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**Working Paper**

## Do We Need New Modelling Approaches in Macroeconomics?

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Do We Need New Modelling  
Approaches in Macroeconomics?

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# Do We Need New Modelling Approaches in Macroeconomics?

## Abstract

The economic and financial crisis that emerged in 2008 also initiated an intense discussion on macroeconomic research and the role of economists in society. The debate focuses on three main issues. Firstly, it is argued that economists failed to predict the crisis and to design early warning systems. Secondly, it is claimed that economists use models of the macroeconomy which fail to integrate financial markets and which are inadequate to model large economic crises. Thirdly, the issue has been raised that economists invoke unrealistic assumptions concerning human behaviour by assuming that all agents are self-centred, rationally optimizing individuals. In this paper, we focus on the first two issues. Overall, our thrust is that the above statements are a caricature of modern economic theory and empirics. A rich field of research developed already before the crisis and picked up shortcomings of previous models.

Keywords: financial crisis, economic forecasting and early warning systems, macroeconomic modelling

JEL Classification: B4, C5, E1

# Brauchen wir neue Modellierungsansätze in der Makroökonomik?

## Zusammenfassung

Die im Jahr 2008 einsetzende weltweite Finanzkrise hat auch eine intensive Debatte über Methoden und die Bedeutung makroökonomischer Forschung ausgelöst. Dabei stehen drei Punkte im Zentrum der Diskussion: Erstens hätten Ökonomen die Krise nicht vorhergesehen und keine wirksamen Frühwarnsysteme vorzuweisen. Zweitens seien Finanzmärkte nur unzureichend in den gängigen makroökonomischen Modellen berücksichtigt. Drittens seien die Annahmen der Makroökonomien bezüglich des menschlichen Verhaltens unrealistisch, insbesondere die Annahme rationaler und optimierender Individuen. In diesem Beitrag gehen wir auf die ersten beiden Punkte ein. Aus unserer Sicht vernachlässigt die Kritik an der modernen Makroökonomik wichtige Fortschritte der vergangenen Jahre. Es gibt eine Reihe von vielversprechenden neuen Ansätzen, finanzielle Aspekte in makroökonomischen Modellen besser zu modellieren.

Schlagwörter: Finanzkrise, ökonomische Prognosen und Frühwarnsysteme, makroökonomische Modellierung

JEL-Klassifikation: B4, C5, E1

The root cause of the poor state of affairs in the field of macroeconomics lies in a fundamental tension in academic macroeconomics between the enormous complexity of its subject and the micro-theory-like precision to which we aspire.

Caballero, 2010, p. 17

## 1 Introduction

The economic and financial crisis that emerged in 2008 also initiated an intense discussion on macroeconomic research and the role of economists in society. The debate focuses on three main issues. Firstly, it is argued that economists failed to predict the crisis and to design early warning systems. Secondly, it is claimed that economists use models of the macroeconomy which fail to integrate financial markets and which are inadequate to model large economic crises. Thirdly, the issue has been raised that economists invoke unrealistic assumptions concerning human behaviour by assuming that all agents are self-centred, rationally optimizing individuals.

In this chapter, we focus on the first two issues. We do not aim at reviewing the extent literature – including work by Nobel laureates in economics in the past decades – which successfully questions standard behavioural assumptions in economics.

Overall, our thrust is that the above statements are a caricature of modern economic theory and empirics. A rich field of research developed already before the crisis and picked up shortcomings of previous models. Clearly, modelling large economic systems and the behaviour of many individual agents is challenging. It requires the simultaneous modelling of different markets, global interactions, the behaviour of many different individuals and firms, and the dynamics of non-linear systems. Capturing all of these aspects in a single theoretical or empirical model would probably not improve our understanding of the underlying economic relationships. However, many recent developments in economics help us to understand how individual parts of the system work.

This chapter centres on the main arguments that are being brought forward in criticizing the field of economics and its role during the recent crisis. For each argument, we discuss its validity and we show how the economics profession has picked up the issues. Our review and representation of the literature is highly subjective and selective. We apologize to all who may not feel properly represented by our arguments. Any shortcomings and serious omissions are unintentional.

In section 2, we address the claim that economists have failed to predict the financial crisis, and we discuss the quality of economic forecasts. In section 3, we discuss the reliability of early warning systems and the progress made in the field of improving these models. In section 4, we discuss recent advances in modelling the link between financial markets and the macroeconomy. In section 5, we sketch approaches that allow modelling feedback between the micro- and the macroeconomy. Section 6 concludes.

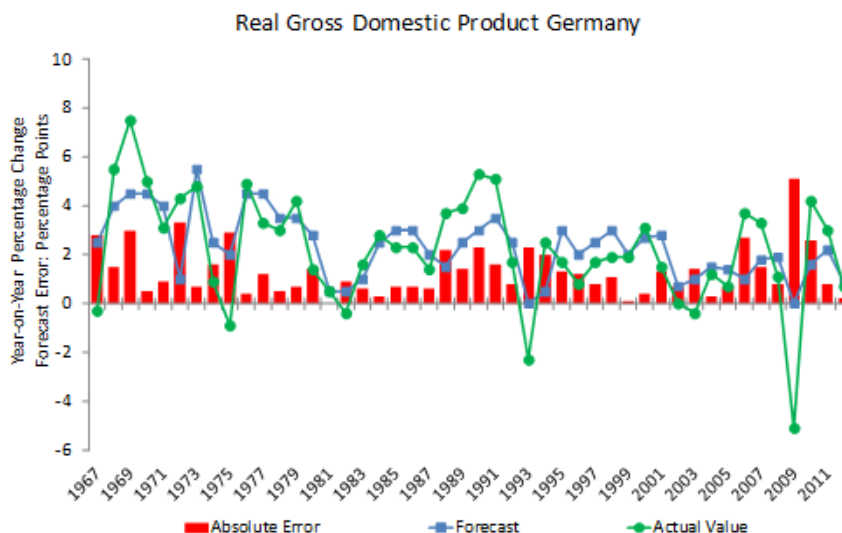
## **2 Have Economists Failed to Predict the Crisis?**

One focal point of public discussions on the role of economists is economic forecasts. Although most economists are not engaged in quantitative forecasts, forecasts yet attract the lion's share of media attention. Consequently, the role of economists in predicting the recent banking and sovereign debt crisis and in forecasting the evolution of gross domestic product (GDP) has received particular attention. We discuss the possibility as well as limits of economic forecasts in two steps. In this section, we focus on the errors of professional forecasters over time and in particular during the crisis; in the following section, we go beyond this debate and ask whether early warning systems can be improved to provide signals of future crises.

### **2.1 Is the Forecast Error for 2009 Extraordinarily Large?**

Many institutional economic forecasters have not predicted the financial crises. In autumn 2008, the European Central Bank (ECB) predicted a GDP growth rate of 1.2 per cent for the euro area in 2009 (realization,  $-4.4$  per cent), the International Monetary Fund (IMF) a growth rate of world GDP in 2009 of 3.0 per cent (realization,  $-0.4$  per cent), the Organisation for Economic Co-operation and Development (OECD) a growth rate of world trade in 2009 of 1.9 per cent (realization,  $-10.6$  per cent), and the German research institutes a growth rate of German GDP in 2009 of 0.2 per cent (realization,  $-5.1$  per cent).

However, wrong economic predictions are not specific to the financial crisis. Figure 1a shows the absolute forecast errors of the German research institutes and of the German Council of Economic Experts from 1967 to 2012. The average absolute



*Note:* The figure shows one-year ahead forecasts for the annual growth rate of real GDP in Germany that were published in autumn for the next year, together with actual GDP growth rates and absolute forecast errors.

*Sources:* Bruttel (2013) and own calculations.

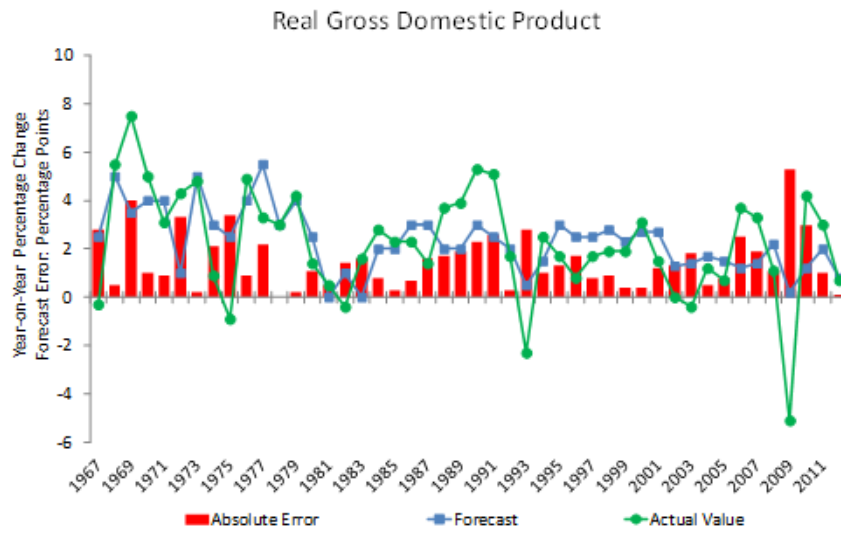
Figure 1a: Council of Economic Experts (SVR)

forecast error for the year-on-year growth rate of German real gross domestic product between 1967 and 2012 is slightly less than 1.5 percentage points. The forecasts are not systematically biased, the average forecast error is about  $-0.1$  percentage points and not statistically different from zero. The forecasts of both the Council of Economic Experts and the research institutes are optimal in the sense that one-step forecast errors are uncorrelated.

Figure 1b shows the histogram of the forecast errors. It cannot be rejected that they exhibit a normal distribution (Table 1). The largest forecast error occurs for 2009, the year in which the financial crisis hit real activity in Germany.

A one-sided Rosner outlier test rejects the null hypotheses that the forecast errors for 2009 are no outliers at the 5 per cent significance level. In this sense, the forecasts for 2009 were extraordinary bad. Based on previous forecast errors, the research institutes regularly provide 68 per cent forecast intervals together with their point estimates. For 2009, this interval ranged from  $-0.9$  to  $1.3$  per cent (Projektgruppe Gemeinschaftsdiagnose 2008, p. 48). The actual GDP growth rate ( $-5.1$  per cent) was far below the lower bound of this interval. Furthermore, in autumn 2008, the research institutes simulated an additional risk scenario for 2009 in which the 68 per

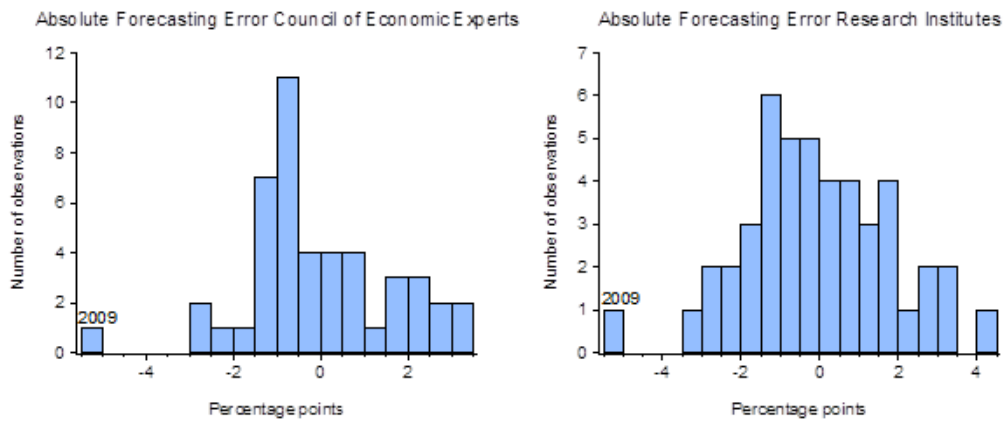




*Note:* The figure shows one-year ahead forecasts for the annual growth rate of real GDP in Germany that were published in autumn for the next year, together with actual GDP growth rates and absolute forecast errors.

*Sources:* Bruttel (2013) and own calculations.

Figure 1b: Joint forecast of major German research institutes (GD)



*Note:* The figures show histograms of one-year ahead forecast errors of forecasts for the annual growth rate of real GDP that have been published in autumn for the next year, respectively.

*Sources:* Own calculations based on Bruttel (2013).

Figure 2: Histogram of forecast errors

	Full Sample					1967-1989			
	JB-p	ME	EV	MSE	MAE	ME	EV	MSE	MAE
GD	0.94	-0.12	3.43	1.86	1.48	0.01	3.25	3.25	1.44
SVR	0.68	-0.11	2.76	2.77	1.32	-0.04	2.44	2.44	1.25
	1990–2012					1990–2012 w/o 2009			
	ME	EV	MSE	MAE		ME	EV	MSE	MAE
GD	-0.24	3.58	3.64	1.52		-0.01	2.53	2.53	1.35
SVR	-0.18	3.07	3.1	1.39		0.04	2.06	2.06	1.22

*Notes:* GD refers to the research institutes and SVR to the Council of Economic Experts. JB-p is the p-value of a Jarque-Bera Test on normality, ME the mean error, EV the error variance, MSE the mean squared error, MAE the mean absolute error.

*Sources:* Own calculations based on GD and SVR forecasts and actual GDP growth rates from Bruttel (2013).

Table 1: Characteristics of forecast errors for real GDP growth rate forecasts one year ahead, for Germany

cent forecast interval ranged from  $-1.9$  per cent to  $0.3$  per cent. The actual GDP growth rate was also below the lower bound of this interval.

Overall, the forecast error for 2009 was extraordinary large. Before addressing the question of why the forecasts for 2009 were so inaccurate, we first discuss why macroeconomic forecasts are also rather imprecise under normal circumstances.

## 2.2 Why Does the Accuracy of Macroeconomic Forecasts not Improve Over Time?

The average absolute forecast error for real GDP growth rates in Germany in the next year is larger than one percentage point. A natural question is whether the forecasting accuracy has been increasing over time. To answer this question, we split the sample 1967 to 2012 into two sub-samples and analyse whether the absolute forecast error or the root mean squared forecast error is different in the two sub-samples. Since the forecast error of 2009 is an outlier, we consider the second sub-sample with and without this unusually large error. Table 1 shows the corresponding statistics. Both the root mean squared error and the mean absolute error are slightly larger in the second sub-sample. Yet if 2009 is excluded, the root mean squared error and the mean absolute error are slightly smaller in the second period. Interestingly, there is

no evidence that forecast errors have become substantially lower over time even if the largest forecast error is neglected.

Of course, we cannot exclude that forecast accuracy improved but that larger shocks have prevented forecast errors from decreasing. However, there seem to be very plausible reasons for non-decreasing forecast errors. Some authors argue that forecasters are simply not clever enough to provide better forecasts. However, this explanation is not very convincing (Döpke and Fritsche, 2009; Döpke et al., 2010). Good forecasters should be rewarded through higher profits on financial markets and through better access to public research funding. Therefore, research institutes and bank economists try to improve the economic forecasting tools.

However, there are three reasons why economic forecasting accuracy has not improved over time – at least when considering forecasting horizons of two or more quarters. Firstly, the forecasting target is moving. Data on economic activity are regularly revised. In Germany, quarterly GDP growth rates are on average (1999–2012) revised by 0.3 percentage points between their first and final publication; that is, by almost 100 per cent of the average quarterly growth rate. Which vintage of GDP publications should be targeted by the researchers? In the public discussion, the first official value is often the benchmark for forecasting performance; yet from an economic point of view, the final value that includes the latest information should be the target. Moreover, even the final official GDP figures are only estimates of economic activity and hence still affected by a certain amount of measurement error. This is different from other prominent forecasting areas such as weather forecasts: the actual temperature is measured with a high degree of precision in real time. Furthermore, information on the current economic situation is only published with time lags. Reducing the time lags would probably reduce forecast errors for very short horizons and therefore also improve the basis for medium-term forecasts.

Secondly, economists still have only very incomplete information about actual structural economic relationships. Controlled experiments that are usually applied in other sciences are not possible when analysing aggregate economic fluctuations. Macroeconomists have to test their theories using empirical data, and it is very difficult to unanimously identify causal relationships. Moreover, many sources of economic fluctuations that might be relevant in the future have not been observed in the past. Therefore, econometric models that are estimated using past data may not be suitable for quantifying the effects of unprecedented shocks.

Thirdly, economic development is not exogenous with respect to forecasts. Many economic decisions are based upon expectations about future developments, and expectations are affected by economic forecasts published by researchers. However, as stated before, we still know very little about aggregate structural economic relationships and about expectations formation. Therefore, the interaction between forecasts and economic development cannot consistently be incorporated into economic forecasts (Morgenstern, 1928). Overall, the low accuracy of economic forecasts is more likely to be the result of the fundamental uncertainty about the relevant economic relations and about the nature of underlying shocks than the result of low effort or poor techniques.

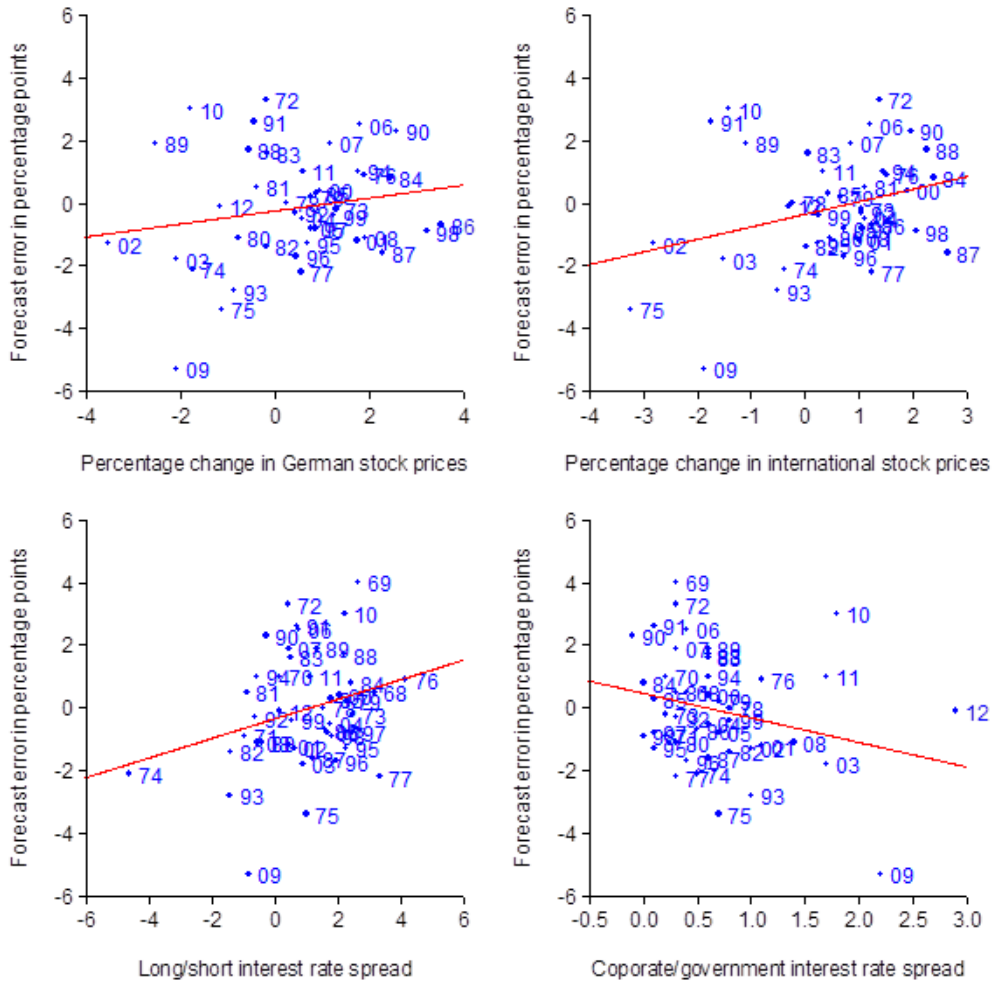
### **2.3 Could the Accuracy of Forecasts be Improved by Using Financial Data?**

Even though uncertainty in economics is fundamental, it is important to analyse whether economic forecasts can be improved by adding more data to the information set of forecasters. In particular, macroeconomic analysis may have underestimated the importance of financial markets and of banks for economic performance. Therefore, forecasting accuracy may be improved by systematically taking into account financial data.

Whether this is the case can be tested by regressing forecast errors on financial data that were available at the time when the forecasts were produced. If forecast errors are correlated with any information that was available at the time of the forecasting exercise, then the forecasts were not efficient.

Figure 3 shows scatter plots of the forecast errors of the German research institutes and financial data that were available when the forecasts were produced. We consider domestic and international stock prices, the term structure of interest rates, and the spread between corporate bond yields and government bond yields. Stock prices depend on expectations on future profits and on risk-adjusted discount rates. Therefore they reflect a broad range of relevant information about future economic development.

The upper two panels in Figure 3 indeed show that there is a positive relationship between the forecast errors (actual minus predicted real GDP growth rates) and



*Note:* The figures show scatter plots of one-year ahead forecast errors of the annual growth rate of real GDP in Germany published by the German research institutes (GD) in autumn for the next year, respectively, and financial market indicators that have been available prior to the publication of the forecasts. In the upper left panel, the financial market indicator is the 12-month moving average of the percentage change in the MSCI stock market index for Germany, in the upper right panel the percentage change in the MSCI World index, in the lower left panel the difference between the yield of long-term German government bonds and money market rates, in the lower right panel the difference between the yield on German corporate bonds and the yield on long-term German government bonds.

*Sources:* Bruttel (2013) for forecast errors, MSCI for stock market indices, and Deutsche Bundesbank for bond yields.

Figure 3: Lagged financial data and forecast errors

previous asset price movements. We considered the monthly change of a 12-month moving average of the Morgan Stanley Capital International (MSCI) Germany index and of the MSCI World index in the month before the publication of the respective forecast. The result is robust with respect to other transformations such as three- or six-month percentage changes in the stock price.

The lower left figure reveals that the term structure of interest rates also contains some additional predictive power. Long-term interest rates summarize expectations on future short-term interest rates which, in turn, depend on future economic developments. If the spread between long-term and short-term interest rates is large, market participants expect economic conditions to improve.

Finally, the spread between corporate bond yields and government bond yields in the month before the publication of the forecasts is negatively correlated with subsequent forecast errors. This spread can be interpreted as a risk premium that firms have to pay compared to the borrowing costs of governments. Accordingly, high spreads signal high risks.

However, the four scatter plots also show that the relationships between financial variables and the forecast errors are rather loose: the observations do not lie on an exact regression line but fluctuate widely around it. The estimated slope coefficients are not significantly different from zero at a 5 per cent significance level, but only at the 10 per cent level. In particular, the forecast error for 2009 is not explained by the information contained in the financial data. This implies that even if the relationships reflected by the regression lines in Figure 3 had been incorporated into the forecasts of autumn 2008 for 2009, the forecast error would have been unusually large. It might be argued that this is the result of non-linearities. However, given that we do not have many observations at the upper and lower tails of the forecast error distribution, it is hardly possible to infer such non-linear relationships from the data.

In sum, it may be true that financial and monetary aspects have not played a major role in macroeconomic models before the crisis. But the empirical relationship between financial and monetary aspects is not strong enough to substantially increase the accuracy of economic forecasts.

## 2.4 How Should We Interpret Economic Forecasts?

Do the previous findings imply that we should stop spending money on economic forecasting? We do not think that this is the case. Economic forecasts seem to be efficient in the sense that they are unbiased. Furthermore, forecast errors are uncorrelated, and they do not seem to be correlated with information that is actually available when forecasts are produced. Therefore, they are still an important foundation of rational economic decisions. The average absolute forecast errors of the German economic research institutes and the German Council of Economic Experts are also smaller than the forecast error if simply the unconditional mean was used as a forecast for next year's real GDP growth rate.

Moreover, forecasts from independent institutions may be superior to government forecasts. Political considerations may bias forecasts in different directions. On the one hand, there may be incentives to underestimate future economic activity because too-low forecasts may be used to argue ex post that government actions have led to a better outcome. On the other hand, there may be political incentives to overestimate future economic growth and accordingly government revenue in order to justify higher public spending. Both considerations would probably lead to less efficient forecasts and policy decisions grounded on evidence to a lesser extent.

However, forecasts that are based upon independent scientific expertise should be interpreted more carefully than in the past. In particular, the effort in explaining the uncertainty that is related to economic forecasts should be increased. Although researchers regularly report forecast intervals, these play hardly any role in the public discussion. Additionally, the reasons for the uncertainty should be better explained by economists. Not claiming to know more about future economic developments than is actually known would in the long run also improve the public standing of the macroeconomics profession.

## 3 Have Early Warning Systems Been Insufficient?

The discussion on the reliability of economic forecasts goes beyond discussions on predicting the growth rate of GDP or other key macroeconomic aggregates. Given that financial and banking sector crises have occurred frequently in economic history,

and given that these crises have severe negative implications for aggregate output (Barro, 2001; Reinhart and Rogoff, 2010), the question is whether we can improve upon our prediction of financial crises.

### **3.1 How Can Financial Crises Be Predicted?**

The costs of financial crises can be substantial, and they arise through three channels (Dornbusch, 2001): an increase of government debt through, for instance, the costs of bailing out financial institutions or through higher foreign debt service; the possibility of a socially undesirable redistribution of income and wealth; and last but not least, large and possibly persistent output losses. Reducing these costs by providing early warnings and by allowing policy-makers to react to these warnings can thus have large positive welfare effects.

Yet, existing early warning systems have not proven very reliable in preventing the recent banking and sovereign debt crises. The statement that early warning systems have been ineffective is thus a variant of the statement that the economics profession has failed to properly predict the crisis. It is true to the extent that many traditional early warning systems which are used in economics have insufficiently accounted for factors that contributed to the crisis, such as asset price bubbles and weaknesses in banking systems. Yet, it was well understood even before the crisis that no single early warning system sufficiently accounts for all relevant features (Edison, 2003).

The discussion on how to predict financial crises is not new, and needs to start from a definition of what a financial crisis actually is about. Mishkin (2004) characterizes a financial crisis as a situation in which financial markets are disrupted, in which adverse selection and moral hazard problems become much worse, such that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities. If information problems become worse, fewer borrowers will be able to finance their operations on capital markets, they will have to cut down production and eventually also have to lay off workers. In markets characterized by information problems, the insolvency of some firms might be taken as a signal about the quality of other firms. This might cause a run on other financial institutions and thus aggravate the crisis.



Even though the above-mentioned factors (deterioration of balance sheets, increases in interest rates or in uncertainty) are aimed at a better measurement of financial crises (or the risk of an upcoming crisis), they remain somewhat impractical for forecasting purposes. Balance sheet information becomes available with a time lag only, and it is not always easy to interpret. Not all episodes of increasing interest rates lead to financial crises, and it is difficult to measure the degree of uncertainty in an economy. Still, the empirical literature on financial crises in general and currency crises in particular has identified a long list of potentially explanatory variables, and it is difficult to isolate those which policy-makers should pay attention to. In surveying the existing literature, Kaminsky et al. (1998) provide a list of 105 potential indicators which can be classified into nine groups: capital account indicators, debt profiles, current account indicators, financial liberalization, real sector variables, fiscal variables, institutional factors, structural factors and political variables.

The empirical models that can be used to analyse these data fall into two main groups. A first group of models, probit models, use (cross-sectional) data to estimate the probability that a crisis will occur in a given country at a given point in time. Frankel and Rose (1996) provide an early application. A second approach to determine the probability of a (currency) crisis is the so-called signal extraction approach that has been proposed by Kaminsky et al. (1998). The idea behind this approach is to find variables which tend to increase or decrease prior to currency crises in a systematic way. Hence, any significant change in such an indicator can be taken as a signal that a crisis is coming up.

The signal extraction approach has a number of shortcomings. First, standard statistical tests cannot be used to test its results. This is in contrast to the probit analysis, which gives significance levels for the variables under study. El-Shagi et al. (2013) show how bootstrapping can be used to statistically assess a signal extraction model. Second, the traditional approach does not provide information on how to weight different indicators, nor on how different indicators might be linked. More recent work, however, also explores both the link between different indicator sets and the quality of predictions (Knedlik and von Schweinitz, 2012). Finally, no information is provided concerning structural determinants of changes in any of the indicators. For example, if a high share of short-term debt is a good predictor of crises, the

questions need to be raised of what factors are driving the share of short term debt, and what can be done to prevent a worsening of the situation.

Generally, Edison (2003) concludes that the performance of early warning systems developed on the basis of the signalling approach is mixed. Although the performance of the indicators is reasonably robust across time periods and countries, her model gives many false alarms. She thus proposes to use standard surveillance methods together with early warning systems to predict crises. This lesson may not have been properly learned. It is interesting to note that an Independent Evaluation Office of the IMF concluded that there were warnings before the crisis, but they were not heard. The report argues that this is due to ‘group think’, ‘intellectual capture’ and ‘inadequate analytical approaches’.

### **3.2 The Way Forward**

The shortcomings of crisis prediction models are well understood, and improvements are taking place with regard to both methodology and institutional structures. In methodological terms, Borio and Drehmann (2009) and many others look at the possibilities of incorporating additional financial sector variables into prediction models. These approaches mirror the efforts that are being made in terms of including financial variables such as stock market developments and indicators of banking distress into standard time series forecasting models (see subsection 2.3). Also, the new models take a closer look at the implications of different objective functions of policy-makers (Knedlik, forthcoming).

What are these new institutional frameworks? In Europe, there are essentially two new institutional arrangements which in one way or another were set up to prevent future real and financial crisis. The first is the European System Risk Board (ESRB). The ESRB has the function of macroprudential supervision and of ensuring the stability of the entire financial system by analysing appropriate indicators. Its work is addressed to public institutions (governments, central banks), and it issues (confidential) warnings and recommendations. The European Central Bank (ECB) contributes analyses and data. The role of the ESRB has been described as follows: ‘The ESRB and its macroprudential policies will have three main tasks: to identify and prioritize systemic risks; to issue early warnings when significant systemic risks emerge; and to issue policy recommendations for remedial action in

response to the risks it identifies.’ The second new institutional structure is the European Commission’s Macroeconomic Imbalance Procedure (MIP), a ‘surveillance mechanism that aims to identify potential risks early on, prevent the emergence of harmful macroeconomic imbalances and correct the imbalances that are already in place’.

Establishing these new institutions has advantages because key indicators are monitored more closely and because mechanisms are developed which trigger early intervention. However, there are also institutional shortcomings. First, the ESRB does not work independently from central banks, which may give rise to conflicts of interest. Similar issues might arise in the context of the macroeconomic imbalances procedure. Second, information is only partially available for external researchers. This happens for good reasons because early release of critical information may increase market instability. At the same time, this may lead to a lack of external, independent research and a lack of sound replication studies. In short, we see scope for more closely integrating the new institutional procedures for crisis prevention with up-to-date academic research.

## **4 Do Macroeconomic Models Fail to Properly Account for Financial Markets?**

Traditional macroeconomic models do not sufficiently take into account relevant features of financial markets. In this sense, there has been a disconnection between theoretical modelling of banks and financial markets, and macroeconomic models (Brunnermeier et al., 2012). Many of the features that have proven to be relevant as triggers of the crisis are well understood in the microeconomic banking literature but have not been integrated into mainstream macroeconomic models. In fact, integrating insights from banking theory with macroeconomic modelling is not a trivial task. There are many different mechanisms related to asymmetries in information, and it is difficult to decide which ‘stylized’ features should be integrated into macroeconomic models. But it should also be borne in mind that a good economic model is not expected to fully reflect reality. Rather, a good model should focus on the most important theoretical mechanisms and features of the data.

Standard macroeconomic models thus try to model macroeconomic dynamics by focusing on key markets and actors. Perhaps the most prominent class of models are dynamic stochastic general equilibrium (DSGE) models. Compared to earlier macroeconomic models, these models have the advantage that they derive implications from first principles and thus from an explicit optimization of households, firms and other actors in the economic sphere such as banks. Reviewing the extent literature on DSGE models would be beyond the scope of this chapter. At this point, we want to stress though that DSGE models can in principle account for features that are relevant to the debate on the crisis, and that they can provide interesting benchmarks against other modelling approaches such as agent-based models. DSGE models can account for global feedback effects, for banks and other financial market institutions, for departures from the assumption of rational expectations, or for heterogeneity of firms, workers and banks. In fact, financial accelerator mechanisms (Bernanke et al., 1999) have already been incorporated into DSGE frameworks to model financial frictions.

But when analysing feedback from the banking sector to the macroeconomy, and in particular to fiscal policy, it might be interesting also to go back to a somewhat older literature. The literature on balance-of-payments crises focuses on many aspects which can be used to analyse the bank-sovereign feedback that has become evident during the sovereign debt crisis. In their empirical analysis of twin crises, Kaminsky and Reinhart (1996) show that banking and balance-of-payments crises are usually preceded by similar events such as a fall in foreign exchange reserves, a boom in capital inflows and a lending boom. The theoretical literature offers a number of insights into the possible (common) causes of banking and balance-of-payments crises, which are also closely related to sovereign debt crises.

Velasco (1987) studies a situation in which domestic commercial banks are covered by an automatic deposit insurance system and in which banks are not supervised properly. If the domestic economy is hit by a negative shock, the value of banks' assets declines, and the banks become technically insolvent. However, banks can avert bankruptcy by borrowing from abroad until a certain borrowing limit is reached. At this point, the banks go bankrupt, and the government assumes their (external) liabilities. The ensuing increase in the budget deficit is financed through domestic money expansion. This monetary expansion eventually becomes inconsistent with an exchange rate target, and a speculative attack occurs.

Calvo (1995) similarly assumes that an unlimited lender-of-last-resort facility offered by the central bank (free deposit insurance) exists, which may lead to bank runs. Bank runs, in turn, speed up the timing of a balance-of-payments crisis. He assumes that, following a positive productivity shock, foreign capital is used to finance increased domestic investment. There is an exogenous run on commercial banks. The central bank bails out the commercial banks by exchanging its foreign exchange reserves for the banks' liabilities. The imminent loss of foreign exchange reserves tends to speed up the balance-of-payments crisis. At the same time, the government deficit is reduced because of the interest earned on the commercial banks' assets that have been taken over.

In McKinnon and Pill (1995), overborrowing on international financial markets occurs if domestic banks operate in a distorted microeconomic environment. In the presence of implicit deposit insurance and insufficient banking supervision, external financial liberalization exposes commercial banks to a variety of risks, including foreign exchange rate risks.

Krugman (1998) likewise has a model in which moral hazard in financial institutions caused by (implicit) deposit insurance of the government causes banking crises as the main trigger of currency crises. He argues that investment of financial intermediaries into assets fixed in supply (such as land) can cause substantial asset price fluctuations, even more so if the probability of a bailout of financial institutions becomes endogenous.

Hence, many of these models focus on issues that have proven to be of key importance during the recent crisis (such as interactions between weaknesses in banking systems, deposit insurance and the government deficit). However, the lessons being revealed by these models may not have been heard in the run-up to the current crisis. The reason is that these models focus on issues which were apparently relevant for emerging markets and developing countries, rather than the industrialized countries affected by the current crisis. We see ample scope for developing these mechanisms further and integrating them into theoretical and empirical modelling.

Beyond that, there is a rich new field of research which develops macroeconomic modelling. To give some examples, Gersbach and Rochet (2012) model the link between aggregate investment externalities and macroprudential regulations, Bacchetta et al. (2012) model self-fulfilling risk panics, and recent DSGE models explicitly take

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account of the role of banks (see Angeloni and Faia, 2013; Gerali et al., 2010; and the references cited in Buch et al., forthcoming). At the same time, empirical work is needed to test the mechanisms stressed in these models and modelling the specific feedback from the micro to the macro level.

## **5 Are the Interactions between Micro- and Macroeconomic Developments not Well Understood?**

Heterogeneity in financial markets and banking systems has not traditionally been a core research area. Yet, there are other important fields in macroeconomics in which heterogeneity plays an important role, and similar modelling approaches can be used to study links between financial markets and the macroeconomy. The international trade literature, for instance, asks the question how firm heterogeneity affects macroeconomic outcomes such as growth in the aftermath of trade liberalizations (Melitz, 2003). Ghironi and Melitz (2007) imbed these ideas into a DSGE model. Moreover, Gabaix has done work on granular effects and the effects of idiosyncratic shocks affecting large (manufacturing) firms on the macroeconomy (Gabaix, 2011). There is a large macroeconomic literature on household and worker heterogeneity. Finally, Allen and Gale have done work on financial contagion and the extant literature modelling different types of shocks and different types of insurance mechanisms (Allen and Gale, 2000, 2008).

These examples show that an improved understanding of heterogeneity is essential for an analysis of systemic risk in financial markets. Systemic risks in financial systems arise if distress in one institution or a group of financial institutions threatens the functioning of the entire financial system (Hellwig, 1998, 2008). This can be due to domino effects if creditors of a bank are affected by bank distress because of direct contractual linkages. But systemic risk can also be due to informational contagion if the distress of one bank leads to a run on the assets of other banks even without any direct contractual linkages. This mechanism can lead to a negative spiral of asset prices, as can be seen on markets for government bonds.

Empirically, systemic risk can be measured as the contribution of a bank to the risk of the financial system, using the game theoretic concept of the ‘Shapley value’ (Tarashev et al., 2010). Alternatively, Adrian and Brunnermeier (2011) have suggested the conditional value-at-risk (CoVaR) model, which models the VaR of the financial system conditional on institutions being under distress. Many of these models are relatively data-intensive and require the availability of market data on banks. The empirical findings are relatively straight-forward though. According to most models, systemic risk increases in the risk of a bank, in the size of a bank (‘too big to fail’), in the degree of connectedness (‘too connected to fail’) and in the exposure to macroeconomic risks (‘too many to fail’). The latter is modelled, for instance, by Farhi and Tirole (2012).

In the sense that the size of the shock and the degree of concentration of markets matter, systemic risk is also related to granular effects, which arise if markets are very concentrated: if a few large banks co-exist with many small banks, idiosyncratic shocks to individual banks do not have to cancel out in the aggregate but can affect macroeconomic growth. The importance of granular effects has been shown for aggregate fluctuations in the United States (Gabaix, 2011), for international trade (Di Giovanni and Levchenko, 2009) and for domestic banking markets (Amiti and Weinstein, 2013; Bremus et al., 2013; Carvalho and Gabaix, 2013). Thus, besides issues of connectedness or moral hazard, large banks can affect aggregate growth simply by being large.

Empirically, both the feedback from the macro to the micro level (and reverse) can be modelled by factor-augmented vector autoregressive (FAVAR) model. These models include a large amount of information on firm- or bank-specific time series. These models allow for interaction between macroeconomic factors and the banking system. They look at the impact of identified, mutually orthogonal, macroeconomic shocks. By contrast, panel studies macroeconomic factors to affect banks, but they generally do not take into account feedback from banks to the macroeconomy. Moreover, macroeconomic indicators are reduced-form constructs and a convolution of different types of shocks. In a similar vein, global vector autoregressive (GVAR) models can be used to analyse feedback between different groups of banks and between different countries (Eickmeier and Ng, 2011; Gray et al., 2013). Last but not least, there is a large set of new research results applying network theory and modelling to economics, which provide interesting insights (Haldane, 2009).

Hence, dynamic factor models allow for combining large sets of information at different levels of aggregation. The models can be applied to micro data and thus exploit information from bank-level datasets. Dynamic feedback between bank-specific and macroeconomic developments can be studied, and heterogeneity of banks can be analysed with regard to idiosyncratic shocks and with respect to bank-specific exposure to macroeconomic shocks. Finally, the models allow macroeconomic shocks to be identified.

These examples show that there are many interesting avenues for research, which provide important new insights. At the same time, many open issues remain.

Firstly, we know little about the relevant levels and aspects of heterogeneity. Or, as Caballero (2010) notes: ‘In the limit, aggregate fluctuations may emerge from hard-to-detect and purely idiosyncratic shocks.’ There are certainly many dimensions of heterogeneity that are not relevant for day-to-day policy-making or for many research applications. Yet, other aspects of heterogeneity matter a lot. Ultimately, only work establishing a link from the micro to the macro level will be able to tell which levels of heterogeneity are important.

Second, we need an improved understanding of the implications for financial regulations and how different forms of regulation interact. For example, we know relatively little about the interaction between macroeconomic policy measures and more conventional capital controls, and the effects of changes in microprudential regulations on financial stability still need to be assessed. To some extent, these shortcomings are due to limited information about these policy measures, in particular for external researchers. To some extent, though, they are also due to insufficient time having passed since the new measures were introduced.

Third, it remains difficult to merge different micro-level datasets and to generate general implications for research and policy. This is the reason why, in a new initiative, researchers from different central banks have been brought together in the context of the International Banking Research Network (IBRN). The 2007-2009 financial crisis provided the impetus for the group, underscoring both the need to examine how cross-border banking might contribute to the transmission of financial shocks and the value of analysing micro banking data. The goal is to analyse shock transmission through internationally active banks, using bank-level datasets at national levels, and to share results to facilitate joint insights from different banking systems. The



network can be used to analyse consequences of macroprudential tools and policies to global banks, or to study heterogeneity in the adjustment of banks to liquidity and other shocks. In this sense, it is one contribution towards Caballero's claim that: 'We need to spend much more time modelling and understanding the topology of linkages among agents, markets, institutions, and countries' (Caballero, 2010, p. 9).

## 6 Concluding Remarks

I don't have the answer to this fundamental dilemma, but it does point into [sic] the direction of much more diversification of research and methodology than we currently accept. It also points in the direction of embracing rather than sweeping under the rug, the complexity of the macroeconomic environment.

Caballero, 2010, p. 9

We do not have the one good answer either. But we hope that this chapter has given some guidance for future research. Good science and research is always in flux. It responds to new observations, develops new theories and brings these to the data. Being economists ourselves, we would have a biased view when comparing our field of research to other research areas, and comparing the speed of scientific innovation and creativity of the field. But our impression is that the economics profession has responded to the recent crisis in a lot of promising directions. Only time can tell which of the new approaches will hold up to scrutiny; some of the new modelling approaches will prove to be dead ends, others will succeed.

Our sense is that there is no single 'mainstream' modelling approach, and perhaps it did not exist even prior to the crisis. There are several strands of research which we consider promising for the future.

Firstly, modelling feedback from the micro to the macro level will be the key to an improved understanding of how market structures in banking affect macroeconomic outcomes and which aspects of heterogeneity matter. When modelling this feedback, it should be taken into account that idiosyncratic shocks can affect macroeconomic outcomes but also that common exposure to macroeconomic shocks can have aggregate implications.

Secondly, there will be no single macroeconomic model – and in fact there has never been a single macroeconomic model – that can capture all relevant features of modern macroeconomic systems and financial markets. Hence, when thinking about systemic risk, researchers and policy-makers should have a toolkit of several macroeconomic models and analyse which of the respective models fits best the specific situation at hand. This will also imply comparing standard macroeconomic models with agent-based models. There are many interesting new initiatives, which may also help to integrate this approach into the curriculum for teaching economics. Third, we need more empirical evidence, in particular on the effects of policies that have been implemented after the crisis. This implies, inter alia, enhancing access to data to researchers outside central banks, improved access to existing micro datasets, a closer exchange with research to collect data on shadow banking systems and financial innovations, a systematic collection of data prepared in the context of new early warning systems (ESRB, MIP), and improved databases on (macroprudential) regulations.

And, finally, the new early warning systems and surveillance methods that have been established need to be sufficiently robust. The art will be to strike a good balance between signals and noise. Potentially, lessons can be learned from behavioural literature to avoid ‘group think’ in large institutions, and to improve the modelling of expectations can be useful when designing these new institutions.

## Notes

1. European Central Bank (2008a): ECB staff macroeconomic projections of the euro area in Monthly Bulletin September 2008, 80-82; IMF (2008): World Economic Outlook October 2008, Washington; OECD (2008): OECD Economic Outlook 2008/2, Paris; Projektgruppe Gemeinschaftsdiagnose (2008), Deutschland am Rande einer Rezession, Oktober 2008, Kiel.
2. Biannually, German economic research institutes publish a joint economic forecast (Gemeinschaftsdiagnose). Here, we report the autumn forecasts for the following year. The Council of Economic Experts publishes its forecast about four weeks after the research institutes and can thus base its forecasts on a larger information set.

3. This is in line with earlier research using pre-crisis data; see Döhrn (2006), for example.
4. See Manski (1995, 2013) for a discussion of public policy-making in an uncertain world.
5. See ‘IMF performance in the run-up to the financial and economic crisis: IMF surveillance in 2004-07’, <http://www.ieo-imf.org/ieo/pages/EvaluationImages107.aspx>.
6. Speech by Jean-Claude Trichet, President of the ECB, at the 13th Conference of the ECB-CFS Research Network, Frankfurt am Main, 27 September 2010.
7. For details, see [http://ec.europa.eu/economy\\_finance/economic\\_governance/macroeconomic\\_imbalance\\_procedure/index\\_en.htm](http://ec.europa.eu/economy_finance/economic_governance/macroeconomic_imbalance_procedure/index_en.htm).
8. We owe this point to a keynote lecture given by Martin Hellwig at the conference, The Structure of Banking Systems and Financial Stability, 19-20 September 2013, organized by the Special Priority Program (SPP 1578) ‘Financial Market Imperfections and Macroeconomic Performance’ and the Max Planck Institute (MPI) for Research on Collective Goods (Bonn).

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