Early estimates of GDP growth rates by error correction models

FRANÇOISE CHARPIN, GIAN LUIGI MAZZI
AND FILIPPO MOAURO

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Abstract

This paper investigates the use of error correction models to estimate coincident GDP quarterly growth rates. We have carried out this investigation, for the euro area and the five main countries (Germany, France, Italy, Spain, and the Netherlands). We have found no cointegration relation for Italy and Spain, and so we have run usual bridge models. Pseudo real time simulations are provided for each country and the euro area. Finally, two euro area GDP growth rates estimates are compared: one produced directly by the euro area error correction model, with one provided indirectly by aggregating the estimates for the five countries.

Keywords: coincident indicators, GDP nowcasting, euro area, error correction models, bridge models, real-time simulation

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1. Introduction

This paper investigates the use of an error correction model to estimate coincident GDP quarterly growth rates. The model is a bridge model with a cointegration relation. This means that monthly hard data are necessarily introduced in the model because I (1) series are needed to compose the cointegration relation. The accounting identity (1) suggests the possibility to observe a cointegration relation between GDP and some demand components.

(1) GDP = private consumption + public consumption + investment + inventory changes + exports –imports

For some demand components, like exports and imports, information is available on a monthly basis, while for some others, for instance, households' consumption, monthly retail sales can be used as a proxy. Then an equilibrium relation may exist between GDP and some monthly proxies of demand components. Since the monthly information we use in bridge models are published ahead of GDP, these hard data can be considered as exogenous. Thus we can estimate an individual error correction equation, instead of a system of equations.

If y denotes the logarithm of GDP, x_h the logarithm of the h hard data (quarterly converted) and z_k some I(0) variable, the error correction model (2) is estimated:

(2) $$\Delta y = c + \alpha y_{-1} + \sum_h a_h x_{h,-1} + \sum_h b_h \Delta x_h + \sum_k d_k z_k$$

The cointegration test is carried out with the T-ratio of coefficient □ and the Ericsson-Mackinnon Table (2002).

When cointegration is not accepted, the usual bridge model (3) prevails:

(3) $$\Delta y = c + \sum_h b_h \Delta x_h + \sum_k d_k z_k$$

Models (2) and (3) give the GDP growth rate of the coincident quarter T for estimation dates included between (T+0) and (T+45). The missing observations of hard data on quarter T are forecasted using auxiliary monthly regressions (which contain autoregressive terms and survey data).

For the euro area and its main countries, potential variables entering the cointegration relation are: retail sales, consumption in manufactured goods (in France), exports and imports (with a negative sign). Other I(0) variables, z_k, can be the IPI growth rate, the construction output growth rate, the change in unemployment rate, survey data, the dollar-euro exchange rate (in growth rate) and financial data (interest rates, stock index). Some variables are lagged especially, exchange rates, financial data and some survey data.

Section 2 describes the five country models and the euro area model. No cointegration relation has been found for Italy and Spain where usual bridge models are estimated. Pseudo real time simulations are reported for each country and the euro area. Section 3 compares two approaches to obtain the euro area GDP growth rate, a direct one by using an error correction model with an indirect one by aggregating the five countries' estimates.

2. Country-models specification

We describe first country models where a cointegration relation has been found and start with France (for a presentation of a model implemented in July 2011, see Charpin, 2011). Pseudo real time simulations are run over 2007-2011 to assess the relevance of each model. We have not run real time simulations, due to the lack of availability in real time of some data used by our country models. This is for instance the case for consumption in manufactured goods in the French model. This variable plays a crucial rule for estimating French GDP growth and is moreover very rapidly[4] published, so it cannot be replaced, for example, by retail sales. Moreover, in almost all our country models, foreign trade plays an important role, most frequently through exports but also, through imports for Germany. These foreign trade data are not available in real time because only extra euro area foreign trade is followed in real time in the Eurostat database. Consequently, the simulations shown in this Section have been carried out with the set of information available at the end of October 2011. Moreover, they are carried out without missing data i.e. we consider that monthly data are known for the quarter we estimate. This will give an optimistic assessment of the accuracy of each model.

2.1 France

The cointegration relation embeds the logarithms of GDP, consumption in manufactured goods, and exports. Other variables of the right side of the model are (i) the log-difference of industrial production, of consumption in manufactured goods, of exports, of real MSCI stock index, (ii) the first difference in opinions on the ability to save (two lags, French consumer survey), on the probable output trend (French business survey), the first difference of the construction confidence indicator (two lags, EU construction survey). The estimated coefficients and their T-ratios are reported in Table 1. The cointegration is strong (the T-ratio is equal to -6.8, the 5% critical value being -3.5). This is due to the availability of monthly consumption in manufactured goods, which is a substantial part of households' consumption. We know that in France, households' consumption is the main growth engine.

[4] Consumption of month *t* is published at most 30 days after the end of month *t*.

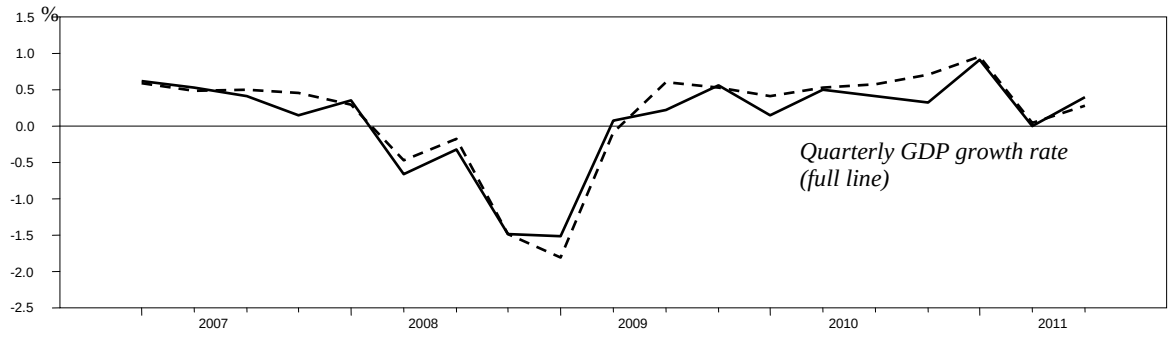
Table 1: Estimation results of the French bridge ECM over 1989Q1-2011Q3

Equation left hand side: log-diff GDP Standard error of dependant variable= 0.0050	Transfor-mation	Lag	Coef-ficient	T-Stat
GDP	log	1	-0.199	-6.8
Real exports	log	1	0.043	6.7
Real consumption in manufactured goods	log	1	0.054	6.0
Real exports	log-diff	0	0.037	3.5
Real consumption in manufactured goods	log-diff	0	0.084	7.0
Industrial production index	log-diff	0	0.101	5.6
Opinion on probable output trend (French industrial survey)	diff	0	0.0001	3.1
Households' opinion on the ability to save (French survey)	diff	2	0.0003	2.8
Construction confidence indicator (European survey)	diff	2	0.0001	2.8
Real MSCI stock index	log-diff	1	0.009	3.4
Constant			2.177	6.8
Rbar2 = 0.897 DW=2.0 SEE=0.0016				

Source: Authors' calculations

Figure 1 shows the pseudo real time simulations obtained with this model over 2007-2011. The root mean square error (RMSE) is equal to 0.19 percentage point. The model is not perfect because it leads to an overestimation between 2009Q3 and 2010Q4. Nevertheless, over a longer time period (2001-2011), this model gives a better RMSE than the factor model we use for France (see Charpin 2011).

Figure 1: Pseudo real time simulations (dotted line) of the French model over 2007-2011



Source: Authors' calculations

2.2 Germany

The cointegration relation embeds GDP, exports and imports, all expressed in logarithms. In this equilibrium relation, exports have a positive coefficient whereas imports have a negative coefficient. We know that in Germany, exports are the main growth engine, instead of consumption in France. Other variables of the right side of the model are (i) the log-difference of industrial production, of construction output, of exports, of retail sales, (ii) the first difference in opinions in consumer survey concerning the expected saving situation over the next 12 months and major purchases over the next 12 months (one lag), the short-term interest rate in first difference (one lag). The estimated coefficients and their T-ratios are reported in Table 2. Cointegration is accepted only at a significance level of 10%. Nevertheless, we trust this model because it gives unbiased estimates and a better accuracy than a factor model we implemented before.

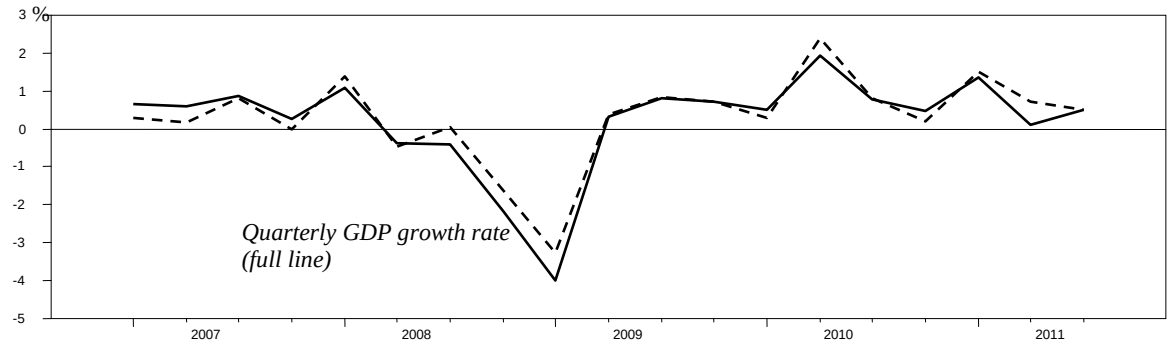
Table 2: Estimation results of the German bridge ECM over 1992Q2-2011Q3

Equation left hand side: log-diff GDP **Standard error of dependant variable= 0.0085**	Transfor- mation	Lag	Coef- ficient	T-Stat
GDP	log	1	-0.103	-3.0
Real exports	log	1	0.078	4.4
Real imports	log	1	-0.067	-3.6
Real exports	log-diff	0	0.071	4.0
Industrial production	log-diff	0	0.152	5.9
Construction output	log-diff	0	0.050	7.4
Real retail sales	log-diff	0	0.172	5.3
Households' opinion on major purchases over next 12 months	diff	1	0.0007	5.6
Households' opinion on the expected saving situation over next 12 months	diff	0	0.0006	3.4
Short-term interest rate	diff	1	-0.002	-2.2
Constant			0.614	3.2
Rbar2 = 0.874 DW=2.4 SEE=0.0030				

Source: Authors' calculations

Figure 2 shows the pseudo real time simulations obtained with this model over 2007-2011. The root mean square error is equal to 0.34 percentage point, much higher than in France, but GDP growth volatility is also higher.

Figure 2: Pseudo real time simulations (dotted line) of the German model over 2007-2011



Source: Authors' calculations

2.3 The Netherlands

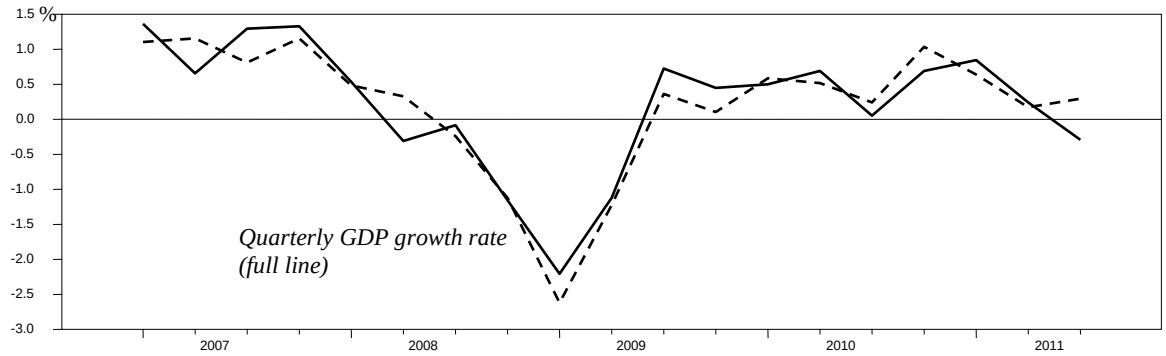
The cointegration relation embeds the logarithms of GDP, retail sales and exports. Other variables of the right side of the model are (i) the log-difference of industrial production, of retail sales, of exports, (ii) the first difference in opinions on order book position in construction, on the activity compared to last months (construction survey), households' opinion on the economic situation. The estimated coefficients and their T-ratios are reported in Table 3. Cointegration is almost accepted at a significance level of 5%.

Table 3: Estimation results of the Dutch bridge ECM over 1993Q1-2011Q3

Equation left hand side: log-diff GDP **Standard error of dependant variable= 0.0066**	Transfor-mation	Lag	Coefficient	T-Stat
GDP	log	1	-0.121	-3.4
Real exports	log	1	0.027	2.6
Real retail sales	log	1	0.066	3.4
Real exports	log-diff	0	0.034	2.9
Real retail sales	log-diff	0	0.133	3.7
Industrial production index	log-diff	0	0.100	5.4
Order book position (construction survey)	diff	0	0.0004	3.5
Activity compared to last months (construction survey)	diff	0	0.0002	4.3
Economic situation last 12 months (consumer survey)	diff	0	0.0001	4.3
Constant			1.158	3.1
Rbar2 = 0.821 DW=2.2 SEE=0.0028				

Source: Authors' calculations

Figure 3: Pseudo real time simulations (dotted line) of the Dutch model over 2007-2011



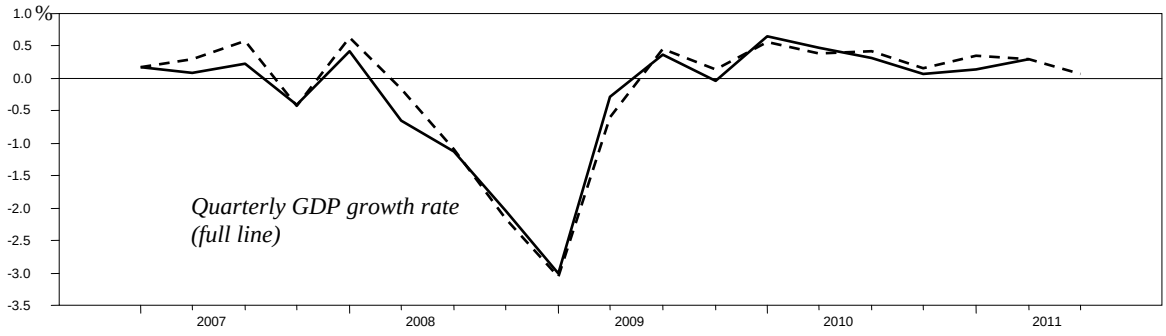
Source: Authors' calculations

Figure 3 shows the pseudo real time simulations obtained with this model over 2007-2011. The root mean square error is equal to 0.33 percentage point. The accuracy of this model is weak.

2.4 Italy

No cointegration relation has been found. The Italian GDP quarterly growth rate is obtained using a bridge model. The GDP growth rate is determined by the industrial production index (growth rate), real exports (growth rate), real effective exchange rate (growth rate, three lags), opinion of industrials on production expectation for months ahead (level), opinion of industrials on stocks (change), opinion of retailers on stocks (level, one lag), households' opinion on major purchases at present (change, one lag). The standard error of estimate is equal to 0.24 % whereas the standard error of the GDP growth rate is equal to 0.67 %.

Figure 4: Pseudo real time simulations (dotted line) of the Italian model over 2007-2011



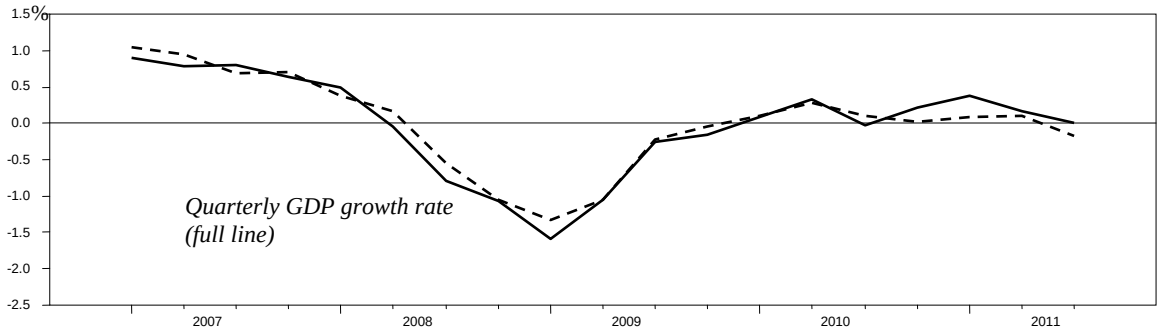
Source: Authors' calculations

Figure 4 shows the pseudo real time simulations obtained with this model over 2007-2011. The root mean square error is equal to 0.20 percentage point.

2.5 Spain

No cointegration relation has been found. Thus Spanish GDP quarterly growth rate is obtained using a bridge model. Unfortunately, there is no series of construction output in Spain which would have been useful since the building sector was the growth engine before the financial crisis. Among available hard data, only one is significant in the GDP growth equation, namely the change in the unemployment rate. The other variables entering the equation are the opinion on employment (retail trade survey, one lag), the change in opinion on export order book position (industrial survey, one lag), the change in opinion on the financial situation over next 12 months (consumer survey, one lag), the real euro-dollar exchange rate (growth rate, one lag), the real oil price (growth rate, five lags). The standard error of the estimate is 0.14% whereas the standard error of the GDP growth rate is 0.60%.

Figure 5: Pseudo real time simulations (dotted line) of the Spanish model over 2007-2011



Source: Authors' calculations

Figure 5 shows the pseudo real time simulations obtained with this model over 2007-2011. The root mean square error is equal to 0.15 percentage point. Since 2010Q4, the model has been underestimating growth rates.

2.6 Euro area

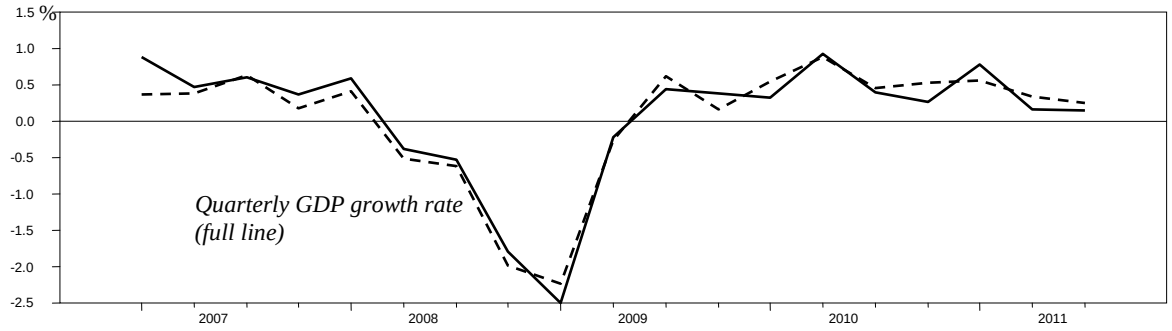
In this model, the cointegration relation embeds GDP, retail sales and exports logarithms. Other variables of the right side of the model (Table 4) are (i) the log-differences of industrial production, construction output, exports, unemployment rate, euro-dollar exchange rate (two lags), (ii) the difference of opinions concerning the present business situation (retail trade survey), the major purchases over the next 12 months (one lag, consumer survey). Cointegration is accepted only at a 10% significance level and only in the recent period.

Table 4: Estimation results of the bridge ECM over 1992Q2-2011Q3

Equation left hand side: log-diff GDP **Standard error of dependant variable= 0.0060**	Transfor-mation	Lag	Coef-ficient	T-Stat
GDP	log	1	-0.082	-3.1
Real exports	log	1	0.018	2.6
Real retail sales	log	1	0.044	2.4
Industrial production	log-diff	0	0.149	5.9
Construction output	log-diff	0	0.032	4.2
Real exports	log-diff	0	0.046	2.6
Unemployment rate	log-diff	0	-0.064	-4.2
Households' opinion on major purchases over next 12 mths	diff	1	0.0006	3.1
Opinion on the present business situation (retail survey)	diff	0	0.00009	2.2
Real euro-dollar exchange rate	log-diff	2	-0.013	-2.6
Constant			0.341	3.0
Rbar2 = 0.916 SEE=0.0017 DW=2.3				

Source: Authors' calculations

Figure 6: *Pseudo real time simulations (dotted line) of the euro area model over 2007-2011*



Source: Authors' calculations

Figure 6 shows the pseudo real time simulations obtained with this model over 2007-2011. The root mean square error is equal to 0.22 percentage point. In fact, the cointegration is only significant since 2009Q4 (at a level of 10%). Simulations, run before this quarter, are not relevant because we kept the same error correction model although no cointegration is found. They underestimate growth over 2007-2008.

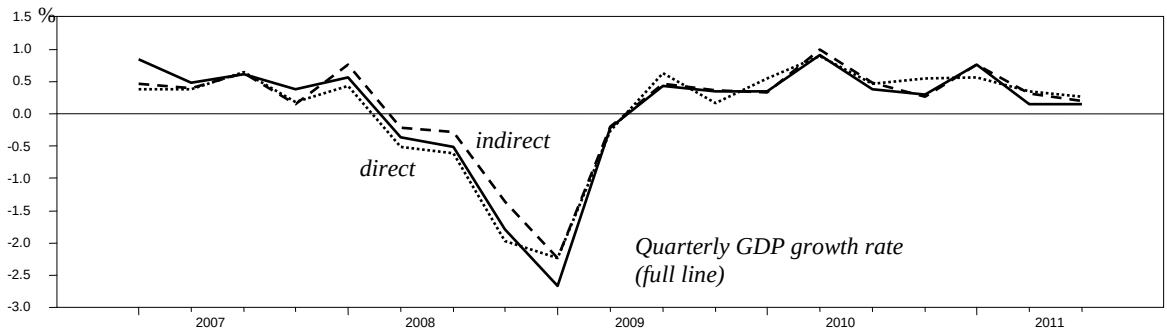
3. Direct and indirect approaches for euro area GDP growth rates

To estimate the euro area GDP quarterly growth rate, we can adopt an indirect approach. This means aggregating estimates of the six main countries whose domestic GDP estimates are used by Eurostat to calculate the euro area flash estimates. Until today, we have implemented five models for the five main countries, namely Germany, France, Italy, Spain, and the Netherlands. The sixth country, Belgium, still has to be added.

To calculate euro area estimates based on the five country estimates presented above, we need aggregation weights. The latter are derived from a regression which determines euro area growth on the basis of the five domestic GDP growth rates. The regression has a constant term and is estimated by the Cochrane-Orcutt method if residuals have an autocorrelation of order one. The estimation period starts in 1995Q2. This regression is run at each estimation date.

On Figure 7 we compare the estimates of the indirect approach with the estimates derived from the error correction model of Section 2.6. In terms of RMSE, the indirect approach is a bit better, 0.20 percentage point against 0.22. Starting from 2009Q1, the indirect approach is particularly satisfactory: GDP fluctuations are well and much better tracked than with the direct approach. Over year 2008, the indirect approach overestimates growth, especially for 2008Q3 2008Q4 and 2009Q1. This is essentially due to the German model (see Figure 2).

Figure 7: ***Pseudo real time simulations (dotted line) given by the direct and indirect approaches over 2007-2011***



Source: Authors' calculations

4. Conclusions

In this paper, we have experimented a new type of bridge models, which include a cointegration relation. In principle, these error correction models should be more relevant than simple bridge models. For France, we find that ECM are even slightly more relevant than a factor model. We can observe that cointegration is strong only in France where a series of monthly consumption in manufactured goods is available. On the contrary, the absence of construction output series in Spain explains perhaps why we find no cointegration relation in this country.

A second result of this paper is that an indirect approach to estimate GDP growth could be slightly better than a direct one. But more work has to be done before definitely reaching this conclusion.

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This paper presents a disaggregated approach to the early estimates of the GDP growth based on ECM models for the major euro area member state economies. This approach is then compared within a pseudo real-time simulation exercise with a direct one based on an ECM model of the euro area GDP.

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