Practice and prospects of medium-term economic forecasting

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Practice and prospects of medium-term economic forecasting

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Abstract

Government agencies and other national and international institutions are asked to perform forecasts over the medium term. In particular, the EU Stability and Growth Pact contains the obligation to formulate stability programmes over four years, covering a general economic outlook as well as the projected development of public finances. However, the current practice of performing medium-term economic projections is unsatisfactory from a methodological point of view as the applied methodology has been developed for short-run forecasting and it is questionable whether these methods are useful for the medium term. In particular, currently medium-term projections are mostly based on the neoclassical Solow growth model with an aggregate production function with labour, capital, and exogenous technological progress. It might be argued, however, that for medium-run projections endogenous growth models might be better suited. In this paper we give an overview of currently used methods for medium-term macroeconomic projections. Then we analyse the performance of medium-term forecasts for Austria to illustrate the strengths and weaknesses of the typical approach. In particular, the five-year projections of real GDP growth, inflation and the unemployment rate are investigated. Finally, we describe some approaches to improve medium-run projections.

JEL classification: C53; E32, E37; E66

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1. Introduction

Government agencies and other national and international institutions are asked to perform forecasts over a time horizon of more than three years. In particular, the Stability and Growth Pact contains the obligation for the EU Member States to formulate stability programmes over four years, covering a general economic outlook as well as the projected development of public finances (Strauch et al. 2004). Another example is the Congressional Budget Office which performs budget projections over a time horizon of ten years. This time horizon from three to ten years is often called the medium term. A time horizon of more than two years is also important for monetary policy because prices can be affected by policy measures only with a substantial time lag. A medium-term orientation also allows monetary policy to avoid excessive volatility in short-term interest rates. In a stylised model estimated for the Euro Area it can be shown that the medium run should be viewed as a time horizon of four years (Smets 2003).

However, the current practice of performing medium-term economic projections is unsatisfactory from a methodological point of view as the applied methodology has been developed for short-run forecasting and it is questionable whether these methods are useful for the medium term. It is often stressed that medium-run forecasts are not meant as the most likely path of the economy. In contrast, it is argued that these projections are scenario simulations because they are conditioned on various assumptions. Nevertheless, government agencies calculate projections which are the basis for medium-term budget plans. It is not foreseen to calculate alternative budget projections for example in the Stability and Growth Pact.

In this paper we illustrate the state of the art of medium-term forecasting and discuss some approaches to improve medium-term forecasts. In an overview of current approaches it is shown that medium-term projections are mostly based on the neoclassical Solow growth model with an aggregate Cobb-Douglas production function with labour, capital, and exogenous technological progress. While the production function is used to calculate potential output, the transition of actual output back to potential in most approaches is determined by demand factors. In this sense most of these models treat the medium run as a prolongation of the short run. We illustrate the performance of this approach by evaluating the medium-term forecasts of the IHS for Austria which are based on this type of model. The results suggest that these forecasts tend to interpret short-run cyclical movements as structural developments.

Based on this finding it is likely that model based medium-term projections can be improved by incorporating factors that determine long-run economic growth in these models. This is in line with recent empirical studies on the performance of medium-term forecasts (Batista and Zalduendo 2004; Lindh 2004). In these papers it is therefore argued that the success of endogenous growth models in recent years recommends the consideration for example of R&D and human capital developments over the medium term.

The outline of the paper is as follows: In section two we give an overview of approaches for medium-run forecasting. Afterwards, in section three we analyse the performance of medium-run forecasts based on a typical model. Section four discusses some approaches to improve medium-run forecasts, and section five concludes.

2. Practice of medium-term forecasting

Forecasting is an important topic in economics which has led to a huge variety of forecasting methods. However, most of these methods are developed for the short run and it is not clear a priori that these methods are also useful for a time horizon from three to ten years. To classify these approaches it is useful to rank them with regard to their empirical and theoretical coherence. Empirical coherence means the ability of a forecasting method to replicate the history of one or more time series. Theoretical coherence means that the forecast can be explained in line with an economic model. As pointed out by Pagan (2003) there is a trade-off between both concepts for many reasons and therefore the selection of a forecasting method includes a weighting for both aspects. In figure 1 we rank some widely-used methods with regard to empirical and theoretical coherence.

If the only goal is to predict the future outcome of a time series like GDP, a time series approach is one opportunity. However, formal test of the information content of time series give ambiguous results. For example, Galbraith (2003) shows that there is no valuable information in US GDP after two quarters. Öller (1985) finds that using an ARIMA model for a three year ahead forecast for Finnish GDP contains valuable information. Using a different approach, Diebold and Kilian (1997) get the result that the information content of US GDP is close to zero after 15 quarters.

Nevertheless, the common approach for medium-term projections is to use structural macroeconomic models at least for two reasons. The first reason is that users of medium-run forecasts are not only interested in the development of GDP, but in a consistent projection of a comprehensive set of macroeconomic variables. Structural models allow to predict a large number of macroeconomic aggregates and to account for their interactions over the forecasting horizon. This is not the case with univariate time series models and, due to the degrees of freedom problem, not feasible with VAR models. Another reason is that by using a macroeconometric model it is possible to interpret the outcome of important macroeconomic variables with regard to the evolution of exogenous variables and the underlying economic structure of the model. This dependence on assumptions about exogenous variables and the underlying structure is the reason why these projections are not forecasts in the technical sense. Some authors call medium-run projections “scenarios” to stress the uncertainty of such medium-run projections. However, by performing alternative projections and stochastic simulations both aspects can be assessed in macroeconometric models. This enhances the credibility of medium-run forecasts.

Some examples of these models and a selected list of their characteristics are given in Table 1.These models currently in use can be roughly grouped into two classes. A first category of models that are relatively sharply focused on empirical coherence includes those operated by the New Zealand and Australian Treasuries (Powell and Murphy 1997). Both of these models also have a very strong theoretical foundation and derive the short-term relationships from Keynesian theory; the nature of the long-run relationships is neo-classical. Concessions are made in these models, however, to facilitate their use for forecasting in the

Treasuries.[1] This is illustrated by the example of the NAIRU. In New Zealand's NZTM the NAIRU is predetermined exogenously because it is plausible to assume, for short and medium-term forecasts, that it remains relatively constant. For policy simulation purposes, on the other hand, it is important that the NAIRU is determined endogenously in view of its significance to a series of effect relationships (Szeto 2002).

In models with an explicit long-term equilibrium, the two components are specified independently and brought together only later. This modelling approach is adopted by the Australian and New Zealand models. To arrive at the equations for the long-term equilibrium, the supply block is jointly estimated with a maximum likelihood approach in the New Zealand model. The demand-side equations are estimated with OLS because the relations are interpreted as co-integrating relations. The model's dynamic structure, which is currently being calibrated, is especially significant, however, for the short and medium-term forecasts. Work is in hand to estimate the dynamic structure in the future as well. Most of the models used for the medium term belong to the second class of multi-equation error correction (or structural error correction) models. For this reason, this class contains the largest variety. Although their theoretical foundations differ considerably, they all based on the neo-classical principle of synthesis. The models' neo-classically oriented supply side plays an especially prominent role in those that are used to compute scenarios or produce forecasts over a period of up to 15 years; that is to say the medium to long term. The JADE model of the CPB, for example, which was built to analyse the medium- and long-term effects of shocks and policy measures, contains a fairly extensively modelled production sector and labour market. In this model the equilibrium unemployment rate is endogenous so that the adjustment of the reaction of the labour market is important for the transition to the long-run equilibrium.

In contrast, models covering a period of no more than five years generally dispose of a comprehensively modelled demand side and thus place more emphasis on Keynesian elements. In these models the transition to the steady state takes place mainly through the adjustment of prices and wages. Examples are the HMTM of the UK Treasury and models in Nordic countries like ADAM and KESSU. These models facilitate testing of the effects and relationships derived from theory at least on the level of the single equations.

Within this second framework a two step procedure is used to perform a medium-term forecast. In a first step, the level of potential GDP over the next five years is determined. The second step is to derive the transition path of actual GDP from its current level towards the level of potential GDP. To calculate potential output again filter techniques as well as economic concepts can be used (Barabas et al. 2008). However, from a practical point of view using a production function is the dominant approach (Kappler 2007). For example the CBO which has a long tradition in medium-run forecasting uses a production function approach to calculate potential output (CBO 2001) for five economic sectors. In the following we sketch the procedure chosen by the EU Commission because of its relevance for EU member countries. Both approaches are closely related (D'Auri et al. 2010; Denis et al. 2006).

[1] In this respect these models differ from the increasingly popular estimated DSGE-models which put even more weight on theoretical coherence. Despite this fact DSGE-models perform quite well in short-term forecasting. An increasing number of national and international institutions use DSGE-models for forecasting. However, to our knowledge these models are not regularly used for medium-run forecasting.

The approach proposed by the European Commission is based on a Cobb-Douglas production function. In a first step the data for GDP, labour input and capital is used to calculate a series for total factor productivity (TFP) as the Solow residual, i.e. that part of the change in GDP that is not accounted for by changes in the input factors. In a second step, in order to calculate potential GDP it is assumed that TFP and labour input fluctuate around a certain trend over the business cycle. In this case it is necessary to calculate the trends of TFP and labour input. In contrast no adjustments are necessary for the capital stock because potential output is related to the full utilisation of the capital stock. In the simplest case TFP is assumed to follow a linear trend. This was formerly done by the EU Commission. The current approach is to use the HP-filter to calculate the trend TFP (Denis et al. 2006). The approach to get the trend for labour input is more complicated. The trend labour force is obtained by multiplying the (HP-)trend of the participation rate with the population of working age. In addition the trend NAWRU is calculated, where the NAWRU (non-accelerating wage rate of unemployment) is defined as the rate of unemployment consistent with constant wage inflation. The trend employment is then adjusted with the trend NAWRU. The resulting term is multiplied with the trend of average hours worked.

Substituting these values into the production function gives the historical values of potential output. To predict potential output over the medium term it is necessary to predict the evolution of these input factors. The EU Commission also suggests methods for these calculations. Total factor productivity and average hours worked are forecasted using an ARIMA model. A forecast of the population of working age is taken from Eurostat, while participation rate changes are forecasted using an AR model. The NAWRU is forecasted allowing for 50 % of the most recent change to extend into the future. To calculate the capital stock over the forecasting horizon it is assumed that the ratio of investment to potential GDP is constant. This makes the capital stock endogenous.

Prior to estimating potential output with the aid of a production function, international organisations like the OECD and the European Commission identified potential output as trend production which was estimated by de-trending actual GDP. The OECD, e.g., switched at about the mid of the 1990s to a production function approach. Before, trend GDP had been estimated with a split time trend (Giorno et al., 1995). On its meeting in July 2002, the ECOFIN Council of the European Union decided to use the production function approach as the reference method for calculating potential GDP. This methodology was first employed for the Autumn 2002 economic forecast of the European Commission. Before, for many Member States potential - or trend - GDP had been estimated by applying a HP filter to accrual GDP, mainly due to the limited availability of certain time series required for the production function approach. In particular, consistent capital stock data had been a bottle-neck for some countries.

To get a forecast of real GDP over the medium-term it is necessary to link actual GDP to potential output. A common approach is to perform a short-term forecast over two years and assume that the gap between real and potential GDP is closed at the end of the five year horizon. However, currently it is more appropriate to deviate from this assumption. The drop in production observed in 2009 together with the consequences of the financial crisis and of the increase in unemployment on economic activity also in the mid-term was so dramatic that presently it seems unrealistic to assume that the economy will return to its production possibility frontier within five years, even when taking into account that probably also potential GDP has been negatively affected.

Actual GDP together with other important macroeconomic aggregates like (un)employment or inflation are typically obtained with a macroeconometric model. One typical structural multi-equation model is the LIMA model for Austria. A description of an earlier version of the model can be found in Hofer and Kunst (2005).[2] LIMA is essentially demand-driven, i.e. actual GDP is determined from the expenditure side. Hence, the model contains behavioural equations for private consumption, housing and equipment investment, exports and imports. In addition, consumer prices as well as the deflators of the GDP expenditure components, labour demand by companies, labour supply by private households and the wage formation process are covered by behavioural equations. Unemployment is defined as the difference between labour demand by companies and labour supply by private households. Furthermore, the public sector is modelled in some detail. Government consumption is exogenous, but many revenue and expenditure items which fluctuate with economic activity are endogenously determined. The supply-side comes into play via potential GDP. The capacity utilisation rate, i.e. actual as percentage of potential GDP enters different price equations of the model. In case of a negative output gap, i.e. an under-utilisation of capacities, inflation will be lower, thus moderating wage pressure. Hence, companies increase employment which generates income and ultimately private consumption. In addition, in the case of low inflation consumption is also supported by raising real disposable income. Both effects lead to a closing of the output gap. In case of a high capacity utilisation, inflation will be higher with a detrimental effect on real activity.

In the current model version, potential output is determined by applying a Hodrick-Precott filter to actual GDP. Before applying the Hodrick-Prescott filter, a time series model is fitted to the growth rate of GDP. This time series model is then used to extrapolate GDP. The HP filter is then run over the extended GDP series so as to overcome the end-point problem which is inherent to any filtering technique. . The application of a production function to determine potential GDP was prohibited by data constraints. After the transition to the current version of the National Accounts (ESA95), there occurred some delay in calculating consistent capital stock time series for Austria. However, as now capital stock series for Austria are available, in the next model update potential GDP will be determined with a production function instead of the HP trend. In this new model version, the production function approach as suggested by the European Commission will be implemented as far as possible, i.e. potential GDP will be determined via a Cobb-Douglas production function with potential employment, the capital stock and trend total factor productivity. Hence, also this approach involves a substantial application of the Hodrick-Prescott-Filter: the HP filter is utilised to generate the trend of the structural unemployment rate (i.e., the NAIRU), the trend labour force participation rate and trend total factor productivity.

[2] Since the most recent mid-term projection which is analysed in this paper was generated in 2004 (see below), the model version documented in Hofer and Kunst (2005) represents the state of the model that was used for the most recent projections evaluated below.

3. An illustrative example: mid-term projections at IHS

In this section, the mid-term projections published by the Institute for Advanced Studies (IHS) are evaluated. To our knowledge the literature that examines the performance of macroeconomic mid-term forecasts is very scarce. A forecast evaluation is complicated by the possibility that forecasts may influence the behaviour of economic agents. As a result, the "reality" to which the projection is compared is different from the "reality" which would have occurred without the forecast. The prediction of a downturn may affect expectations in such a way that the economy actually slows down, e.g. because private households become more cautious in their spending decisions or because companies invest less than they would have done otherwise. Up to a certain degree, forecasts may therefore become self-fulfilling. The opposite, i.e. a self-destructive forecast is likewise conceivable. Faced with an unfavourable forecast, policymakers might take measures to stimulate growth, or at least let the automatic stabilisers operate. Furthermore, model-based economic projections are always conditional on assumptions about exogenous variables like world trade or international raw material prices. A forecast error is therefore not necessarily indicative of a "wrong" forecast, as a forecast error might result from wrong assumptions about exogenous variables. If, on the other hand, the projection coincides with the true realisation although the underlying assumptions were wrong, then the projection has to be considered as wrong (see Baumgartner 2002).

With these caveats in mind, in the following the accuracy of the mid-term projections published by IHS is analysed. [3] The Institute for Advanced Studies has a long tradition of producing economic forecasts. In addition to the quarterly short-term forecasts, which cover a period of two years, once a year a mid-term projection for a five-year horizon is published (see, e.g. Felderer et al. 2009). The projections are produced with the aid of the annual macroeconometric model LIMA. In the following, these mid-term projections, which are available since 1987, are evaluated.

As the projections cover a five-year horizon, and given the fact that at the time of writing this paper the GDP figures for 2009 have not yet been published, the last mid-term projection that could be included and confronted with the actual development was the projection published in 2004. This time span generates 18 mid-term projections that could be included in the evaluation exercise.

The medium-term projections analysed in this section have been published in the period 1987 to 2004. During most of this time, international organisations derived potential or trend GDP by applying statistical filters like the Hodrick-Prescott filter to actual GDP (see above). Hence, it does not seem to be problematic that also in the IHS macroeconometric model LIMA potential GDP has until recently been determined via a HP filter. Furthermore, empirical studies of potential GDP growth rates and output gaps show that the broad developments are in general highly correlated across measures (see, e.g., Giorno et al., 1995). In particular, there is no systematic difference between the assessment of potential GDP and output gaps derived with the production function approach or a statistical filter. It should only be mentioned that while for medium-term projections an assessment of the actual and future

[3] For an evaluation of short-term forecasts for Austria, see Baumgartner (2002) and Ragacs and Schneider (2007).

development of potential GDP is crucial, also other macroeconomic aggregates are important. A medium-term projection comprises not only forecasts of potential GDP, but also of actual production, the demand components of GDP, wages, prices, employment and unemployment as well as the budget balance. Summing up, for the evaluation of the medium-term projections it does not seem overwhelmingly important which method has been applied to estimate potential output.

The evaluation covers three central macroeconomic indicators: real GDP growth, the unemployment rate and the inflation rate. The IHS projections are compared with forecasts generated with two alternative models: first, a VAR model including the three variables of interest and second, three autoregressive (AR) models, one for each of the three variables under consideration. For each model, the lag length was set to two. The choice of two lags was based both on selection criteria like the Akaike information criterion and on the consideration that at least two lags are necessary to generate some cyclical fluctuations in the variables. With only one lag, the models would converge too quickly to their long-run equilibria.

In mid-term projections, the focus of interest lies on the average development over the forecast period. Hence, when generating a mid-term projection, one is in general not so much interested in forecasting exactly the actual outcome in any single year of the forecasting horizon, as it is the case for short-term, i.e. two-year forecasts. Therefore, in the following particular attention is given to the question which of the forecasts (IHS, VAR, AR) is best regarding the projection of the five-year average of real GDP growth, inflation and unemployment. GDP is subject to substantial revisions over time. Not only are GDP figures revised when new statistical information becomes available. In addition, from time to time the entire system of National Accounts is substantially revised. This was e.g. the case when switching from ESA68 to ESA95. Furthermore, recently the calculation of real GDP has been changed from constant prices of a base year to previous year's prices. Hence, it is not entirely clear with which "reality" the GDP projections should be compared. In order to take this feature into account, in the present paper both the first publication of the GDP growth rate and the figure according to the most recent vintage of National Accounts have been taken. As an example for the magnitude of these revisions, in 1988 real GDP growth amounted to 4.2% according to the first publication and to 2.9% according to the most recent National Accounts vintage. The unemployment rate and the inflation rate are generally not revised in later years; therefore such a distinction was not necessary for those two variables.

The projections are evaluated by means of the following criteria:

1. The accuracy of the IHS projections are compared to forecasts generated with alternative models.
2. It is analysed which of the models how often comes closest to the actual outcome.
3. It is investigated whether the IHS projections are on average unbiased, or if there are systematic forecast errors.

Turning to the first criterion, i.e. the comparison of the IHS projections to projections generated with alternative models (i.e. the VAR and the AR models), the projections are analysed on the basis of the following statistical tests:

a. Mean error (ME). The mean error is defined as the difference between the forecast and the actual value:

$$\frac{1}{N}\sum_{t=1}^{N}\hat{x}_t - x_t$$

$\hat{x}$ and x denote the projection and the actual value, respectively, t is the time period, and N is defined as the projection horizon.

b. Mean squared error (MSE). While in the mean error positive and negative deviations of the projection from the actual value cancel out, this is not the case with the MSE where the deviations are squared:

$$\frac{1}{N}\sum_{t=1}^{N}\left(\hat{x}_t - x_t\right)^2$$

c. Mean absolute deviation (MAD). The MAD measures the absolute differences between the projection and the actual outcome:

$$\frac{1}{N}\sum_{t=1}^{N}\left|\hat{x}_t - x_t\right|$$

The mean absolute deviation can be interpreted as the mean deviation of the projection from the actual outcome in percentage points.

d. Theil's inequality coefficient U2. Theil's inequality coefficient U2 compares the forecast with a naïve no-change forecast. In the case of five-year averages this means that the average of the past five years is taken as the benchmark forecast for the outcome in the following five-year period. The U2 statistic will take the value 1 under the naïve forecasting method. Values less than 1 indicate greater forecasting accuracy than the naïve forecasts, values greater than 1 indicate the opposite. Theil's U2 statistic is defined by the following formula:

$$\sqrt{\frac{\sum_{t=1}^{N-1}\left(\frac{(\hat{x}_{t+1} - x_{t+1})}{x_t}\right)^2}{\sum_{t=1}^{N-1}\left(\frac{x_{t+1} - x_t}{x_t}\right)^2}}$$

Tables 2 to 4 show the results of this evaluation exercise. Table 2 compares the projection of the average real GDP growth rate over the 5-year forecast period with the first publication (upper panel) as well as the most recent vintage of the National Accounts (lower panel). The unemployment projections are evaluated in table 3, while table 4 is devoted to the inflation rate. In order to check whether the projections could be improved over time, the second half of the evaluation period (1996-2004) is shown in addition to the results for the entire sample

(1987-2004). The forecasts of the 5-year averages of the three variables under consideration are visualised in figures 2 to 4.

As table 2 reveals, the VAR model, including all three variables of interest (real GDP growth, the inflation rate and the unemployment rate) traces the actual development of the 5-year average GDP growth rate remarkably well. The IHS projections, which are essentially based on a fully fledged structural macroeconometric model, enhanced by expert judgement, are in general not able to beat the VAR model. In contrast, the single-equation autoregressive (AR) models which explain the three variables under consideration exclusively on the basis of the past development of the respective variable are clearly worse. It is evident that the IHS projections could be improved over time, which is not the case for the forecasts generated with the time series models. That the forecasting performance of the VAR and AR models cannot be improved over time is to be expected as these models do not include any learning rule. It is striking that the projections with respect to the most recent National Accounts release are better than the forecasts of the first publication of the GDP figures.

Regarding the unemployment rate, the VAR model again generates the best projections (see table 3). However, for this variable even the simple time series models beat the IHS forecasts. An inspection of figure 2 reveals that the relatively unfavourable IHS result is to a considerable extent driven by too optimistic five-year projections published in 1989/1990 and in the low-growth period 2001-2003.

Turning to the inflation projections, the IHS has been able to beat the time series models. All statistical error measures are better for the IHS projections as compared to the VAR and AR models. However, the differences are relatively small. Furthermore, an improvement of the projections over time can be shown, as the forecast errors are smaller in the second half of the sample than in the entire period.

These results are in line with previous forecast evaluations for Austria (Baumgartner (2002) and Ragacs and Schneider (2007), which also find that inflation forecasts are more accurate than GDP forecasts. There it is argued that usually inflation fluctuates less than GDP growth, and that past realisations of inflation, i.e. the values on which the projections are based, undergo less data revisions than National Accounts figures.

It is striking that for all models and for each of the three macroeconomic indicators Theil's inequality coefficient U2 exceeds one. This result indicates that the naive no-change forecasts (i.e. to take the average of the past five years as the projection of the average of the following five years) would have been better. Interestingly, this outcome can be found regarding the five-year averages, but in general not for each single year.[4] This means that for the projection of the second, third, fourth and fifth year, Theil's U2 is below one in the cases of GDP growth and inflation. Only for the unemployment rate, Theil's U2 exceeds one also for the projections of the outcome in single years.

In particular regarding GDP growth and the inflation rate, the IHS forecasts become relatively better in the second half of the sample. The forecast accuracy of the IHS projections

[4] For reasons of conciseness, the results for single years are not included in this paper, but can be obtained from the authors upon request.

improves over time, while the accuracy of the time series models is more or less stable over time. The IHS inflation projections even beat the time series models in the latter part of the period. Hence, towards the end of the projection sample covered in the evaluation, the forecasts generated by the IHS do not deviate substantially from those produced with the time series models.

In addition to looking at the absolute or relative deviations of the projections from the true values of the target variables, another way of comparing different projections is to analyse how often which forecast comes closest to the actual outcome. Such an analysis is the basis of table 5 which shows the average rank of the projections made by the IHS and with the time series models. The table depicts the average rank over the period 1987 to 2004 regarding the projection of the 5-year average of the respective variable. As an example, the model that comes closest to the actual five-year average of GDP growth in 1987 (i.e., the 5 years starting in 1987) gets rank 1 in that particular year, and the second best and third best models the ranks 2 and 3, respectively. As can be seen, for GDP growth the VAR model gets clearly more often the rank 1 than the AR model and the IHS forecasts, and the IHS forecasts are on average closer to the actual development than the simple time series models. Regarding the unemployment projections, the VAR model is again the winner, this time followed by the AR models. Finally, IHS and the time series models generate more or less equally often the best, middle and worst five-year projection of the inflation rate.

As a third criterion of forecast accuracy it is tested whether systematic errors can be detected in the IHS projections. In the absence of systematic errors, the mean of the projection should be equal to the mean of the actual outcome. As suggested by Mincer and Zarnowitz (1969), this can be tested by estimating the following equation:

$$\hat{x}_t = a + b \cdot x_t + \varepsilon_t ,$$

where, as before, $\hat{x}$ and x denote the projection and the actual value, respectively, t is the time period, and ε is the error term.

It is formally tested whether the constant a is zero and b takes the value 1. If the constant is significantly different from zero, the projections systematically under- or over-estimate the variable in question, as a constant value biases the projection. If the coefficient b is significantly different from 1, the projection deviates more or less proportionally from the actual outcome. The Hypotheses (a = 0, b = 1) are jointly tested by estimating the above equation and then performing a Wald test on coefficient restrictions. The Wald statistic measures how close the unrestricted estimates come to satisfying the restrictions under the null hypothesis. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions. The power of the Wald tests have to be qualified insofar as the underlying time series are relatively short as just 18 five-year projections could be included in the evaluation exercise.

The variables under consideration are again the five-year averages of real GDP growth, the unemployment rate and the inflation rate. The results of the tests are reported in table 6, where the Wald test statistic is displayed. A significant value of the test statistic leads to the rejection of the null hypothesis of unbiased projections. In the final column it is stated whether the null hypothesis of unbiased projections can be rejected for the variables under consideration. As can be seen, the projections of GDP growth are biased. On the other hand, both for the unemployment rate and the inflation rate the null hypothesis of unbiased projections cannot be rejected.

Summing the forecasting evaluation up, it seems that the professional forecasters, assisted by a structural macroeconometric model, as well as the simple time series models tend to attach too much weight to the most recent economic developments. This applies in particular to real GDP growth and the unemployment rate. The five-year averages of these two macroeconomic indicators fluctuate in general less than expected by forecasters. Hence, in general macroeconomic shocks cause business cycle fluctuations, but they tend to affect the long-term growth less than it may seem to be the case at the time the shock occurs. As a conclusion, in mid-term projections it is important to distinguish between business cycle fluctuations and more structural, mid to long-term developments.

4. Approaches to improve models for medium-term forecasting

Due to the needs of users of medium-run forecasts it is common practice to produce them by using macroeconometric models. Most of these models are traditional demand driven business cycle models, extended by a production function to determine potential output. Despite this slight modification, most of the models used for medium-run forecasting treat the medium term as an extension of the short run. However, some authors argue that this approach neglects some important aspects because the medium run can be seen as the transition from business cycles to growth. They explicitly argue in favour of a special treatment of the medium run. They highlight some aspects of what they think are neither a phenomenon of the short nor of the long run. Solow (2000) mentions the transition from fixed to flexible prices. Other authors point to the rise of the capital share in continental Europe (Blanchard 1997; McAdam and Willman 2008). To account for this fact it is necessary to represent the supply side of the economy by a CES production function instead of a Cobb-Douglas function. Besides this more technical aspect it is not clear what the ingredients for a theory of the medium run should be and whether we need an explicit theory at all. However, the discussion about medium-run phenomena may highlight some aspects that might be helpful to improve medium-run forecasts.

The traditional mechanism to converge from the short to the long run is the adjustment of prices and wages. This transition is explicitly modelled in new Keynesian DSGE models. These models became increasingly popular in recent years also for forecasting. In an influential paper Smets and Wouters (2007) show that forecasts with these models are able to outperform those of Bayesian VARs at a time horizon of three years. However, empirical findings suggest that firms adjust their prices every five to eight months (Dennis 2008). For wages the evidence is that firms at least in the Euro Area make adjustments once a year (ECB 2009). It is therefore an open question how important wage and price rigidities as well as capital adjustment costs are over the medium term.

Approaches that combine business cycle models with aspects of endogenous growth point to additional factors that might be important for the development of economic activity over the medium run. These models modify standard business cycle models by extending the production sector of the model. One way is to incorporate human capital in the production function. This can be done by incorporating learning-by-doing. This means that technology is endogenous because workers learn to use new technologies. In this case technology depends on labour input as well as on the past level of labour productivity (Stadler 1990). Another way is to incorporate investment in human capital (Gomme 1993). The introduction of a human capital formation process introduces a third alternative for the allocation of time between work, leisure and training. Several papers show that the inclusion of learning-by-doing (Ozlu 1996, Einarsson and Marquis 1997, 1998, Chang et al. 2002, Cooper and Johri 2002) as well as human capital production (Ozlu 1996, Gomme 1993) leads to a better empirical fit than that of pure business cycle models. However, most of these models focus on business cycle frequencies. One exception is Collard (1999). In this paper he analyses a business cycle model with learning by doing. This model with a convenient parameterisation produces a pronounced cycle with a length of ten to fifteen years.

Another approach to combine business cycle and growth models is to endogenise technological change. This can be done by extending the variety of products or by creative destruction, which means that an existing product is replaced by an improved new one. While these models have first been used to explain long waves in economic activity (e.g. Bental and Peled 1996, Andolfatto and MacDonald 1997), recently they have also been used to explain fluctuations in economic activity at lower frequencies (Meliar and Meliar 2004, Phillips and Wrase 2006). Phillips and Wrase (2006) analyse a RBC model with creative destruction at business cycle and medium run frequencies. In this model economic growth is driven by permanent improvements of the production technology while cycles are caused by reallocations of resources between production and R&D. It is shown that if this model is driven by an exogenous productivity shock it fits the data slightly better than a related RBC model at medium-run frequencies (five to twenty years).

An alternative way to introduce endogenous technological change is to assume that technological progress increases the number of varieties of producer goods. If it is assumed that each good is produced by a single firm, product variety is related to the entry and exit of firms (Comin and Gertler 2006, Bilbiie et al. 2007) Comin and Gertler (2006) construct a model with endogenous product variety that is able to generate long-run growth and business cycle fluctuations. This model consists of three sectors for a consumption good and an investment good, respectively, because it is argued that the medium run is important for the transmission of innovations to marketable products. It is therefore necessary to model this process in more detail. The R&D sector produces blueprints for new intermediate goods. In the second sector, adopters buy the blueprint and convert it into a marketable product. This adoption process of new products is endogenous as it depends on the level of economic activity. Therefore the time lag of the diffusion of new ideas is also endogenous. The adopter sells the new intermediate good to the final good producer. The entry and exit of firms in the final goods sector generates a countercyclical variation of price mark-ups. A justification for this modelling approach is the finding that firstly private R&D expenses as an indicator for the development of new technologies is highly correlated with output at high frequencies (Comin 2009). Secondly, at medium-run frequencies the cyclical component of R&D expenditures has a correlation of 0.4 with output at a lead of five years. This finding suggests that information about R&D activity in the private sector probably contains valuable information for forecasting over the medium term.

Comin and Gerter (2006) were the first who explicitly calibrate their model to business cycle and medium run frequencies. To test whether this model is able to reproduce medium-term cycles in the data the moments of selected time series generated by the model are compared with the unconditional moments of the actual data for the business cycle as well as the medium-term cycle frequency. For most of the time series the moments of the artificial time series are quite close to those of the actual data. However, Comin and Gertler define the medium run as frequencies from 2 to 200 quarters which is a quite long time span. It is therefore an open question whether the diffusion of new technologies contains useful information over a time horizon from 3 to 5 years.

Despite these approaches to combine business cycle and growth models, up to now only little empirical work has been done to test whether information about long-run growth is useful to improve medium-run forecasts. Exceptions are Batista and Zalduendo (2004) and Linth (2004). Batista and Zalduendo (2004) estimate growth equations for a panel of countries. Among other variables the authors include income, human capital openness and fertility rates to forecast five-year GDP growth rates. The authors compare their results with the official five-year projections of the IMF. On average the forecasts based on these growth equations outperform the official IMF forecasts despite the fact that the IMF include country-specific information that is not included in the growth equations. The idea that long run economic growth determinants are also useful to forecast GDP growth in the medium term was also tested by Lindh (2004). He finds that age structure data for Sweden improve predictions of potential GDP growth over the medium term. These results are promising for further attempts to improve medium-run forecasts.

5. Conclusions

In view of the importance of medium-term forecasts for economic policy-making it seems to be necessary to refine the methods currently in use. The present practice to perform a medium-run projection is to calculate the path of potential output over the forecasting horizon and then using a macroeconometric model to project the transition path of actual output to its potential level. This implies that it is usually assumed that at the end of the projection period the output gap is closed. To utilise models for medium-term forecasting is reasonable because users of medium-run forecasts often need information about the development of GDP as well as of other important variables. In particular, medium-term projections are often performed in the process of medium-term fiscal planning. For this purpose, the future development of real economic activity together with its implications for the public budget have to be derived jointly. Structural models enable to take the complex interactions between a large number of macroeconomic aggregates into account. However, the typical structure of these models is unsatisfactory form an empirical as well as from a theoretical point of view. A first shortcoming is that typically the determinants of potential output – with the capital stock as the only exception – are exogenous to the business cycle dynamics. This is in conflict with the empirical finding that business cycle and medium-run dynamics are related. Medium-term models should therefore incorporate a link between business cycle fluctuations and potential output.

Another weakness of most medium-run models is that they solely incorporate the feedback from potential output to economic demand via the output gap. Other potentially important factors of economic supply, for example the entry and exit of new firms and cyclical R&D activity as well as the formation of human capital, are neglected. This is the reason why the transition path of actual output back to its potential level is mainly demand driven. As shown in this paper, this approach tends to attach too much weight on the short-run dynamics of economic activity. This finding is in line with other empirical studies which show that considering the information of growth determinants for medium-run forecasts helps to improve the forecasting performance of these models.

Up to now proposals to improve medium-term forecasts are scarce. Nevertheless, existing approaches to combine business cycle and growth models are promising. In particular, the huge literature on endogenous growth offers many starting points for further improvements of medium-run models. Which aspects of long-run growth are also relevant over the medium term is an open question. However, incorporating aspects of endogenous growth in business cycle models, e.g. information on R&D activity have good prospects.

Tables and Figures

Table 1: Selected macroeconometric models used for medium-term forecasting

Model	Frequency	Equations (stochastic)	Estimation technique	Forecast horizon
Australia (TRYM)	quarterly	ca. 125 (25)	16 of the 25 equations estimated as a system	10 years
Belgium (HERMES)	annual	3100 (450)	First differences or error correction	5 years
Denmark (ADAM)	annual	2500	First differences or error correction	5 years
Finland (KESSU)	annual	969 (240)	Error correction	10 years
United Kingdom (HMTM)	quarterly	(350)	Error correction	5 years
Canada (CEFM96)	quarterly	113	Non-linear single equations	4 years
New Zealand (NZTM)	quarterly	101	Supply block: system with FIML, Demand block: single equation cointegration	10 years
Netherlands (JADE)	annual	ca 2000 (ca. 50)	Error correction	12 years
Norway (MODAG)	annual	1225 (183)	n.a.	15 years
Austria (LIMA)	annual	134 (34)		5 years
Germany (RWI)	quarterly	120 (30)	Error correction	5 years

Table 2: Projections of real GDP growth

	Recent vintage					
	Total sample (1987 - 2004)			**second half (1996 - 2004)**		
	IHS	VAR	AR	IHS	VAR	AR
ME	0.26	0.18	-0.30	0.30	0.42	-0.21
MSE	0.97	0.31	1.34	0.43	0.32	1.02
MAD	0.79	0.44	1.04	0.56	0.45	0.92
Theil	2.33	1.40	2.71	2.07	1.89	2.99
	1st publication					
	Total sample (1987 - 2004)			**second half (1996 - 2004)**		
	IHS	VAR	AR	IHS	VAR	AR
ME	-0.02	-0.10	-0.57	-0.05	0.07	-0.56
MSE	0.69	0.17	1.45	0.38	0.18	1.35
MAD	0.71	0.35	1.08	0.53	0.36	1.08
Theil	2.09	1.02	3.16	1.43	1.06	2.93

Notes: ME: Mean Error, MSE: Mean Squared Error, MAD: Mean Absolute Deviation; Theil: Theil's inequality coefficient U2.

Source: own calculations.

Table 3: Projections of the unemployment rate

	Total sample (1987 - 2004)			**second half (1996 - 2004)**		
	IHS	VAR	AR	IHS	VAR	AR
ME	-0.25	-0.11	0.26	-0.43	-0.06	0.57
MSE	0.82	0.13	0.33	0.80	0.16	0.53
MAD	0.79	0.29	0.48	0.74	0.35	0.63
Theil	4.84	1.89	2.98	6.13	2.59	4.65

Notes: ME: Mean Error, MSE: Mean Squared Error, MAD: Mean Absolute Deviation; Theil: Theil's inequality coefficient U2.

Source: own calculations.

Table 4: Projections of the inflation rate

	Total sample (1987 - 2004)			**second half (1996 - 2004)**		
	IHS	VAR	AR	IHS	VAR	AR
ME	0.26	-0.18	0.00	-0.18	-0.24	0.14
MSE	0.43	0.69	0.59	0.14	0.30	0.24
MAD	0.50	0.68	0.62	0.33	0.44	0.38
Theil	2.40	2.67	2.68	1.71	2.55	1.95

Notes: ME: Mean Error, MSE: Mean Squared Error, MAD: Mean Absolute Deviation; Theil: Theil's inequality coefficient U2.

Source: own calculations.

Table 5: Average rank of the different models (basis: projections of 5-year averages)

	IHS	VAR	AR
GDP	2.2	1.3	2.5
Unemployment rate	2.5	1.4	2.1
Inflation rate	2.0	2.1	1.9

Source: own calculations.

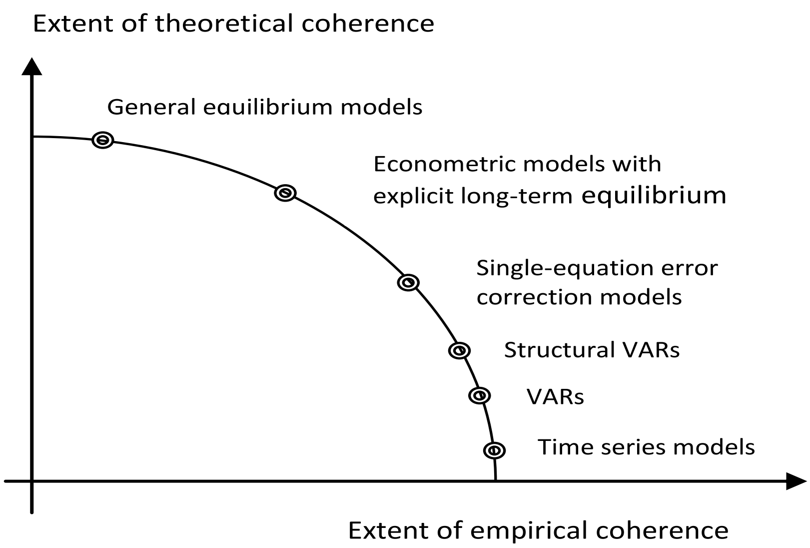
Table 6: Test whether IHS projections are biased

Variable	Wald test	Biased
GDP growth 1st release	29.654***	yes
GDP growth current	36.265***	yes
Unemployment rate	0.248	no
Inflation rate	1.944	no

Notes: Test equation: projection = a + b· true value. *"***" denotes significance on the 1 percent level.*

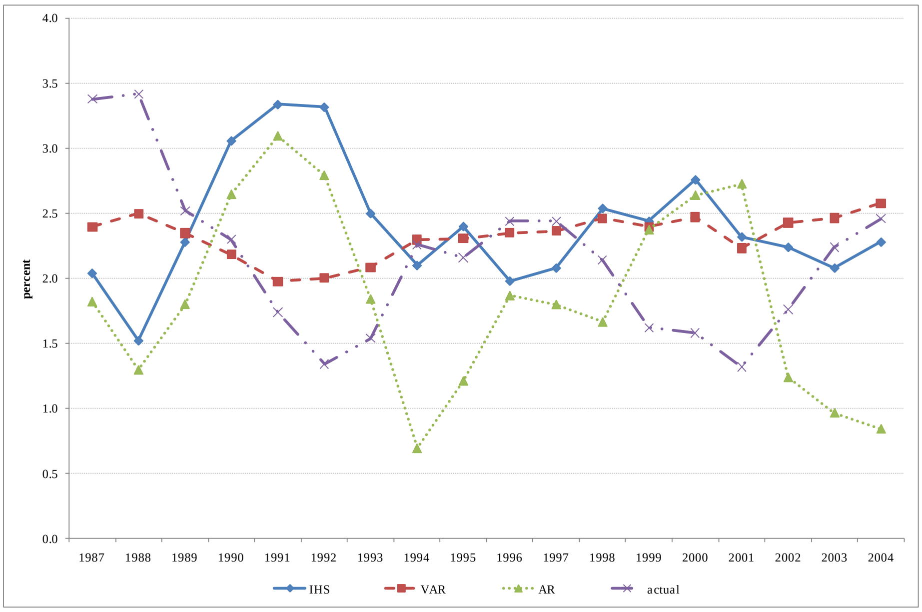
Source: own calculations

Figure 1: Trade-off between theoretical and empirical coherence of macroeconometric models



Source: After Pagan (2003).

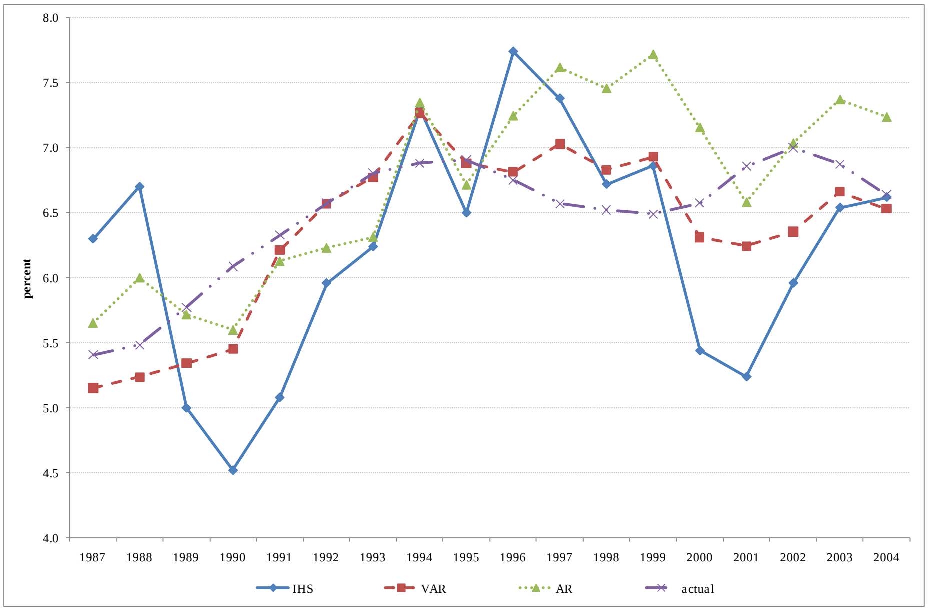
Figure 2: Real GDP (5-year averages) - comparison of projections



Note: Shown are 5-year averages, starting in the respective year.

Source: own calculations.

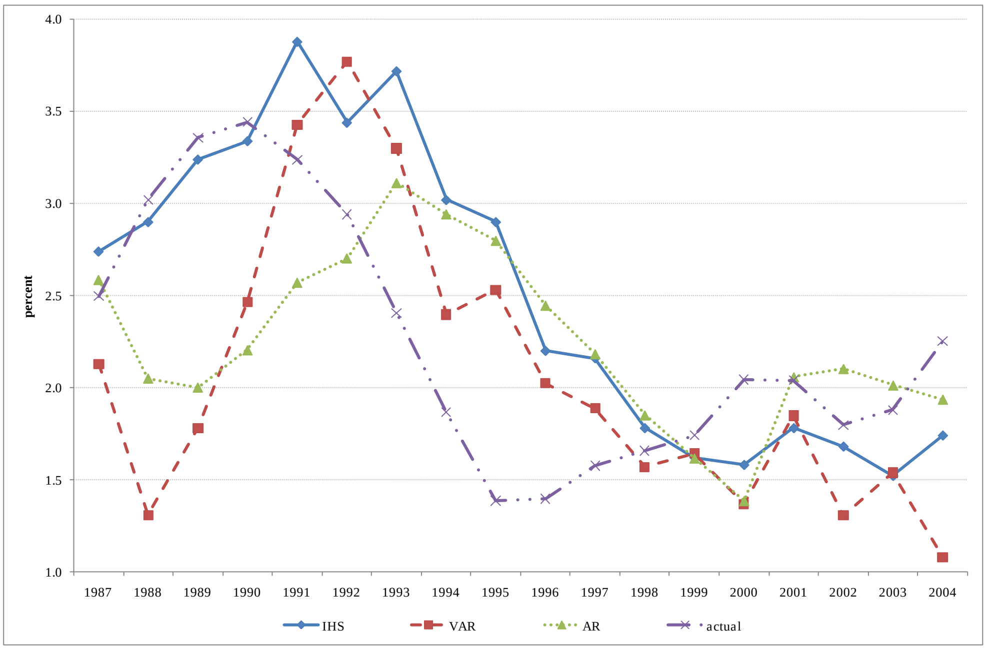
Figure 3: Unemployment rate (5-year averages) - comparison of projections



Note: Shown are 5-year averages, starting in the respective year.

Source: own calculations.

Figure 4: Inflation rate (5-year averages) - comparison of projections



Note: Shown are 5-year averages, starting in the respective year

Source: own calculations.

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Praxis und Zukunftsperspektiven mittelfristiger Wirtschaftsprognosen

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Zusammenfassung

Regierungen sowie nationale und internationale Organisationen haben ein Interesse daran, Wirtschaftsprognosen über die mittlere Frist zu erstellen. So verpflichtet der europäische Stabilitäts- und Wachstumspakt die Mitgliedstaaten des Euroraums dazu, jährliche Stabilitätsprogramme mit Vier-Jahres-Projektionen der wirtschaftlichen Rahmenbedingungen und der Entwicklung des Staatshaushalts zu liefern. Die gegenwärtige Praxis der Erstellung mittelfristiger Wirtschaftsprojektionen kann dahingehend kritisiert werden, dass die verwendeten Methoden primär für kurzfristige Prognosen entwickelt wurden, während in der mittleren Frist andere Faktoren als für die kurzfristige Wirtschaftsentwicklung relevant sein könnten. In der Regel basieren die Mittelfristprojektionen auf dem Solow-Modell mit einer gesamtwirtschaftlichen Produktionsfunktion mit den Einsatzfaktoren Arbeit, Kapital und exogener technischer Fortschritt. Es könnte jedoch argumentiert werden, dass für die mittlere Frist das endogene Wachstumsmodell besser geeignet sein könnte. In diesem Beitrag geben wir zunächst einen Überblick über den aktuellen Stand der Methoden mittelfristiger Wirtschaftsprojektionen. Anschließend analysieren wir die mittelfristigen Projektionen für Österreich, um die Stärken und Schwächen des üblicherweise verwendeten Ansatzes zu illustrieren. Im Speziellen untersuchen wir die Fünf-Jahres-Prognosen des realen BIP-Wachstums, der Inflationsrate und der Arbeitslosenquote. Schließlich beschreiben wir einige Ansätze, mit deren Hilfe Mittelfristprojektionen verbessert werden könnten.

JEL-Klassifikation: C53; E32, E37; E66

Schlüsselwörter: Ökonometrische Modelle; Makroökonomische Prognosen; Gesamtwirtschaftliche Produktionsfunktion; Österreich