Stefan Bergheim

Long-Run Growth Forecasting

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Stefan Bergheim
Raimundstr. 121
60320 Frankfurt
Germany
stefan.bergheim@googlemail.com

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To my mother

Acknowledgement

List of variables and coefficients

Y total GDP

y GDP per capita (Y/L)

$\dot{y}$ change of GDP per capita dy/dt

$\hat{y}$ percentage change of GDP per capita $\dot{y}/y$

K physical capital

k physical capital per capita

$\hat{k}$ growth rate of per capita capital stock

a share of capital in national income

α elasticity of output with respect to capital input

r real interest rate

I investment in physical capital

κ growth rate of investment

L total labor supply

n growth rate of population $L_t = L_0 e^{nt}$

w real wage rate

H human capital

h human capital per capita

$\hat{h}$ growth rate of human capital per capita

S years of education

R work experience

o trade openness per capita

A level of "technology" or of total factor productivity TFP

g growth rate of technology $A_t = A_0 e^{gt}$

E country-specific efficiency

x other drivers of per-capita income

s savings rate

s_k saving to accumulate physical capital

s_h saving to accumulate human capital

t time

i index of countries

u fraction of human capital reinvested

β elasticity of human capital; or regression coefficient

γ capital-output ratio K/Y

δ depreciation rate

ϵ regression error

η coefficient in Dickey-Fuller regression

λ rate of convergence

μ coefficient on trade openness in technical progress function

π coefficient on cointegration errors

ρ rate of time preference

σ rate of risk aversion

ϕ return to human capital

ω coefficient on human capital in technical progress function

List of abbreviations

ECB European Central Bank
ECO Economic Outlook database (by OECD)
GDP Gross domestic product
IMF International Monetary Fund
MRW Mankiw, Romer and Weil (1992)
OECD Organisation for Economic Co-operation and Development
PMG Pooled mean group estimator
PPP Purchasing power parity
PWT Penn World Table
R&D Research and development
RMSE Root mean squared error
TFP Total factor productivity
UN United Nations
WDI World Development Indicators (by World Bank)
WEO World Economic Outlook (by IMF)

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The importance of long-run growth analysis

Forecasts are usually made to help and guide decision making. Good forecasts are preconditions for good, informed decisions. These decisions may vary from a financial market bet on interest rate changes to the policy decision on how to structure a country's pension system. Ideally, decision-makers should be as well prepared as possible for the future, which would allow them to act appropriately. To detect challenges and opportunities in a timely manner decision-makers require a good forecasting framework. Given the role governments, companies and individuals play, knowledge about the drivers and linkages that determine the future will allow these players to actually shape the future themselves.

1.1 Frequent forecast failures

Unfortunately, history is full of examples of poor predictions and therefore poor decisions. In the early 1990s, the USA was seen by many as a sclerotic economy destined for anemic economic growth with high unemployment and to be overtaken by Japan within a few years. As we know today, these predictions could not have been more wrong. Growth of US gross domestic product (GDP) averaged 3.3% per year between 1992 and 2005. Asset markets in the US surged as they became increasingly confident that the future would be much brighter than assumed in the early 1990s.

By contrast, Japan in the early 1990s was seen as a role model. In the event, a decade of economic stagnation, falling asset prices and banking sector problems followed and made many forecasters look incompetent. Germany is another case where trend GDP growth has been overestimated significantly for the past 10 years. From about 2% in 1995 the consensus forecast for trend growth was revised down to around 1% by 2005. Actual growth over the years 2001-05 was just 0.7%. Year after year, growth expectations of investors and companies had to be revised downwards. Had investors known already in the mid-1990s just how low Germany's growth potential was, some investment

plans would have turned out quite differently: production capacities would not have been expanded as much and investors would have avoided companies with a large exposure to German domestic demand.

Forecast errors are not confined to developed markets. The frequent crises in emerging markets over the past two decades tended to be even more severe and surprising. For example, the 1997 crisis in emerging Asia caught many investors by surprise - who wished they had been better able to anticipate the difficulties. Even worse, after retreating from Asia during the crisis, many companies were surprised by the rapid rebound of countries like Korea and Malaysia - and wished they had had a framework to tell them to stay engaged in these countries.

This anecdotal evidence is supported by more formal analysis. The forecasts in the International Monetary Fund's semi-annual World Economic Outlook (WEO) displayed a tendency to systematically overpredict real GDP growth as Timmerman (2006) shows. Between 1991 and 2003, the next-year forecasts in the September WEOs for France, Germany, Italy and Japan were on average a full percentage point too high. This bias points to a significant overestimation of trend growth. Indeed, one of Timmerman's recommendations on how to address these forecast errors is to have "more frequent reviews of estimates of potential output growth" (op. cit. p. 9). This would entail a more thorough modeling of trend growth using elements of growth theory.

The IMF is not alone in having made these systematic forecast errors. They are also visible in the European Central Bank's (ECB) staff forecasts for the euro area and in consensus forecasts. For the year 2003 the staff forecast for GDP started out at 2.5% - way above the final outcome of 0.5%. Forecasts for 2002, 2004 and 2005 were also too high by between 0.4 and 2.1 percentage points. The consensus according to the ECB's Survey of Professional Forecasters did not fare much better. In the first quarter of 2001 the five-year ahead GDP forecast was 2.7%, while growth over 2001-05 actually averaged just 1.4%.

Repeated small differences in growth rates can lead to large differences in outcomes many years down the road. A growth rate of per capita GDP of 1.5% does not look all that different from a growth rate of 2%. But over 20 years, this translates into a 10% difference in income levels - not a negligible amount.

These persistent and large forecast errors indicate that economists do not yet have the appropriate theories, data and/or statistical tools to adequately model the developments of national economies. Unfortunately, the task at hand is really enormous: Lucas (1988, p. 13) observed that "The growth rate of an entire economy is not an easy thing to move around. Economic growth, being a summary measure of the activities of an entire society, necessarily depends, in some way, on everything that goes on in a society."

In trying to help reduce forecast errors in the future, this study makes three contributions. First, it provides an assessment of the main existing theories of economic growth and proposes an augmented Kaldor model as the most

reasonable synthesis. It is the first work to derive hypotheses of pair-wise coin-tegration among the key variables in growth models. Second, this study applies modern non-stationary panel estimation techniques to test these hypotheses for 40 countries for the period from 1971 to 2003. And third, it presents long-run growth forecasts for the years 2006-20. A forecast competition will show that forecasts based on the theories outlined here can outperform consensus forecasts and simple time-series models.

The time horizon is the medium to long run of 5 to 20 years. In economics the term "growth" already refers to the long-run development of an economy, the evolution of its potential or trend output. However, since the media and financial markets frequently use "growth" when referring to changes in GDP over shorter periods of a year or even a quarter (which are the combined result of trend and cyclical factors), this study uses the term "long-run growth" to avoid any uncertainty regarding the time horizon.

While the ultimate goal of this study is to derive a set of forecasts, the path to these forecasts is at least as important. A forecaster has to understand the assumptions made, the limits of theories, the datasets used and has to cross-check the insights with real world experience. Unfortunately, the theoretical and empirical growth literature has not yet produced a consensus on some of the most important questions: How important is the accumulation of physical capital for GDP growth? Is investment exogenous or endogenous? Should population growth be treated as exogenous? Does an increase in education lead to higher output? What is the best econometric technique to try to answer these questions?

1.2 Strong demand - but little supply

Demand for substantiated long-term growth forecasts is high following the surprises and forecast errors made in the past. Growth forecasts are used in many areas in business and financial markets and by governments.

Businesses require forecasts for economic growth for their budgeting, strategic planning and for the analysis of business cases. Since many corporate investments, such as a new chemical plant, have investment horizons of 10 to 15 years they also require GDP forecasts over a similar horizon. The need for a neutral forecast is particularly strong here because individual business units have a genuine interest in presenting high forecasts, which may steer the allocation of resources to their unit. If budgets, strategic plans and selected business cases are based on wrong assumptions, losses for the whole company may ensue. If production and inventories are too high relative to actual demand in the future, then prices may need to be set below initial plans to clear inventory. Just-in-time production may ease some of these difficulties, but production capacities nevertheless have to be aligned with expected demand.

Financial markets make heavy use of long-run GDP forecasts in many ways. For example, many pricing models are based on the economy's underlying growth trend: Government bond yields are often priced on the sum of expected real GDP growth and inflation. And these bond yields are themselves the benchmark against which other assets (equities, real estate) are priced. Fund managers try to outperform their peers by comparing the growth forecast that the market is pricing in at the moment with their own, possibly model-based, forecast for long-run growth. They would prefer to invest in markets that few others see as promising today but that will show their strength in the near future.

When assessing the risk of overheating of an economy, the current growth rate of GDP is compared to the rate of potential GDP growth. Business cycle analysis usually starts from trend growth and then adds or subtracts from it depending on the current state of policy variables and exogenous developments (e. g. oil, exchange rate). But most of these analyses use past trends as a starting point. If trend growth is on a downward trajectory, this may lead to a series of downward revisions of growth forecasts and upward revisions of inflation forecasts - as seen in Europe and especially in Germany since 2001.

Furthermore, policy-makers are interested in specific advice on how to strengthen their countries' growth performance - or how to prepare for geopolitical changes resulting from diverging economic outcomes. A systematic analytical framework and a set of conditional forecasts for growth would make their tasks easier.

Long-run growth forecasts are also important for international organizations like the World Bank or the International Monetary Fund. A stabilization program and the associated recommendations may look quite different depending on the economy's underlying growth potential. It turns out that the IMF's medium-term growth projections have a tendency to err on the high side. As Batista and Zalduendo (2004) emphasize, this "over-optimism may lead to complacency regarding the adequacy of growth-oriented structural reforms pursued by a country."

In addition, national fiscal authorities require solid forecasts for trend GDP growth to estimate future tax revenue and pension liabilities. Wrong estimates of revenue and expenditure may lead policy-makers to cut tax rates and expand welfare spending. The result would be unexpectedly high fiscal deficits - as seen in many European countries since 2001. Around the turn of the millennium, many European governments used GDP forecasts that turned out to be too high because they were too optimistic both on the cyclical and on the trend development of GDP. This meant that budget deficits turned out much higher than expected and led to major political upheaval inside the European Union because several countries did not comply with the Stability and Growth Pact.

Likewise, central banks need a good grasp of the growth rate of potential GDP over the medium term. If a central bank overestimates the trend growth rate, it may supply too much liquidity and end up with unexpectedly high in-