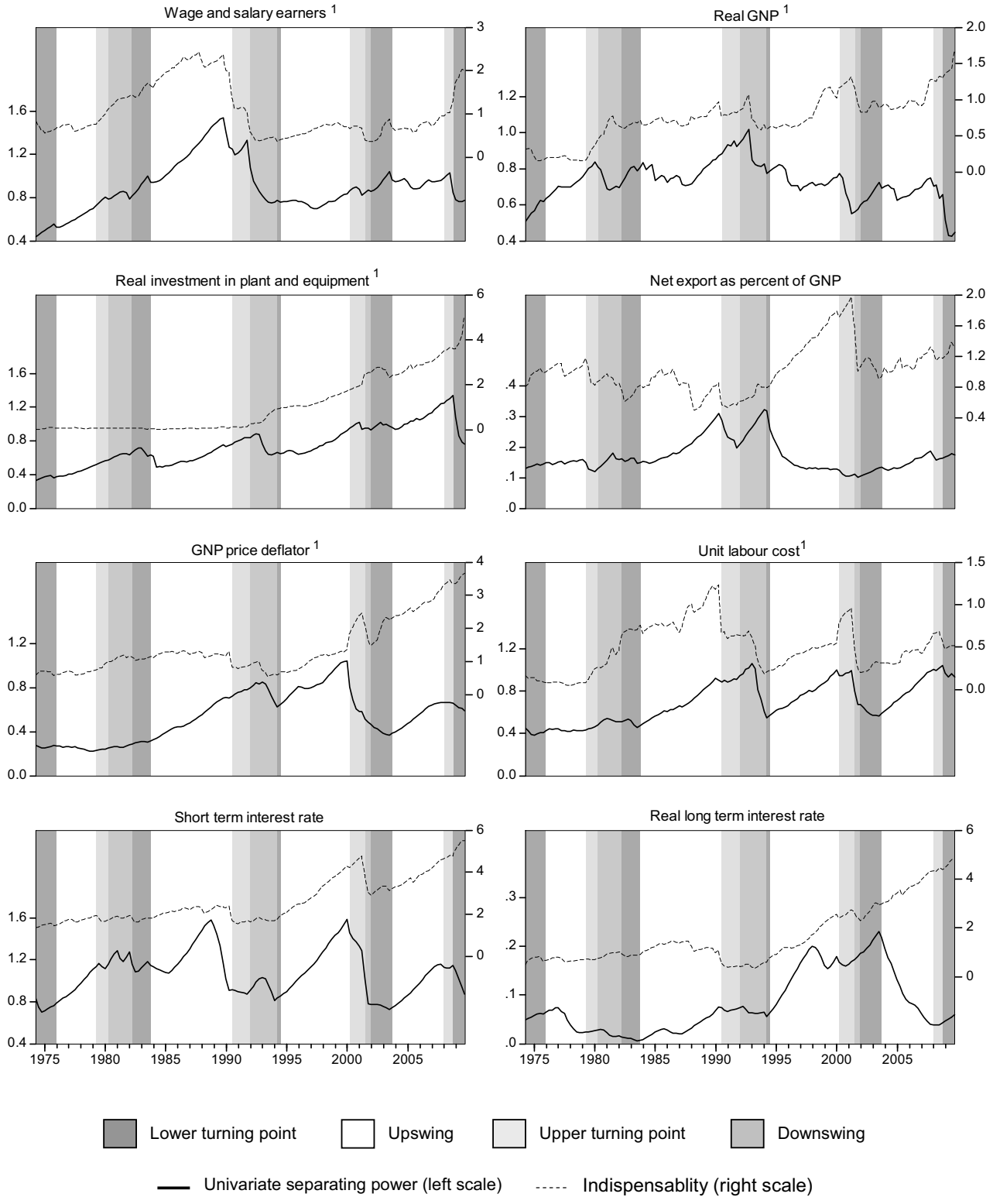
Authors' computations.– 1) LTP: Lower turning point. UP: upswing. UTP: upper turning point. DOWN: downswing. – 2) Cycles and phases according to the classifications in Table 1. – 3) The discriminant functions based on data from the sample period 1974-II to 2007-IV. – 4) One-step-ahead classifications. Results in parentheses.

3.2 The parameters

Comparing with previous experiences the average values of the classifying variables for the phases and cycles of the tenth cycle and the LTP 2008-IV to 2009-I (Table 6, Appendix) reveals a number of interesting differences. While net exports were a driving force on the demand side to an unusual degree, real investment in plant and equipment was beyond previous experience, especially if it is taken into account that the usual negative part of the DOWN-phase is missing here and shows up in the LTP phase in which this variable usually undergoes a much smaller decline. Over the cycle and in particular in the UTP unit labour cost, inflation and interest rates were notably lower than in all cycles before and UTP, pointing again at a very unusual "balanced" UTP. Corresponding with this the LTP-phase appears as much deeper than in previous cycles. This holds in particular for unit labour costs. The main reasons for this are the considerable efforts by employers to keep employment stable, subsidized by considerable government ("Kurzarbeitergeld"). Thereby they returned to "labour hoarding" practiced in the early 1960s (fourth cycle) and early 1970s (sixth and seventh cycles) when they feared a shortage of labour after the end of recessions and hence kept lay offs beyond what was needed currently.

The same holds true for the two other sample periods, though the significance improves. The parameters or their weights, respectively, changed somewhat. This holds even if the shorter sample periods are taken into account. However, the basic structure remains more or less unchanged—employment ranks high, followed by real demand, cost, prices and interest rates, although the latter experienced considerable gains of importance. Again, one could argue that four or five quarters will hardly have great effects in a sample of 60 or more quarters even if the co-factors are of a very unusual magnitude.

Figure 3 Univariate measure of separation and measure of indispensability (1974–2009)



Authors' computations. – 1) Rates of change in percent.

4. Summary and conclusions

While there were warnings of the coming crisis in Germany since mid-2008, it actually started in 2008-IV/2009-I (LDA/DLDA), nearly one year after the U.S. had officially entered a recession. Now, it is already the longest (and deepest) crisis the FRG has ever experienced. Judging from the classification scheme used here, the crisis led to the premature end of the Upper turning point phase, skipped the DOWN-phase and went immediately into the crisis, the lower turning point phase. While there had been extremely short LTP phases before, the complete absence of a phase is new experience for Germany. Nevertheless, beside this the tenth cycle (2002-I to 2008-III) does not exhibit any particularities, certainly not that of a cycle stopped by monetary authorities because of stabilization requirements or of an oil price shock. Quite the contrary, the UTP-phase was unusually moderate.

This judgment is backed by the rather good classification results for the tenth cycle and the LTP of the eleventh. It is too early to decide whether the experience of the past six quarters will lead to a new picture of the German cycle as rendered by the discriminant parameters or weights, but so far the crisis seems to be the result of the extremely unusual high values of the demand variables—real GDP, investment in plants and net exports (exports is not an argument in the discriminant functions) and not by new reactions of the macroeconomic variables employed. Notwithstanding the crisis' size and magnitude, in cyclical terms its importance and innovation have to be qualified. It fits well in the FRG's cycle history as hardened by the stability of a number of discriminant functions.

As to the current LTP-phase, it appears to be a mixture of a DOWN-phase and an LTP-phase. Despite its long duration, its further course is not easy to foresee. Probably the most important are, first, the fact that the UTP phase had not shown serious and actual needs for correction; second, to a large extent the crisis had been the result of the collapse of world trade, of course, with strong consequences for Germany's automotive and machinery industries. Therefore, the present growth of the FRG's economy is the result of exports and investment as direct and indirect consequences of the revival of world trade.

Was the crisis 2008ff a "perfect storm" as Fair (2009) argues for the U.S. pointing at the random coincidence of a number smaller crises such as a rise in import prices, a fall of equity prices, a financial crisis, a decline of exports and of all four together? For Germany and probably also for most of the rest of Europe, the diagnosis is different. The crisis had a more or less single and unique cause: the extremely sudden collapse of exports and its immediate translation into a cut of investments in machinery. Of course, the extreme dependence on exports (net export counted recently for approximately 8 percent of German GDP in 2008) contributed to this situation. As with any crisis, once it has started other sectors are infected, but the origin lies elsewhere. We will see in which way and how quickly the current crisis will be overcome or whether new obstacles come into play. All in all, it was anything but a perfect storm. Of course, this is an analytical statement and whether it will have material implications and consequences for the speed and size of the recession and of the upturn we will have to wait.

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Appendix

Classical and Dynamic Linear Discriminant Analysis

The formal purpose of discrimination is to assign an object to one of g distinct classes based on observed values of a set of variables. The specific problem of discrimination considered in this paper can be outlined as follows. Let $\boldsymbol{x}_t' = (X_{1t},...,X_{pt})$ $(t = 1,2,3,...)$ denote a multiple time series. The vector $\boldsymbol{x}_t$ is a vector of classifying variables representing the multivariate structure of the business cycle in time period t (e.g., a month or a quarter). Based on an observed value of $\boldsymbol{x}_t$ it is used to decide to which phase (class) $1,2,...,g$ of the cycle the period t (object) of the observation corresponds. Modern discriminant analysis offers a multitude of procedures to solve this problem. In the present study the classical approach of linear discriminant analysis (LDA) and a new dynamic variant of LDA (DLDA) were utilized.

The classical LDA approach proposed by Fisher (1936) uses linear canonical functions

$$k_{it} = \boldsymbol{a}_i' \boldsymbol{x}_t \qquad (i = 1,...,q) \tag{1}$$

to project the p dimensional variable space onto a q dimensional discriminant subspace so the separation of the transformed class centroids is maximized while the within-class variances of the transformed observations are minimized. It holds that $q \leq min\{p, g-1\}$. A period t is assigned to that cycle phase whose transformed centroid is closest to the vector $\boldsymbol{k}_t' = (k_{1t},...,k_{qt})$ of the period's canonical variates. Fisher's approach is distribution-free, but it does assume implicitly that the covariance structure is the same in all classes, because a pooled estimate of the common covariance matrix is used. The resulting classification rule can be derived alternatively using Bayesian argumentation although here more restrictive assumptions are made: The data within each class are assumed to be multivariate normally distributed with class-specific means and common covariances (see Wassermann, 2004, p. 356).

LDA was designed to classify cross-sectional data rather than time series data. Consequently the estimated canonical discriminant functions characterize an "average business cycle" with respect to the time span of the sample data used for estimation. Of course, the multivariate structure of the business cycle is not time-invariant. To analyze the evolution of the cycle and intra-cyclical changes a dynamic approach for discrimination analysis is needed.

DLDA (Schuhr, 2007; Heilemann, Schuhr, 2008) solves the classification problem under the assumption of $N(\boldsymbol{\mu}_{\gamma t}, \boldsymbol{\Sigma}_t)$ normally distributed vectors $\boldsymbol{x}_t$. The mean vectors $\boldsymbol{\mu}_{\gamma t}$ $(\gamma = 1,...,g)$ vary from phase to phase of the business cycle. The covariance matrices $\boldsymbol{\Sigma}_t$ are phase-invariant. In contrast to classical LDA, means and covariances change through time. According to the Bayesian decision rule, a time period t will be assigned to the cycle phase with maximum a posteriori phase probability given $\boldsymbol{x}_t$. Equivalently, the linear discriminant functions can be evaluated

$$d_{\gamma t}(\boldsymbol{x}_t) = -\frac{1}{2}\boldsymbol{\mu}_{\gamma t}' \boldsymbol{\Sigma}_t^{-1} \boldsymbol{\mu}_{\gamma t} + \boldsymbol{\mu}_{\gamma t}' \boldsymbol{\Sigma}_t^{-1} \boldsymbol{x}_t + ln\, \pi_{\gamma t} \qquad (\gamma = 1,...,g)\,. \tag{2}$$

Period t will be assigned to phase $\hat{\gamma}$ with maximum value $d_{\hat{\gamma} t}(\boldsymbol{x}_t) = \max_{\gamma=1,...,g} d_{\gamma t}(\boldsymbol{x}_t)$.

The distribution parameters $\boldsymbol{\mu}_{kt}$ and $\boldsymbol{\Sigma}_t$ $(t = 1,2,3,...)$ are estimated recursively by exponential smoothing techniques (see Brown, 1962). For any period t the observed values of $(\boldsymbol{x}_\tau, y_\tau)$ $(\tau = 1,2,...,t-1)$ are used as the information set. The variable $y_\tau \in \{1,2,...,g\}$ indicates the *a priori* classification of a period τ with respect to the phases of the business cycle. Since the estimation procedure uses only data points $(\boldsymbol{x}_\tau, y_\tau)$ with $\tau < t$ and the classification of period t is an "out-of-the-

sample" forecast of the actual cycle phase. Let $\hat{\boldsymbol{\mu}}_{\gamma t} = \boldsymbol{m}_{\gamma,t-1}$ and $\hat{\boldsymbol{\Sigma}}_t = \boldsymbol{S}_{t-1}$ denote the estimators of $\boldsymbol{\mu}_{kt}$ ($\gamma = 1,...,g$) and $\boldsymbol{\Sigma}_t$. The statistics follow the recursion equations:

$$\boldsymbol{m}_{\gamma\tau} = \begin{cases} \alpha \cdot \boldsymbol{x}_\tau + (1-\alpha) \cdot \boldsymbol{m}_{\gamma,\tau-1} & \text{, if } y_\tau = \gamma \\ \boldsymbol{m}_{\gamma,\tau-1} & \text{, otherwise} \end{cases} \qquad (\tau = 1,...,t-1) \tag{3}$$

and

$$\boldsymbol{S}_\tau = \beta \cdot \boldsymbol{z}_\tau \boldsymbol{z}'_\tau + (1-\beta) \cdot \boldsymbol{S}_{\tau-1} \qquad (\tau = 1,...,t-1) \tag{4}$$

with $\boldsymbol{z}_\tau = \boldsymbol{x}_\tau - \boldsymbol{m}_{\gamma\tau}$ if $y_\tau = \gamma$. The equations are initiated by starting values $\boldsymbol{m}_{\gamma 0}$ ($\gamma = 1,...,g$) and $\boldsymbol{S}_0$. The estimators are weighted moving averages of past observations. The weights decrease exponentially with the age of the data. The smoothing parameters α and β control the speed of the decrease and therefore the "memory" of the procedure.[12] These constants have to be fixed carefully in the ranges $0 < \alpha < 1$ and $0 < \beta < 1$, respectively. Large values cause the estimators to react quickly to changes of the mean and the covariance structure of the time series, but also to random fluctuations. The smaller the values, the slower the response.[13] The *a priori* phase probabilities $\pi_{\gamma t}$ can be estimated by the relative frequencies of the phases up to time period $\tau = t-1$ or ignored by the presetting of uniform probabilities.

DLDA should not only classify time periods, but also inform about the classification power of the classifying variables. In context with the analysis of variance Hotelling's trace criterion is a well known multivariate measure of separation (Hotelling, 1951; Ahrens, Läuter, 1974, p. 108). The measure can be adopted easily for the purpose of business cycle analysis based on time series data. Using the statistics (3) and (4) we obtain

$$T^2(X_{1t},...,X_{pt}) = \frac{1}{t-g} \cdot \sum_{\gamma=1}^{g} n_{\gamma t} \cdot \left(\boldsymbol{m}_{\gamma t} - \boldsymbol{m}_{\bullet t}\right)' \boldsymbol{S}_t^{-1} \left(\boldsymbol{m}_{\gamma t} - \boldsymbol{m}_{\bullet t}\right), \tag{5}$$

where $n_{\gamma t} = \sum_{\tau=1}^{t} I_{\{\, y_\tau = \gamma \}}$ and $\boldsymbol{m}_{\bullet t} = t^{-1} \cdot \sum_{\gamma=1}^{g} n_{\gamma t} \cdot \boldsymbol{m}_{\gamma t}$. It always holds $T^2 \geq 0$. If $T^2 = 0$ the set of classifying variables $X_{1t},...,X_{pt}$ completely fails to separate the phases of the cycle in period t. The larger T^2, the larger the separation power. If T^2 will be computed for successive time periods $t = 1,2,3,...$, the statistic allows a comparison of the development of the instantaneous separation power in time.

The multivariate measure of separation also can be defined for any subset of the *p*-dimensional variable set. For a single variable X_{it} the resulting univariate measure of separation is:

$$T^2(X_{it}) = \frac{1}{(t-g) \cdot s_{ii,t}} \cdot \sum_{\gamma=1}^{g} n_{\gamma t} \cdot (m_{i,\gamma t} - m_{i,\bullet t})^2 , \tag{6}$$

where $s_{ii,t}$ is the (*i*,*i*)-th element of $\boldsymbol{S}_t$ and $m_{i,\gamma t}$ is the *i*-th element of $\boldsymbol{m}_{\gamma t}$. Similar to the usual *F*-statistic of univariate analysis of variance, the ratio (6) measures the sum of squares between the classes (phases) relative to the sum of squares within the classes (phases) in a single dimension. The statistic allows a comparison of the separation power of different scalar variables in one time period or a comparison of the instantaneous separation power of one variable in different time periods. Obviously the statistic ignores the interdependence of the elements of a *p*-dimensional set of

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[12] The estimation of time varying covariances by exponential weighted moving averages is also a characteristic of the RiskMetrics approach (J. P. Morgan, 1996).

[13] For the computation of the starting values and the choice of the smoothing parameters see Schuhr, 2009.

classifying variables. To explore whether or not a variable X_{it} is redundant, the decline of separation power after elimination of X_{it} from the set

$$U(X_{it}) = T^2(X_{1t},...,X_{pt}) - T^2(X_{1t},...,X_{i-1,t},X_{i+1,t},...,X_{pt}) \tag{7}$$

is a useful measure of indispensability. It always holds $0 \le U(X_{it}) \le T^2(X_{1t},...,X_{pt})$. If $U = 0$ the classifier X_{it} is redundant in time period t. A large value of (7) indicates an indispensable variable.

In the present study quarterly data of eight variables (section 2) from the sample period 1974-II to 2009-IV and the phase-classifications in Table 1 were used as the training data for LDA and DLDA. All a priori phase probabilities were set uniformly to 0.25. The DLDA smoothing parameters were fixed at $\alpha = \beta = 0.03$. This choice minimized the classification error rate by DLDA over the whole training sample. The term 'classification error' stands for a disaccord of a phase classification according to Table 1 and the predicted phase by LDA or DLDA

Table 6 Average values of classifying variables (1963–2009)

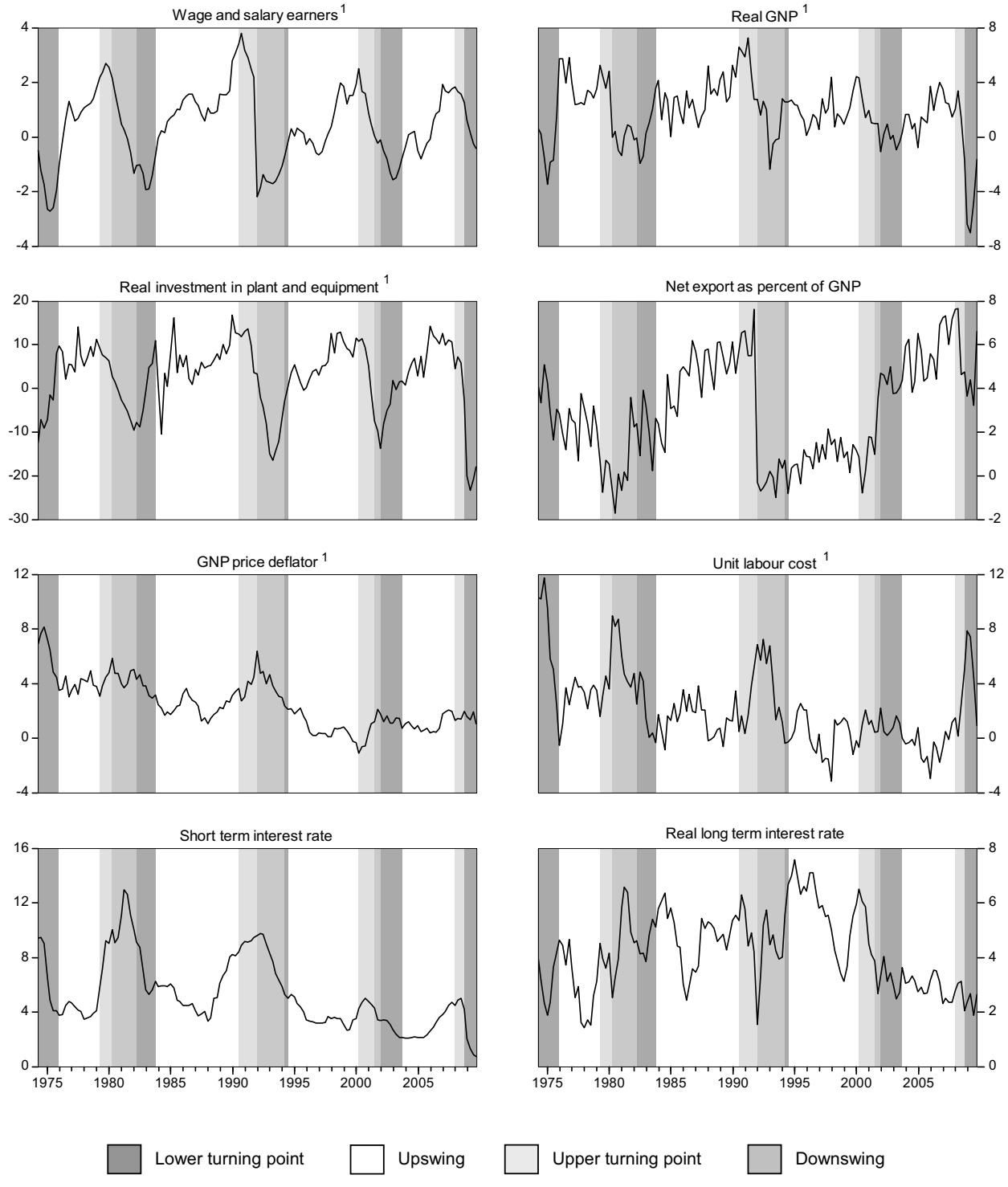
Variable	Cycle[1]	Phase[1]				
		Lower turning point	Upswing	Upper turning point	Downswing	All
Wage and salary earners[2]	4	0.89	1.17	1.40	0.44	0.92
	5	-3.37	1.41	2.59	2.40	0.72
	6	1.25	1.03	1.54	1.34	1.29
	7	-1.91	0.81	2.45	0.45	0.33
	8	-1.44	1.10	2.99	-1.61	0.51
	9	-0.71	0.49	1.42	-0.09	0.56
	10	-0.99	0.38	1.68	-	0.17
	11	0.27	…	…	…	0.27
	All	-1.02	0.80	2.09	0.26	0.54
Real GNP[2]	4	-1.35	5.75	5.64	3.54	4.46
	5	-0.35	6.09	7.16	5.27	4.46
	6	2.84	3.58	6.01	3.52	3.72
	7	-0.86	3.69	4.54	-0.06	1.86
	8	-0.02	2.85	5.55	0.94	2.47
	9	2.55	1.94	2.31	0.98	1.96
	10	-0.17	1.81	2.26	-	1.35
	11	-4.31	…	…	…	-4.31
	All	-0.51	2.96	4.52	2.11	2.37
Real investment in plant and equipment[2]	4	-2.84	4.22	8.82	0.97	3.42
	5	-9.17	12.51	18.89	14.85	8.85
	6	0.69	-3.52	-0.20	-4.31	-1.82
	7	-4.55	7.45	7.56	-3.11	2.20
	8	-1.97	6.05	10.70	-8.41	2.92
	9	-2.78	5.97	7.15	-8.54	4.94
	10	-3.92	7.76	5.85	-	4.52
	11	-17.04	…	…	…	-17.04
	All	-5.60	6.62	8.46	-1.61	3.10
Net exports as percent of GNP	4	0.89	1.66	0.84	1.13	1.26
	5	3.65	3.26	2.97	2.04	2.96
	6	1.76	1.43	2.79	3.61	2.49
	7	3.47	2.36	0.28	0.34	1.84
	8	2.10	4.43	6.26	-0.18	3.50
	9	0.71	0.88	0.77	2.26	0.94
	10	4.30	5.63	6.64	-	5.40
	11	4.52	…	…	…	4.52
	All	3.22	3.18	3.06	1.09	2.79

Table 6, continued

Variable	Cycle[1]	Phase[1]				
		Lower turning point	Upswing	Upper turning point	Downswing	All
GNP price deflator[2]	4	4.22	2.61	4.08	3.50	3.32
	5	1.58	2.69	4.90	7.79	4.19
	6	7.17	5.00	5.58	6.29	6.25
	7	6.52	3.89	4.04	4.62	4.67
	8	3.78	2.32	3.66	4.21	3.03
	9	2.33	0.80	-0.17	1.65	0.75
	10	1.38	1.00	1.38	-	1.14
	11	1.57	…	…	…	1.57
	All	3.64	2.03	2.98	4.80	2.96
Unit labour cost[2]	4	5.72	1.50	3.84	4.67	3.39
	5	0.45	1.42	4.97	11.11	4.46
	6	7.75	5.34	5.74	8.17	7.15
	7	7.85	2.95	3.20	6.16	4.86
	8	2.23	1.41	2.18	4.53	2.19
	9	-0.39	0.19	0.94	0.47	0.31
	10	0.98	-0.59	1.36	-	0.03
	11	5.15	…	…	…	5.15
	All	3.97	1.05	2.70	6.09	2.73
Short term interest rate	4	3.40	3.95	4.73	6.40	4.98
	5	4.28	4.02	7.15	8.89	5.88
	6	6.43	4.75	7.92	12.74	8.50
	7	6.78	4.05	7.82	10.80	6.81
	8	6.92	5.42	9.05	8.13	6.57
	9	5.29	3.67	4.67	3.86	3.90
	10	2.92	2.87	4.77	-	3.09
	11	1.83	…	…	…	1.83
	All	4.86	4.14	6.70	8.85	5.47
Real long term interest rate	4	1.88	3.52	2.37	4.05	3.40
	5	5.43	3.89	2.34	0.37	3.03
	6	0.98	3.25	3.02	3.57	2.56
	7	3.07	2.97	4.06	4.74	3.57
	8	4.49	4.74	5.16	4.14	4.65
	9	5.55	5.67	5.40	3.26	5.47
	10	3.16	2.95	2.99	-	3.01
	11	2.32	…	…	…	2.32
	All	3.29	4.23	4.04	3.59	3.92

Authors' computations. – 1) Cycles and phases according to the classifications in Table 1. – 2) Rates of change in percent.

Figure 4 Classifying variables (1974–2009)



1) Rates of change in percent.

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