Journal of Macroeconomics 34 (2012) 2–10

Contents lists available at ScienceDirect

Journal of Macroeconomics

journal homepage: www.elsevier.com/locate/jmacro

Has macro progressed?

Ray C. Fair *

Cowles Foundation and International Center for Finance, Yale University, New Haven, CT 06520-8281, United States

ARTICLE INFO

Article history:
Received 24 May 2010
Accepted 17 September 2010
Available online 2 October 2010

Keywords:
Macro models
Cowles Commission approach

ABSTRACT

There have been a number of recent papers arguing that there has been considerable convergence in macro research and to the good. This paper considers the question whether what has been converged to is good. Has progress been made in understanding how the macro economy works?

1. Introduction

There have been a number of recent papers arguing that there has been considerable convergence in macro research and to the good. Blanchard (2009, p. 2) states: "…after the explosion… of the field in the 1970s, there has been enormous progress and substantial convergence. … The state of macro is good." Woodford (2009, pp. 267, 269) states: "Has there been a convergence of views in macroeconomics? Of course," and "…it is now widely agreed that macroeconomic analysis should employ models with coherent intertemporal general-equilibrium foundations." Chari et al. (2009, p. 242) state: "Viewed from a distance, modern macroeconomists, whether New Keynesian or neoclassical, are all alike, at least in the sense that we use the same methodology, work with similar models, agree on which reduced-form shocks are needed for models to fit the data, and agree on broad principles for policy." Galí and Gertler (2007, p. 26) in discussing the synthesis of the New Keynesian and real business cycle approaches state: "Overall, the progress has been remarkable. A decade ago it would have been unimaginable that a tightly structured macroeconometric model would have much hope of capturing real-world data, let alone of being of any use in the monetary policy process."

It seems clear that there has been convergence. This "new" macro, which I will call "macro 2," dominates the macro literature, and there is little controversy in refereed journals about the appropriate methodology to use. I have been working on macro models since the late 1960s, where at that time the dominant methodology was what I will call the "Cowles Commission approach," or "macro 1," and I am still using this methodology. This paper is an evaluation of macro 2 from a macro 1 perspective. Has the movement to the new macro improved our understanding of how the macro economy works?

Section 2 discusses the goals of macro research, where from the perspective of this paper the goal is to find the model that best approximates the macro economy. Section 3 discusses the data to be explained. One might wonder why such a section is needed, but, as discussed in Section 6, macro 2 is not as careful about data as is macro 1. Nitty gritty data work, which characterized macro 1 from the beginning, is largely missing from macro 2. Section 4 provides a brief review of macro 1, which provides a basis of comparison to macro 2 in Sections 5 and 6. Section 7 concludes by questioning the sensibility and feasibility of the macro 2 methodology and arguing for a return to macro 1. The Appendix summarizes some of the properties

* Tel.: +1 203 432 3715.
E-mail address: ray.fair@yale.edu
URL: http://fairmodel.econ.yale.edu

0164-0704/$ - see front matter © 2010 Elsevier Inc. All rights reserved.
doi:10.1016/j.jmacro.2010.09.009

of the US economy that I have estimated in my modeling work—properties that if true need to be accounted for in a complete macro model.

2. Goals of macro research

As in any discipline, there are many goals and interests in macro. Solow (2008, p. 246), for example, states: "My general preference is for small, transparent, tailored models, often partial equilibrium, usually aimed at understanding some little piece of the (macro-)economic mechanism." This view is echoed in Blanchard (2009, p. 17), where one of his hopes/pleas is "for the rehabilitation of partial equilibrium modeling in macroeconomics."

Although partial equilibrium models can shed light on important macroeconomic questions, the main goal of macro from the beginning has been to explain the entire economy—to develop models that can explain well fluctuations in all the key macroeconomic variables. This is true of both the new macro, where the emphasis is on general equilibrium models, and of the old, where complete models of the economy are specified and estimated. The focus of this paper is on complete models.

This emphasis on explaining fluctuations should not be confused with forecasting. It is sometimes said that a certain model may be good at forecasting, but does not correctly explain the economy. A correctly specified model, however, should not forecast worse than a misspecified model conditional on use of the same information. Real-time forecasting is something one may do after a model has been specified, estimated, and tested. It is of the nature of an after thought. In fact, although a correctly specified model should produce more accurate ex ante forecasts than a misspecified model, its forecast errors could be large. If, for example, changes in asset prices, like stock prices and housing prices, are essentially unforecastable and if asset values have important effects on aggregate consumption through household wealth effects, a model that correctly accounts for these wealth effects may not forecast well if it cannot forecast changes in asset prices.

"Explaining fluctuations well" should also not be taken to be an interest only in short run issues. Ideally, a correctly specified model should explain both short run and long run movements in the macro variables. If a model has poor dynamic properties, it is not a good model even if can explain short run fluctuations well.

The issues of "explaining versus forecasting" and "short run versus long run" are related to Gregory Mankiw's (2006) distinction between macroeconomists as scientists and as engineers. Although one might say that scientists are interested in the long run and in "explaining" while engineers are interested in the short run and in "forecasting," this is not relevant for the choice of models. Both scientists and engineers should be concerned with developing and using the best model—the model that best explains economic fluctuations. A correctly specified model is of interest to both; the goal is to find and use the best model.

3. The data

Four key macroeconomic variables are real GDP, the GDP deflator, the unemployment rate, and a short term interest rate. A complete macro model must at least explain these. The following discussion will focus on the United States. Quarterly national income and product accounts (NIPA) data are available from 1948 and quarterly flow of funds accounts (FFA) data are available from 1952. The US population was about 158 million in 1952 and 307 million in 2009.

The NIPA provide data on GDP and many components. How much disaggregation is necessary to explain GDP? My experience is at a minimum nine categories: three consumption categories (services, c_1, nondurables, c_2, durables, c_3), three investment categories (housing, i_1, plant and equipment, i_2, inventory, i_3), imports, m, exports, x, and government spending, g. GDP, y, by definition is $c_1 + c_2 + c_3 + i_1 + i_2 + i_3 - m + x + g + d$, where d is a discrepancy term due to the use of chain-link price indices in constructing the data. Data on output of the private sector (called the "firm sector" below), y_f, are also available.

The NIPA also provide data on the GDP deflator and other aggregate price indices. For use below, let p_f denote the price deflator for firm output. Considerable data on the income side are available—wages, interest, dividends, profits, transfer payments, taxes. Finally, data on capital stocks are available—durables, housing, plant and equipment, and inventories.

The bureau of labor statistics (BLS) provides data on employment, hours, and the labor force. My experience is that at a minimum the labor force needs to be disaggregated into males 25–54, females 25–54, and all others 16 and over. Denote these l_1, l_2, and l_3. Some people have two jobs, and from the data one can get an estimate of this number, n. Data are available on the number of jobs in the firm (private) sector, j_f, the number of jobs in the government sector (state and local, federal civilian, federal military), j_g, the number of hours worked per job in the firm sector, h_f, and the number of hours worked per job in the government sector, h_g. The unemployment rate is by definition $(l_1 + l_2 + l_3 - j_f - j_g + n)/(l_1 + l_2 + l_3)$. Productivity in the firm sector is by definition y_f divided by $j_f \cdot h_f$. From NIPA wage data and BLS employment data, one can get estimates of wage rates. For use below, let w_f denote a wage rate index for the firm sector.

From the Federal Reserve one can get data on short term and long term interest rates. The FFA provide flow of funds data and financial stock data. It is possible to link the FFA data to the NIPA income-side data, which accounts for all financial flows among the sectors and all balance sheet constraints. A common aggregation of sectors is (1) household, (2) non financial firm, (3) financial firm, (4) state and local government, (5) federal government (including the monetary authority), and (6) foreign.

Considerable international data are available from the IMF and the OECD: exchange rates, oil prices, national income data for other countries, trade flows. A major change in empirical macro in the last 30 years has been an increase in these data. Multicountry models can now be easily estimated.

4. Macro 1

Shimer (2009, p. 280) in his discussion of the convergence in macro argues that "…virtually all modern macroeconomic models build upon two foundations … First, households maximize expected utility subject to a budget constraint. Second, firms maximize expected profits." In this respect the new macro does not differ from the old. The Cowles Commission (CC) approach that macro 1 follows uses theory to choose left hand side and right hand side variables in equations to be estimated. The estimated equations are taken to be approximations to the decision equations of agents. Early examples are Tinbergen (1939) and Klein (1950). Theory was clearly important in this work. Nearly half of Klein's (1950) book is devoted to intertemporal optimizing models of households and firms.

Consider modeling household behavior. A household can be considered to solve a multiperiod maximization problem subject to a lifetime budget constraint. Given, say, the data outlined in Section 3, the main decision variables might be domestically-produced and foreign-produced purchases of services, nondurables, durable goods, and housing plus how much labor to supply. Taken as given by the household would be the initial stocks of durables and housing, the initial value of net financial wealth, and current and expected future values of wage rates, prices, interest rates, exchange rates, tax rates, and transfer payments and other non labor income. Age of household, life expectancy, and bequest values are also relevant.

In moving from this theory to econometric specifications is the realization that the data pertain to millions of households. The aim is to find equations that are consistent with the theory and explain the aggregate data well—good approximations to aggregate decision equations. Given the data in Section 3, there would be equations explaining c_1, c_2, c_3, i_1, m, l_1, l_2, l_3, and n. The explanatory variables to try are those taken as given by the household in its maximization problem, including variables that affect its future expectations.

Considering now modeling firm behavior. A firm can also be considered to solve a multiperiod maximization problem, where the objective is the present discounted value of expected future after-tax cash flow. Assuming a monopolistically competitive environment, the decision variables might be the firm's price, wage rate, output, investment, and employment. Taken as given by the firm would be its initial stocks of inventories and capital, current and expected future demand curves for its output and labor supply curves it faces, and current and expected future values of interest rates and tax rates. The expected demand and supply curves would reflect the firm's expectations of its competitors' behavior.

Given the data in Section 3, this theory would be used to specify equations explaining p_f, w_f, y_f, i_2, j_f, and h_f. Inventory investment, i_3, by definition is then y_f minus total sales of the firm sector. The explanatory variables to try are those taken as given by the firm in its maximization problem, including variables that affect its future expectations.

In moving from theory to empirical specifications, the CC approach uses lagged values freely, in particular lagged dependent variables. These are meant to pick up expectational effects if, say, expectations are adaptive or partial adjustment effects if there is psychological inertia in responding to changes. In a widely cited paper Griliches (1967) pointed out that it is difficult to distinguish in the data between adaptive expectations and partial adjustment. The difference has to do with serial correlation properties of the error term, and this is subtle to test. The CC approach generally ignores this distinction. If lagged variables are significant, this may be do to expectational effects, partial adjustment effects, or some combination of the two. The aim is to get good approximations to the decision equations, and the theory of household and firm behavior used to guide the specifications is taken to be compatible with either adaptive expectations or partial adjustment or both.

In this setup unemployment can be explained as follows. The maximization problems of firms result in values of prices and wages and other variables (including the amount of labor demanded). These solutions are based on a certain set of expectations about product demand schedules and labor supply schedules. The maximization problems of households result in values of the consumption goods and labor supply. These solutions are based on a certain set of expectations about prices and wages. It may be that the total amount of labor demanded by firms (and by the government) is less than the amount that households want to supply. Assuming that firms only hire the amount of labor that they want, unemployment can be considered the difference between the amount households would like to supply from solving their maximization problems and the amount firms demand from solving their maximization problems. If this difference is positive, then the prices and wages set by firms would not be market clearing. Note that this lack of market clearing does not have to be from any stickiness in changing prices and wages. It may simply be from using expectations that turn out not to be right. Lack of market clearing in the goods market would take the form of unintended inventory investment.[1]

Moving now from household and firm behavior to the behavior of the monetary authority, both macros 1 and 2 deal with interest rate rules. These rules are usually referred to as "Taylor rules," from Taylor (1993), although they have a longer history. The first rule is in Dewald and Johnson (1963), who regressed the Treasury bill rate on a constant, the Treasury bill rate lagged once, real GNP, the unemployment rate, the balance-of-payments deficit, and the consumer price index. The next example is in Christian (1968). I added an interest rate rule to my US model in Fair (1978). After this, McNees (1986, 1992)

[1] In the early 1970s there was a "disequilibrium" literature analyzing the consequences of prices and wages not being market clearing. A key paper was Barro and Grossman (1971). This literature took prices and wages as predetermined, and so it had limited appeal. In my theoretical work at this time—Fair (1974)—I endogenized prices and wages by assuming that firms behave in a monopolistically competitive environment and determine prices and wages along with other decision variables by solving multiperiod maximization problems. If expectations are not rational, this can lead to disequilibrium, as just outlined. That theory did not catch on. Interest began to be focused on the assumption of rational expectations, and it was not appealing to explain disequilibrium from expectation errors. Interest also began to be focused on price and wage rigidities like menu costs and Calvo pricing.

estimated rules in which some of the explanatory variables were the Fed's internal forecasts of various updates. Khoury (1990) provides an extensive list of estimated rules through 1986.

The relationship between long term and short term interest rates is an important one in macro. Macro 1 models have long estimated ''term structure'' equations, where a long term rate is regressed on current and lagged values of a short term rate. The theory behind this is that long term rates depend on current and expected future short term rates, and the use of lagged values is meant to pick up expectational effects. Estimated term structure equations link long term rates to the short term rate that is determined by the interest rate rule.

There are usually many identities in macro 1 models, especially if the NIPA and FFA data are linked. There are identities relating changes in net financial assets to financial saving (or dissaving). For example, for the household sector the change in net financial assets is equal to the financial saving of the household sector plus capital gains or losses on stocks held by the household sector. This identity links changes in stock prices to changes in household financial wealth. For the federal government the change in its debt is equal to the federal deficit (plus or minus a few other items). Federal interest payments increase as the debt increases, and this can be modeled given data from the FFA on the federal debt and from the NIPA on federal interest payments.

Other identities relate to the physical stock variables. For each stock variable, say the stock of housing, there is an identity that says that the stock of housing at the end of the current period is equal to one minus the depreciation rate times the stock at the end of the previous period plus housing investment in the current period. In other words, the stock variables change over time as a function of investment. Productivity is determine from the identity presented in Section 3, given decision equations determining output, jobs, and hours.

The equations to be estimated generally have right hand side endogenous variables and may have serially correlated errors. Two stage least squares, with possibly accounting for serial correlation, is a common method used to obtain consistent estimates. Identification is almost never a problem in this approach because many exogenous and lagged endogenous variables in the model are excluded from each equation. Sims (1980) questioned whether the exclusion restrictions are in fact sensible, but they are within the context of the theory. There are surely many variables that affect household maximization problems that do not affect firm maximization problems and vice versa. One would not add the lagged stock of inventories to consumption equations or the lagged stock of durable goods to employment demand equations.

The CC approach largely ignores potential unit-root problems. It simply assumes, at least implicitly, that all variables are trend stationary. If this assumption is wrong, the coefficient estimates are not affected, but the estimated standard errors and thus hypothesis testing are. Bootstrapping can, however, be used to test the accuracy of the estimated standard errors.

Many techniques are available for testing the estimated equations. Of particular concern is whether the coefficients change over time. How structurally stable are the estimated equations? The search for good fitting equations consistent with the theory is also subject to potential data mining problems if many specifications are tried. Outside sample tests are needed to check for this. The Lucas (1976) critique says that the coefficients may not be stable if they are based on expectations that change over time or change when a new policy regime replaces an old one. This problem is part of the larger problem of potential coefficient instability, and it may not be the most serious. If expectations are not rational or if regimes do not change very often or by very much, any instability caused by Lucas-critique related issues may be small relative to instabilities caused by other things, like the changing age distribution of the population. At any rate, testing is a critical part of the CC approach.

5. Macro 2

The way in which theory is used in the CC approach has been rejected by the new macro. Also rejected is the CC approach to modeling expectations. In macro 2 the maximization problems are taken more seriously in that the aim is to directly estimate the parameters in these problems, and the maximization problems are specified using rational expectations. In early work the parameters were calibrated rather than estimated, but current work mostly uses Bayesian estimation. There is usually some calibration, but many of the parameters are estimated. The models that are estimated are called dynamic stochastic general equilibrium (DSGE) models. Chari et al. (2009, p. 243) state: ''An aphorism among macroeconomists today is that if you have a coherent story to propose, you can do it in a suitably elaborate DSGE model.''

Many of the current DSGE models are making assumptions about rigidities, habit persistence, and adjustment costs that would appeal to one following the CC approach. They are assumptions that seem theoretically appealing and help explain the data. However, they have an ad hoc flavor to them, which purists within the macro 2 community do not like. The main attack comes from Chari et al. (2009), who complain that there are too many free parameters in current DSGE models.

Whatever the differences within macro 2, they are dwarfed by the difference between the way DSGE models are estimated and the way macro 1 models are estimated. Regardless of how many assumptions of an ad hoc nature are used in DSGE models, the models are based on the estimation of parameters of maximization problems. There is no movement toward the way in which theory is used in the CC approach.

6. Macro 2 models

A key message, the main message, of macro 2 is that maximization problems should be specified using the assumption of rational expectations and the parameters of these problems should be directly estimated. To some people brought up under macro 1, this message seems completely loony. How could one think that one or a few maximization problems so well approximate how the aggregate data behave, which are based on the decisions of millions of households and firms, that it is a good idea to try to estimate the parameters of the problems? And how could one think that households and firms know so much about how the economy works that the assumption of rational expectations is a good approximation? This is how I interpret Solow's Bonaparte comment as quoted in Mankiw (2006, p. 38) about why he does not engage the new classical economists. If the person sitting next to you thinks he is Napoleon Bonaparte, the last thing you want to do is get in a discussion of cavalry tactics.

Loony or not, one way of judging the macro 2 message is to examine the latest generation of DSGE models. The DSGE model of Smets and Wouters (2007) is often cited as a state of the art model, and so it is useful to consider. The estimation of the model uses quarterly data on seven variables for the 1966:1–2004:4 period: real GDP, real consumption, real investment, real wage, hours worked, inflation, and the federal funds rate.

Some of the construction of the variables for the model is problematic.[2] First, real consumption is taken to be nominal consumption divided by the GDP deflator, and real investment is taken to be nominal investment divided by the GDP deflator. The relative prices of consumption and investment change over time, and so real consumption and real investment in the model are not the same as in the NIPA. The best estimates of real consumption and real investment are not being used. Second, hours worked is taken to be average weekly hours of all persons in the nonfarm business sector times total civilian employment. This implicitly assumes that government workers have the same average weekly hours as workers in the nonfarm business sector, which is not the case. But more important, civilian employment is used instead of jobs. Some people have two jobs, and so civilian employment underestimates the number of jobs in the economy. This is not just a level difference because the number of people with two jobs is a cyclical variable. In fact, as discussed in Section 4, one of the decision equations of households should be an equation explaining the number of people with two jobs, n.

Another problem, not related to variable construction, is the choice of aggregation. Three very different categories of consumption are aggregated, especially consumption of durable goods, and investment is the sum of housing and plant and equipment investment, which are quite different types of investment. Inventory investment is not modeled, nor is the level of imports. Not modeling imports is particular serious because part of any change in consumption or investment is a change in imports, which is foreign production, not domestic production.

There is a capital stock variable in the model, but no direct data on the capital stock are used. Values of the capital stock variable are generated within the model given the data on the seven variables and a calibrated value of the depreciation rate. So direct data on the capital stock, which are available from the NIPA, are not used in the estimation.

Again, to people brought up under macro 1 it might seem astonishing that anyone could think that a macro model that uses data on seven variables could be taken seriously. Within the context of the discussion in Section 4, some important missing features are: (1) no disaggregation of consumption, (2) no disaggregation of investment, (3) no modeling of inventory investment, (4) no modeling of imports, (5) no use of data on physical stocks of durable goods, housing, plant and equipment, and inventories, (6) no use of financial wealth data of the household sector, (7) no use of data on tax rates and transfer payments of the state and local governments and the federal government, (8) no use of nonlabor income data like dividends from the firm sector and interest payments from the firm and government sectors, (9) no use of data or modeling of the labor force participation of households and the number of people holding two jobs, (10) no distinction between government employment and firm employment, and no distinction between firms' demand for jobs and demand for hours per job, (11) no long run interest rate in the model, and (12) no use of data on potential cost shock variables like oil prices and exchange rates.

The model thus seems highly misspecified. Assuming it is, then the use of the rational expectations assumption is more problematic than otherwise. It is not realistic to think that if agents are sophisticated enough to have rational expectations, they generate them using a highly misspecified model.

Another recent DSGE model is in Edge et al. (2008). This is one of the models used at the Federal Reserve Board. The estimation of the model uses quarterly data on eleven variables for the 1984:1–2004:4 period. The eleven variables from which the variables used in the model are constructed are: (1) nominal GDP, (2) nominal service and nondurable consumption except for service consumption of owner-occupied nonfarm dwellings and tenant-occupied nonfarm dwellings, (3) nominal durable consumption, (4) nominal housing investment, (5) nominal plant and equipment investment and inventory investment, (6) GDP deflator, (7) deflator pertaining to 2, (8) deflator pertaining to 3, (9) total hours, (10) wage rate variable, and (11) federal funds rate.

This model has better disaggregation than the Smet–Wouters model. Service and nondurable consumption are combined, but durable consumption is treated separately. Plant and equipment investment and inventory investment are combined, but housing investment is treated separately. Also, the deflation issues are not as bad as they are in the Smet–Wouters model. The way the deflation is done, real housing investment and real non-housing investment do not match the NIPA data, but using two deflators gives somewhat more flexibility. There are stock variables in the model, but again no direct data on stocks are used. Values are generated within the model given the above data and calibrated depreciation rates. The missing features in this model are essentially the same as those in the Smets–Wouters model except that there are two consumption categories rather than one and two investment categories rather than one.

[2] The following information is available from the on line data documentation for the published paper.

An open economy DSGE model is in Adolfson et al. (2007). It is a model of the Euro area, based on quarterly data for the 1970:1–2002:4 period. The model is based on data for fifteen variables: the GDP deflator, the real wage, consumption, investment, the real exchange rate, the short-term interest rate, employment, GDP, exports, imports, the consumption deflator, the investment deflator, foreign output, foreign inflation, and the foreign interest rate. The authors calibrate eight parameters and estimate 51. This model endogenizes imports, which is clearly important to do. Otherwise, its missing features are similar to those discussed for the Smets–Wouters model.

A typical DSGE model has a key property that from my work seems wrong.[3] A good example is the model in Galí and Gertler (2007). In this model a positive price shock—a "cost push" shock (p. 38)— is explosive unless the Fed raises the nominal interest rate more than the increase in the inflation rate. In other words, positive price shocks with the nominal interest rate held constant are expansionary (because the real interest rate falls). In my work, however, they are contractionary. If there is a positive price shock like an oil price increase, nominal wages lag output prices, and so the real wage initially falls. This has a negative effect on consumption. In addition, household real wealth falls because nominal asset prices don't initially rise as much as the price level. This has a negative effect on consumption through a wealth effect. There is little if any offset from lower real interest rates because households appear to respond more to nominal rates than to real rates. Positive price shocks are thus contractionary even if the Fed keeps the nominal interest rate unchanged. This property is important for a monetary authority in deciding how to respond to a positive price shock. If the authority used the Galí and Gertler (2007) model, it would likely raise the nominal interest rate too much thinking that the price shock is otherwise expansionary. Typical DSGE models are thus likely to be misleading for guiding monetary policy if this key property of the models is wrong.

My non macro friends often ask why macroeconomists cannot just compare models in terms of how well they fit the data and choose the model that fits best? Why are you arguing all the time? Alas, macro life is not that simple. Sample periods vary; sample periods are sometimes short, which makes data mining a potential problem; and models differ in the number of exogenous variables. A common procedure is to compute outside sample root means squared errors (RMSEs). Models can then be compared in terms of RMSEs if the sample periods are similar and the exogenous-variable information is similar. It is not, however, common to compare DSGE models to macro 1 models using outside-sample RMSEs. In fact the only case I am away of is in Fair (2007, Table 1), where a DSGE model in Del Negro et al. (2007) is compared to the US model in Fair (2004). The sample periods are similar, although not exact. The four-quarter-ahead RMSE for real GDP for the DSGE model is 2.62%, which compares to 1.33% for the US model in which autoregressive equations are specified for the exogenous variables (so exogenous-variable values are not assumed to be known). The eight-quarter-ahead RMSE for the DSGE model is 6.05%, which compares to 1.84% for the US model. The DSGE model is thus not accurate. This is, of course, only one example, and in future work more comparisons like this should be done.

7. Conclusion

There are two main criticisms that can be made regarding macro 2. The first is simply that its main message is not sensible. People obviously differ on this, and it is not directly testable. The second is that the models developed so far that follow its message are highly misspecified. This second criticism is a technical one, and it may be with more work good models will be generated. This can be tested in the long run by seeing what models develop.

There is, however, a concern about the feasibility of the macro 2 approach. One of the reasons I discussed in some detail in Sections 3 and 4 the data to be explained and the way the CC approach models the data is to emphasize that the macro economy is complicated. It is even more complicated than the above discussion suggests because I have mostly left out multi-country considerations. The list in Section 6 of important missing features of current DSGE models is not complete. In order for the macro 2 approach to have a chance of producing good models, many more variables need to be considered. Fernández-Villaverde (2008, pp. 693–694) has a good discussion of the difficulties of increasing the size of DSGE models. As observable variables are added, shocks or measurement errors have to be added, and this may become problematic with a large number of variables.

Another issue, which comes back in part to whether the macro 2 message is sensible, is the size of the maximization problems. As more and more variables are added, the maximization problems have to get larger and larger. As the problems become larger, the specifications may become more arbitrary. There is more choice about what households and firms are doing. Complaints about free parameters, like those of Chari et al. (2009), may increase. The trouble with the macro 2 approach is that it is locked into a restrictive estimation framework. The estimation problems are tied to the exact specifications of the maximization problems (including the assumption of rational expectations), unlike in the CC approach where the theory is less restrictive. For the macro 2 approach to work, it will have to be the case that the aggregate data can truly be well modeled by assuming they are generated from solutions of specific maximization problems with agents having rational expectations.

If the macro 2 message is not sensible or its methodology is not feasible for estimating realistic models, it is perhaps time to move back to macro 1. This requires dropping the assumption of rational expectations and trusting the theory to impose exclusion restrictions. Otherwise, the CC approach provides considerable flexibility in specification, estimation, and testing. Size is also not a constraint. The cost of abandoning the rational expectations assumption seems small, since the assumption

[3] See Fair (2004, Chapter 7).

seems unlikely to be realistic, and to trust theory like that outlined in Section 4 to provide exclusion restrictions does not seem unreasonable.

Acknowledgement

Without implicating them, I am indebted to William Brainard, Rochelle Edge, Jesús Fernández-Villaverde, Michael Kiley, Jean-Philippe Laforte, and Peter Stalder for helpful comments.

Appendix. Estimated properties of the US economy

This appendix summarizes some of the properties of the US economy that I have estimated in my modeling work. I will continue to use the notation in Section 3. The three categories of consumption are c_1, c_2, and c_3: service, nondurable, and durable. The three categories of investment are i_1, i_2, and i_3: housing, plant and equipment, and inventory. The four measures of labor supply are l_1, l_2, l_3, and n: males 25–54, females 25–54, all others 16 and over, and the number of people with two jobs.

If the following features are in fact characteristic of the economy, they need to be accounted for in a complete macro model. The main argument of this paper is that the macro 2 approach does not seem capable of doing this.

Unless otherwise stated, the reference for the following discussion is Fair (2004). An update of the multicountry (MC) model in Fair (2004) is on the author's website. The US model is a subset of the MC model.

Wealth effects on c_1, c_2, and c_3

Household wealth, both net financial wealth and housing wealth, has important effects on the three categories of consumption. This is the main channel through which changes in stock prices and housing prices affect aggregate demand.

Physical stock effects on c_3, i_1, i_2, and i_3

Other things being equal, the stock of durables has a negative effect on c_3, the stock of housing has a negative effect on i_1, the stock of capital has a negative effect on i_2, and the stock of inventories has a negative effect on i_3. These stock effects mitigate recessions and tame booms. As physical stocks get low in a recession, there is, other things being equal, an increased demand to replenish them, which helps counteract the recession. The opposite happens in a boom. These stock effects are quantitatively important.

Interest rate effects on c_1, c_2, c_3, i_1, and i_2

Interest rates have important effects on consumption and investment demand. Part of these effects are intertemporal substitution effects. These interest rate effects are the main way in which monetary policy affects aggregate demand.

Age distribution effects on c_1, c_2, and c_3

The age distribution of the US population has changed remarkably over time—the largest effect being the baby boom after World War II. The age distribution is estimated to have significant effects on the three categories of consumption.

After-tax real wage effects on l_2, l_3, and n; wealth effects on l_1, l_2, and l_3

The after-tax real wage has a positive effect on three of the four categories of labor supply—the substitution effect dominating. Wealth has a negative effect—negative income effect. So, for example, an increase in stock prices leads, other things being equal, to a decrease in labor supply. Also, an increase in income tax rates leads to a decrease in labor supply.

Discouraged worker effects on l_3 and n

Discouraged worker effects are estimated for two of the four categories of labor supply. As the economy contracts, the labor force of all others 16 and over and the number of people holding two jobs fall, other things being equal.

Measured labor productivity is pro-cyclical because of excess labor responses

Firms are estimated to hold excess labor at times. When output contracts, they do not immediately lay off all the workers they could, given the level of output. (The production function is taken to be fixed proportions in the short run.) Output per worker and output per worker hour are thus pro-cyclical, where the buffer is the amount of excess labor held.

No "new age" of labor productivity

A plot of output per worker hour does not reveal a large increase in productivity in the 1990s. The plot does not show a "new age" of productivity in the last half of the 1990s, which Alan Greenspan argued at the time was taking place.

Capacity utilization is pro-cyclical because of excess capital responses

Firms are estimated to hold excess capital at times. When output contracts, they do not immediately get rid of all the capital they could, given the level of output. Capacity utilization is thus pro-cyclical, like labor productivity.

No Okun's law

Because labor supply responds to the after-tax real wage rate, wealth, and the state of the economy and because excess labor fluctuates as output fluctuates, there is no stable relationship between output growth and the change in the unemployment rate. This relationship depends on changes in other variables and on the state of the economy.

Price equation is nonlinear in levels

Results in Fair (2008) suggest that aggregate price equations should be specified in terms of levels rather than first differences or second differences. The dynamics behind NAIRU equations are not supported by the data. There is also likely to be a nonlinear relationship between the aggregate price level and the unemployment rate at low levels of the unemployment rate, but this is hard to estimate because of few observations at low unemployment rates.

Wage equation is important

Results in Fair (2008) also show that a wage-price specification, where the wage rate appears in the price equation and the price level appears in the wage equation, explains the data better than a reduced form price equation with the wage rate solved out.

Estimated Fed interest rate rule is stable over time

The estimated interest rate rule in the model, which is an updated version of the estimated rule in Fair (1978), has the following stability feature. The hypothesis that the coefficients in the rule are the same for the period 1954:1–1979:3 as they are for the period 1982:4–2009:3 is not rejected. Fed behavior was different during the early Volcker period, 1979:4–1982:3, as announced by the Fed, but not before or after.

Relative price effects on imports

The price of imports relative to the domestic price level has a negative effect on import demand. A depreciation of the dollar thus has a negative effect on imports to the extent that the depreciation raises the price of imports.

Long run PPP effects and short run relative interest rate effects on exchange rates

Exchange rate changes are mostly unpredictable, but some effects of PPP and relative interest rates can be picked up in the estimation of exchange rate equations. This means, for example, that if the US interest rate rises relative to the euro interest rate, the dollar appreciates relative to the euro, other things being equal.

Positive price shocks are contractionary

This feature is discussed at the end of Section 6.

Monetary policy has limited power

Results in Fair (2007) examining optimal monetary policies show that monetary policy cannot come close to eliminating business cycles. This is true even when the interest rate is not close to zero.

Inflation targeting is not a good idea

Results in Fair (2007) also show that the estimated interest rate rule, in which the Fed responds to both inflation and unemployment, is close to being optimal and dominates rules in which only inflation is targeted. Targeting the price level is even worse.

The stock market boom accounts for the large 1995–1999 expansion

The unusually large economic expansion in 1995–1999 can be accounted for by the stock market boom that began in 1995. Had it not been for this boom, it would have been business as usual.

The stock market decline accounts for much of the sluggish 2000:4–2004:3 economy

Results in Fair (2005) show that much of the sluggish economy that began in the last half of 2000 and continued through 2004 in spite of expansionary monetary and fiscal policies can be explained by the stock market decline. The other main culprit was a decline in exports.

More generally, asset-price changes are important

Major asset prices in the US model are stock prices, housing prices, oil prices, and exchange rates. Changes in these prices are essentially unforecastable, and results in Fair (2010) show that between about 25 and 37 percent of the forecast-error variance of output growth over 8 quarters is due to these changes.

Some estimated responses

The following results give a general idea of some quantitative responses in the MC model. The latest update of the model, dated January 30, 2010, is used for the results. Because the model is nonlinear and because the results depend on initial conditions like stock values, the responses differ somewhat depending on the simulation period. For present purposes the 24-quarter period, 2000:1–2005:4, was used. Results for 4, 8, and 24 quarters ahead are given.

An increase in real federal purchases of goods of 1.0% of real GDP leads to an increase in real GDP of 2.0%, 1.8%, and 1.0%. The GDP deflator is larger by 0.5%, 1.0%, and 1.0%. The three month Treasury bill rate (*RS*) is larger by 0.8, 0.9, and 0.4 percentage points, which is the estimated interest rate rule in action. The unemployment rate is lower by 1.0, 1.0, and 0.3 percentage points. An increase in real federal personal transfer payments of 1.0% of real GDP leads to an increase in real GDP of 1.0%, 1.1%, and 0.4%, about half that for an increase in purchases of goods. Results are similar for a personal income tax rate decrease of an amount equivalent to the real transfer payment increase.

If the interest rate rule is dropped and *RS* is increased by 1.0 percentage points, real GDP is lower by 0.4%, 0.7%, and 0.2%. If the capital gains (*CG*) equation is dropped and *CG* is increased by 10 percent of nominal GDP in 2000:1 ($971 billion), nominal GDP is larger by 0.26%, 0.50%, and 0.29%. Real GDP is larger by 0.21%, 0.32%, and −0.03%.

If the interest rate rule is dropped and *RS* is taken to be unchanged from its baseline values and if the US price equation is shocked by 0.5% in 2000:1, real GDP is lower by .18%, .42%, and .85%. This is the property mentioned in the text that a positive price shock with the nominal interest rate held constant is contractionary.

If the estimated exchange rate equations are dropped and the dollar is depreciated by 10% relative to the currencies of all countries in the model, real GDP is lower by .39%, .39%, and .12%. The GDP deflator is larger by 1.35%, 2.11%, and 3.20%. A depreciation of the dollar is thus inflationary and contractionary. It is contractionary because the negative effects from increasing prices more than offsets the positive effects from a decrease in imports and an increase in exports.

References

Adolfson, M., Laséen, S., Lindé, J., Villani, M., 2007. Bayesian estimation of an open economy DSGE model with incomplete pass-through. Journal of International Economics 72, 481–511.
Barro, R.J., Grossman, H.I., 1971. A general disequilibrium model of income and employment. American Economic Review 61, 82–93.
Blanchard, O.J., 2009. The state of macro. Annual Review of Economics 1, 1–20.
Chari, V.V., Kehoe, P.J., McGrattan, E.R., 2009. New Keynesian models: not yet useful for policy analysis. American Economic Journal Macroeconomics 1, 242–266.
Christian, J.W., 1968. A further analysis of the objectives of american monetary policy. Journal of Finance 23, 465–477.
Del Negro, M., Schorfheide, Smets, F., Wouters, R., 2007. On the Fit of New-Keynesian Models. Journal of Business & Economics Statistics 25, 123–149.
Dewald, W.G., Johnson, H.G., 1963. An objective analysis of the objectives of american monetary policy, 1952–1961. In: Carson, D. (Ed.), Banking and Monetary Studies. Richard D. Irvin, Homewood, Illinois, pp. 171–189.
Edge, R.M., Kiley, M.T., Laforte, J.-P., 2008. Journal of Economic Dynamics & Control 32, 2512–2535.
Fair, R.C., 1974. A Model of Macroeconomic Activity. The Theoretical Model, vol. 1. Ballinger Publishing Company, Cambridge, Mass..
Fair, R.C., 1978. The sensitivity of fiscal policy effects to assumptions about the behavior of the federal reserve. Econometrica 46, 1165–1179.
Fair, R.C., 2004. Estimating How the Macroeconomy Works. Harvard University Press, Cambridge, MA.
Fair, R.C., 2005. Policy effects in the post boom US economy. Topics in Macroeconomics 5 (1), 1–29 (article 19).
Fair, R.C., 2007. Evaluating inflation targeting using a macroeconometric model. Economics—the Open-Access. Open-Assessment E-Journal, 2007–8.
Fair, R.C., 2008. Testing price equations. European Economic Review, 1424–1437.
Fair, R.C., 2010. Analyzing Macroeconomic Forecastability. August.
Fernández-Villaverde, J., 2008. Horizons of understanding: a review of Ray Fair's estimating how the macroeconomy works. Journal of Economic Literature 46, 685–703.
Galí, J., Gertler, M., 2007. Macroeconomic modeling for monetary policy evaluation. Journal of Economic Perspectives 21, 25–45.
Griliches, Z., 1967. Distributed lags: a survey. Econometrica 35, 16–49.
Khoury, S.S., 1990. The federal reserve reaction function: a specification search. In: Mayer, Thomas (Ed.), The Political Economy of American Monetary Policy. Cambridge University Press, Cambridge, pp. 27–49.
Klein, L.R., 1950. Economic fluctuations in the United States 1921–1941. Cowles Commission Monograph, vol. 10. John Wiley and Sons, New York.
Lucas Jr., R.E., 1976. Econometric policy evaluation: a critique. In: Brunner, K., Meltzer, A.H. (Eds.), The Phillips Curve and Labor Markets. North Holland, Amsterdam.
Mankiw, N.G., 2006. The macroeconomist as scientist and engineer. Journal of Economic Perspectives 20, 29–46.
McNees, S.K., 1986. Modeling the fed: a forward-looking monetary policy reaction function. New England Economic Review (November/December), 3–8.
McNees, S.K., 1992. A forward-looking monetary policy reaction function: continuity and change. New England Economic Review (November/December), 3–13.
Shimer, R., 2009. Convergence in macroeconomics: the labor wedge. American Economic Journal Macroeconomics 1, 280–297.
Sims, C.A., 1980. Macroeconomics and reality. Econometrica 48, 1–48.
Smets, F., Wouters, R., 2007. Shocks and frictions in US business cycles: a bayesian DSGE approach. American Economic Review 97, 586–606.
Solow, R., 2008. The state of macroeconomics. Journal of Economic Perspectives 22, 243–246.
Taylor, J.B., 1993. Discretion versus policy rules in practice. Carnegie-Rochester Series on Public Policy 39, 195–214.
Tinbergen, J., 1939. Statistical testing of business-cycle theories. Business Cycles in the United States of America, 1919–1932, vol. 2. League of Nations, Geneva.
Woodford, M., 2009. Convergence in macroeconomics: elements of the new synthesis. American Economic Journal Macroeconomics 1, 267–279.