Some Important Macro Points

Ray C. Fair*

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Abstract

This paper lists 19 points that follow from results I have obtained using a structural macroeconomic model (SEM). Such models are more closely tied to the aggregate data than are DSGE models, and I argue that DSGE models and similar models should have properties that are consistent with these points. The aim is to try to bring macro back to its empirical roots.

1 Introduction

It is perhaps an understatement to say that there is currently a wide range of views about the state of macroeconomic research, mostly centered around views about the dynamic stochastic general equilibrium (DSGE) methodology and models. Some view DSGE models as the only game in town. For example, Christiano, Eichenbaum, and Trabandt (2018, p. 136) state: "But we do know that DSGE models will remain central to how macroeconomists think about aggregate phenomena and policy. There is simply no credible alternative to policy analysis in a world of competing economic forces operating on different parts of the economy." Kehoe, Midrigan, and Pastorino (2018, p. 164) state: "[Macroeconomists] agree that a disciplined debate rests on communication in the language of dynamic general equilibrium theory." Chari (2010, p. 32) states: "If you have an interesting and

*Cowles Foundation, Department of Economics, Yale University, New Haven, CT 06520-8281. e-mail: ray.fair@yale.edu; website: *fairmodel.econ.yale.edu*.

a coherent story to tell, you can do so within a DSGE model. If you cannot, it is probably incoherent." And Gali (2018, p. 108) simply states: "New Keynesian economics is alive and well."

Others view the last 40 years—roughly since the Lucas (1976) critique—of research leading up to and including DSGE models as a waste of time, where almost nothing of interest has been learned—the dark ages of macro. For example, Stiglitz (2018, p. 76) states: "I believe that most of the core constituents of the DSGE model are flawed—sufficiently badly flawed that they do not provide even a good starting point for constructing a good macroeconomic model." Hendry and Muellbauer (2018) argue that New Keynesian DSGE models have the wrong microfoundations and advocate an empirical encompassing approach. Romer (2016) simply states in his abstract: "For more than three decades, macroeconomics has gone backwards."

Others take a middle ground, arguing that further research on DSGE models may prove rewarding but lamenting that fact that the DSGE methodology has completely dominated the profession. They argue that the macro profession, including professional journals, should be more open to other types of models. Linde (2018, p. 283), while arguing that DSGE models will "likely remain as a key policy tool in the foreseeable future," states that other models may be useful. Blanchard (2018, p. 44) states that DSGE models "have to become less imperialistic and accept sharing the scene with other approaches to modelization." He lists five kinds of models: Foundational, DSGE, Policy, Toy, and Forecasting. Wren-Lewis (2018, p. 68) talks about the "microfoundations hegemony" in the macro profession. He points out that graduate students who are considering research in macro cannot deviate very far from the DSGE methodology and hope to get published in the top journals. He also argues that more work should have been done in the past decades on traditional structural econometric models (SEMs). These models are what Blanchard (2018) calls policy models, and what I call models in the "Cowles Commission" (CC) tradition. Early models of this type include the models of Tinbergen (1939) and Klein and Goldberger (1955). My macro research in the last

50 years has been in this tradition. I will follow Wren-Lewis (2018) and call these models SEMs.

As I briefly discuss in the next section, SEMs are more closely tied to the data than are DSGE models. Over the years I have obtained many empirical results using my own SEM—denoted the MC model. I have put most of my macro research, including the empirical results, in one document on my website—Macroeconometric Modeling: 2018—abbreviated MM. MM includes chapters on methodology, econometric techniques, numerical procedures, theory, empirical specifications, testing, and results. The results in my previous papers have been updated through 2017 data, which provides a way of examining the sensitivity of the original results to the use of additional data.

I take the bold stance in this paper that DSGE and other models should have properties regarding the aggregate data that are consistent with the properties I have obtained using the MC model. In other words, I am taking the stance that other models should be consistent with the relationships among aggregate variables that I have obtained. The basic idea is that SEMs for whatever theoretical purity they may lack produce more trustworthy empirical results. More will be said about this in the next section. For reference purposes I am going to refer to sections in MM rather than to the original articles upon which they are based. This has the advantages that everything is in one place and that the empirical results are updated. My model of the United States is a subset of the overall MC (multicountry) model, and I will refer to this subset as the "US model" when appropriate. This paper can be read without referring to MM if you are willing to take me at my word.

2 Background

What I have called the CC approach is the following. Theory is used to guide the choice of left-hand-side and right-hand-side variables for the stochastic equations in a model, and the resulting equations are estimated using a consistent estimation technique like two-stage least squares (2SLS). Sometimes restrictions are imposed on the coefficients in an equation, and the equation is then estimated with these restrictions imposed. It is generally not the case that all the coefficients in a stochastic equation are chosen ahead of time and thus no estimation done. In this sense the methodology is empirically driven and the data rule. The use of theory in the CC approach is firmly in the spirit of Koopmans' (1947) argument for the use of theory in examining economic variables. Behavioral equations of economic agents are postulated and estimated. These equations are estimated decision equations of the agents. The CC approach has the advantage of using theory while keeping close to what the data say.

Typical theories for these models are that households behave by maximizing expected utility and that firms behave by maximizing expected profits. The theory that has been used to guide the specification of the MC model is discussed in [MM, 3.1, 3.2]. In the process of using a theory to guide the specification of an equation to be estimated there can be much back and forth movement between specification and estimation. If, for example, a variable or set of variables is not significant or a coefficient estimate is of the wrong expected sign, one may go back to the specification for possible changes. Because of this, there is always a danger of data mining—of finding a statistically significant relationship that is in fact spurious. Testing for misspecification is thus (or should be) an important component of the methodology. There are generally from a theory many exclusion restrictions for each stochastic equation, and so identification is rarely a problem—at least based on the theory used.

The transition from theory to empirical specifications is not always straightforward. The quality of the data is never as good as one might like, so compromises have to be made. Also, extra assumptions usually have to be made for the empirical specifications, in particular about unobserved variables like expectations and about dynamics. There usually is, in other words, considerable "theorizing" involved in this transition process. In many cases future expectations of a variable are assumed to be adaptive—to depend on a few lagged values of the variable itself, and in many cases this is handled by simply adding lagged variables to the equation being estimated. When this is done, it is generally not possible to distinguish partial adjustment effects from expectation effects—both lead to lagged variables being part of the set of explanatory variables [MM, 1.2].

I should add that calling this procedure the CC approach is somewhat misleading. Heckman (2000) points out that the approach outlined in Haavelmo (1944) is much narrower, being in the tradition of classical statistical inference. There is no back and forth between empirical results and specifications. Heckman also points out that this approach was almost never followed in practice. It is much too rigid. I will thus continue to refer to the procedure discussed above as the CC approach even though it is not Haavelmo's.

One should not lose sight of the fact that macro modeling is trying to explain how the economy works using aggregate data. U.S. consumption of services in quarter t is the sum of service consumption across all U.S. consumers in quarter t; U.S. investment in plant and equipment is the sum of plant and equipment investment across all U.S. firms; etc. By construction, there is no consumer and firm heterogeneity in the data. There is currently considerable work adding heterogeneous agents to DSGE models,[1] but this is of limited use for aggregate modeling. At best it may suggest variables to add as explanatory variables to the aggregate equations. For example, it may be that in the future various measures of income inequality suggested by this work will add to the explanatory power of the aggregate equations, where the inequality measures are treated as exogenous. But assuming in DSGE models that, say, some households are liquidity constrained and some are not, is not likely to help explain the aggregate data because the data don't distinguish between different kinds of consumers. Everything is just added up.[2]

[1]See Kaplan and Violante (2018) for a review. A Heterogenous Agent New Keynesian (HANK) model is presented in Kaplan, Moll, and Violante (2018).

[2]In work with Kathryn Dominguez [MM,3.6.2] we have found that one can pick up in aggregate

Heterogeneity was an important part of Orcutt's (1957) agenda. His suggestion was to estimate equations for many homogeneous "units" in the economy. He suggested that with an economy of hundreds of millions units, tens of thousands of units might be sufficient. The interval of time would be short, like a week or a month. The predictions from these equations would be added up to get predictions for the whole economy, which would avoid having to estimate aggregate equations. Orcutt's work led to the creation of microanalytic simulation models, which had important policy results.[3] It turned out, however, that this agenda did not lead to the modeling of the entire economy. It's not infeasible because of the lack of computer power, but the lack of sufficient data to estimate, say, 10,000 sets of behavioral equations. We are thus left with having to deal with aggregate data.

It was mentioned above that the CC approach typically uses lagged variables to pick up partial adjustment and expectational effects. If this use is not a good approximation to reality, the model will be misspecified and may have misleading properties. The true structural parameters are not being estimated, and so the reduced form equations are not right. This problem is discussed in Marschak's (1953) classic paper. Lucas (1976) stressed possible errors in specifying how expectations are formed. In particular, if expectations are rational and if a policy rule is changed, agents will know this and adjust their expectations accordingly. Under adaptive expectations, expectations only adjust over time as the actual values of variables change.

It is possible to add rational expectations to SEMs. Some of the explanatory variables in the stochastic equations can be postulated to be expected future values, and one can then impose model consistent expectations on these values. The future values are what the model predicts them to be. In work with John Taylor [MM, 2.12] we discuss the full information estimation and solution of these models.

The rational expectations assumption is difficult to test, but in general the results

consumption equations significant effects of the changing age distribution in the United States, which is a form of heterogeneity. The age distribution variables are taken to be exogenous.

[3] See Watts (1991) for a review of Orcutt's research.

are negative. Coibion, Gorodnichenko, and Kamdar (2018) review a number of these tests, primarily using survey data. In a recent Bank of England survey of households' inflation expectations—Rowe (2016)—the most important factors were households' current inflation perceptions. I have tested the assumption by adding future values to various structural equations, estimating the equations using a consistent technique, and testing for the statistical significance of their coefficient estimates [MM, 3.6.11, 3.7.3]. Most of the estimates of the future values are not significant, for both the United States and other countries.

The requirements of the rational expectations assumption, that agents know the model and use it to form their future expectations, seem particularly unrealistic when dealing with aggregate data. It's a strain to think that this is a characteristic of aggregate relationships. There are many reasons that aggregate models may be misspecified, including not capturing expectations and partial adjustments well, which is why empirical tests of these models are important. But to reject models that do not assume rational expectations seems unwarranted, especially since the assumption does not seem accurate. The results discussed below are not based on this assumption.

The use of lagged variables is now a feature in DSGE models. This use is justified by assumptions of habit formation, adjustment costs, variable capacity utilization, pricing behavior, and interest rate rules. This procedure is similar to the use of lagged endogenous variables in SEMs to account for lagged adjustment and expectational effects. As DSGE models have added these types of assumptions, they have moved closer to what is standard procedure in SEMs. In this sense there is convergence. It is, of course, at a cost of theoretical purity, and it weakens arguments against SEMs for using lagged variables.

Finally, most DSGE models postulate a steady state around which the economy fluctuates. This seems like too tight a restriction. There is considerable uncertainty regarding the long run path of any economy, and requiring that an economy have a long run steady state does not seem sensible. Similar comments apply to the concept of a natural rate.

There are too many DSGE models to make it feasible to relate the points below to individual models. Some of the points are consistent with some models, and some are not. Also, some of the points are outside of what a model is modeling. DSGE models are less general than SEMs and thus cover less of the macro terrain. More will be said about this in the conclusion.

3 Model Properties

3.1 Wealth in Household Expenditure Equations

The results discussed in this subsection pertain to the United States. I have found that the lagged value of household financial and housing wealth is significant in equations explaining household expenditures on consumption of services, non-durables, and durables and that the lagged value of housing wealth is significant in an equation explaining household expenditures on housing investment [MM, 3.6.3]. Data on household financial and housing wealth can be constructed from data in the Flow of Funds Accounts (FFA). I have tested financial wealth versus housing wealth in the consumption equations to see if they have the same effects. There is some evidence that housing wealth is more important in the durables equation, but overall the results favor simply summing the two [MM, 5.7.2].

In the US model data from the FFA have been linked to data from the National Income and Product Accounts. For example, the change in household financial wealth is equal to the financial saving of the household sector plus capital gains or losses on household equity holdings. Changes in household financial wealth are dominated by changes in equity prices. Although household financial wealth is an endogenous variable in the model, its change is largely unpredictable because the change in equity prices is. Changes in housing wealth are mostly due to changes in housing prices. Although housing wealth is an endogenous variable in the model, its change is also largely unpredictable because the change in housing prices is.

Household wealth is quite important in the model. As an approximation, think about the change in wealth as being exogenous and unpredictable except for drift. This is not exactly true in the model, but close. When either type of wealth changes, consumption changes in the next period, and when housing wealth changes, housing investment changes in the next period. These effects are large. A sustained one dollar increase in real financial wealth leads to an increase in real GDP of about 4 cents after two years and about 6 cents after 5 years. The numbers for a sustained one dollar increase in real housing wealth are 6.5 cents after two years and 7.5 cents after 5 years [MM, 5.7.4].[4] As discussed in Section 4.2 below, much of the fluctuations in the economy since 1995 can be explained by fluctuations in household wealth. In particular, much of the recession of 2008–2009 can be explained by the large decreases in both financial and housing wealth.

The 2008–2009 recession triggered considerable research adding financial factors to DSGE models. Gertler and Gilchrist (2018) and Mian and Sufi (2018) provide reviews. The models are moving away from the assumption of frictionless financial markets. Gertler and Gilchrist (2018) stress household balance sheet constraints and Mian and Sufi (2018) stress credit-driven household demand. Much of this work is too detailed to be relevant for aggregate specifications. Many of the relationships between financial institutions and households and firms that are modeled have no counterpart in aggregate data. Exceptions to this are interest rate spreads, for which data exist. Spreads between non risk free rates and risk free rates tend to rise in times of financial difficulties.

[4]The range of 4 to 7.5 cents is in the ballpark of other estimates, mostly using less aggregate data. Ludvigson and Steindel (1999) estimate 3 to 4 cents. Starr-McCluer (1998) uses survey data to examine the wealth effect, and she concludes that her results are broadly consistent with a modest wealth effect. Mian, Rao, and Sufi (2013, p. 30) find 5 to 7 percent effects of housing wealth on consumption, although these effects vary considerably across zip codes. Zhou and Carroll (2012, p. 18) find a 5 percent effect of housing wealth on consumption. Aladangady (2017) finds a 4.7 cent increase in spending for a dollar increase in housing wealth, although only for homeowners. Paiella and Pistaferri (2017) find 3 cents for Italian households.

An interesting question is whether interest rate spreads have independent explanatory power in the household expenditure equations with the wealth variable included. I have added the corporate AAA/BBB spread and the 10-year government/corporate AAA spread to the four equations, and none of the spreads tried were significant [MM, 5.7.3]. I also tried two variables from Carroll, Slacalek, and Sommer (2013), one measuring credit constraints and one measuring labor income uncertainty, and these were not significant [MM, 5.7.3]. I also tried the excess bond premium (EBP) variable from Gilchrist and Zakrajšek (2012). This variable has a large spike in the 2008–2009 recession. It is not significant when the estimation period ends in 2007:4, but it is for the period ending in 2010:3 [MM, 5.7.3]. The evidence for EBP is thus mixed, depending on how much weight one puts on possible data mining, since it was created after the recession was known. But in general there appears to be little independent information in spreads and other measures of financial difficulties.

The explanation for the 2008–2009 recession in the US model is thus that household wealth fell (unpredictably), which led to large declines in household expenditures, both consumption and housing investment. In the process many bad things happened financially—bankrupticies, credit constraints, liquidity problems, and the like—and in the aggregate data these are accounted for by the fall in wealth.

One final point. Some work adding financial detail to DSGE models suggests that there may be asymmetrical effects in expansions versus contractions, where the effects in contractions are larger in absolute value. This can potentially be tested using aggregate data by treating periods of rising wealth differently from periods of falling wealth in the estimation. I have not attempted this.

Point 1: Household wealth, both financial and housing, affects household expenditures. The change in wealth is largely unpredictable.

3.2 Monetary Policy

Interest rates appear as explanatory variables in the household expenditure equations—a short term rate in the services equation and a long term rate in the other three [MM, 3.6.3]. The long term rate is related to the short term rate through an estimated term structure equation, where the long term rate is postulated to be a function of current and expected future short term rates. Lagged short term rates are used as proxies for expected future short term rates—in effect adaptive expectations [MM, 3.6.6].[5]

An interesting empirical result that I have obtained is that nominal interest rates dominate real interest rates in household expenditure equations. Tests of nominal versus real rates were run for the United States and 17 other countries [MM, 3.12]. Different measures of real interest rates were tried based on different assumptions of expected future inflation. Overall there is very little evidence in favor of real interest rates. Why this is the case is an interesting question. One possibility is that the expected rate of inflation is simply a constant, so that the nominal interest rate specification is also the real interest rate specification (with the constant absorbed in the constant term of the equation). One implication of this result is discussed in Section 3.4 below.

Monetary policy is endogenous in the model, being determined by an estimated interest rate rule. The rule has a short term interest rate as the dependent variable and has as explanatory variables inflation, the unemployment rate, and lagged short term rates. Estimated interest rate rules go back much further than Taylor (1993). 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 can be found in Christian (1968), followed by many others. I added an estimated

[5] A real interest rate appears in the plant and equipment investment equation, but it has a small coefficient estimate and is not statistically significant. Monetary policy in the model works primarily through the interest rates in the household expenditure equations.

interest rate rule to my model in 1978. These rules should thus probably be called Dewald-Johnson rules, since Dewald and Johnson preceded Taylor by about 30 years! An interest rate rule is part of most DSGE models.

There is a large literature on the question of how to identify exogenous monetary policy shocks. Nakamura and Steinsson (2018) have a good discussion of this. For the CC approach, however, identification is not a problem. When estimating an interest rate rule, some of the explanatory variables are endogenous, like current values of inflation and the unemployment rate, since these are affected by the current value of the interest rate. There is correlation between these variables and the error term in the equation. This is handled by estimating the equation by a consistent technique like 2SLS, where the first stage regressors are exogenous and lagged endogenous variables. If the error term is serially correlated, this can be handled by jointly estimating the serial correlation coefficients and the structural coefficients [MM, 2.3.1]. Identification is not a problem because many variables are excluded from the interest rate rule. It could be, of course, that the equation is misspecified, but conditional on no misspecification, there is no identification problem.

Although monetary policy is endogenous in the model given the rule, one can drop the rule and see how the economy responds to a change in the short term interest rate. A sustained one percentage point decrease in the short term interest rate results in an increase in real GDP of about half a percent after 4 quarters and one percent after 8 quarters in the MC model [MM, 4.4.2]. So the long run effect is about one for one. This assumes, of course, no zero lower bound.[6] Monetary policy effects are thus moderate. When I run various stabilization experiments using the MC model (using stochastic simulation), monetary policy rules do not come close to eliminating typical business cycle fluctuations [MM, 4.4].

Point 2: Nominal interest rates dominate real interest rates in explaining household expenditures.

[6] The interest rate rule is estimated only through 2008:3, the period before the zero lower bound.

Point 3: Monetary policy effects on real output are moderate.

3.3 Price and Wage Rate quations

The new Keynesian Phillips curve (NKPC) or something similar is a common part of DSGE models. Coibion, Gorodnichenko, and Kamdar (2018) review these equations and argue that the assumption of rational expectations upon which these equations are based may not be a good approximation to how expectations are actually formed. They consider various survey variables.

Three results from my work on price and wage rate equations are important for present purposes. First, the data support the specification of price equations in log level form [MM, 3.13]. When log price levels lagged once and twice are added to price equations specified in log change form (inflation as the dependent variable), they tend to be highly significant, thus suggesting a log level specification. This test was done for the United States and 15 other countries. There is strong evidence against the NAIRU specification. This would appear to be a first order problem for NKPCs: they have the wrong dynamics. The log level specification is consistent with the theory of firm behavior that I use. The price decision variable of firms in their maximization problem is the price level [MM, 3.2].

Second, the price of imports is an important explanatory variable in price equations. The variable is highly significant in the U.S. equation. It appears with a positive coefficient in the price equations for 21 other countries and is significant in 15 of these. Any price equation that does not have a cost variable like the price of imports in it is likely to be misspecified.

Third, my results suggest that prices and wage rates should be considered together: prices affect wage rates and vice versa [MM, 3.6.4, 3.13.3]. The results for the United States suggest that the aggregate price level is affected by demand and cost factors and that the aggregate wage rate is affected by the price level. The wage rate equation supports the restriction that the growth rate of the real wage rate in the long run is equal to the growth rate of productivity.

A smaller point that is sometimes overlooked is that the aggregate price variable should be the price of domestically produced goods. It should not include import prices, as does the consumer price index and the personal consumption deflator. The agents that are being modeled are domestic producers.

To come back to the log level specification of the price equation, there is likely to be a nonlinear relationship between the (log) price level and the demand variable, say the unemployment rate, where at some low value of the unemployment rate the price level begins to rise much more rapidly than linearly as the unemployment rate falls. It is hard to estimate this nonlinearity in the data because the economy is rarely pushed into this area. Monetary authorities usually intervene before the nonlinear point is reached. The message for policy makers is that they should not think there is some value of the unemployment rate below which the price level accelerates and above which it decelerates. They should think instead that the price level is a negative function of the unemployment rate (or other measures of demand slack), where at some point the function begins to become nonlinear. How bold a policy maker is in pushing the unemployment rate into uncharted waters will depend on how fast he or she thinks the nonlinearity becomes severe.

Point 4: The data support price equations specified in log level form. There is likely a nonlinear relationship between the price level and the demand variable at high values of the demand variable, but this is hard to estimate.

Point 5: Import prices are important explanatory variables in price equations.

Point 6: Prices and wage rates affect each other.

3.4 Price Shocks Have a Negative Effect on Output

Say there is an increase in the domestic price level for some exogenous reason. My results suggest that this is contractionary even if the interest rate rule is turned off and thus the nominal interest rate is exogenous. The increase in the price level lowers real wealth. In addition wage rates do not rise as much as prices in the short run, and so the real wage rate (and thus real income) falls. The declines in real wealth and real income lead to a decrease in household expenditures. The real interest rate falls because inflation is higher, but this does not stimulate household expenditures because the interest rates in the equations are nominal.

In a number of models[7] a positive price shock is expansionary, sometimes explosive, if the nominal interest rate is unchanged. This is because the real interest rate falls, which stimulates consumption and investment. The monetary authority must raise the nominal interest rate more than the increase in the inflation rate to stabilize the economy. The opposite in fact appears to be the case. The monetary authority should lower the nominal interest rate to lessen the contractionary effects.

Point 7: Price Shocks Have a Negative Effect on Output

3.5 Imports and Exports

A macro model treating imports as exogenous is missing a quantitatively important feature about the economy. When there is something that increases household expenditures or firm investment, some of this increased spending is on imports. This effect is quantitatively important in my model as discussed in the next subsection.

My results suggest that treating exports as exogenous is less serious. In the MC model, where exports are endogenous, U.S. exports do respond to, say, an increase in U.S. household expenditures because of the various links among countries, but these effects are second order.

Point 8: Imports are endogenous.

3.6 Government Spending and Tax Multipliers

There is a large literature on estimating the size of the government spending multiplier, much of it not using DSGE models. Reviews are in Ramey (2011) and

[7] The FRB/US model is one example—Federal Reserve Board (2000).

Ramey (2019). Some studies follow a reduced form approach—for example, Hall (2009), Barro and Redlick (2011), and Romer and Romer (2010). The change in real GDP is regressed on the change in the policy variable of interest and a number of other variables. The equation estimated is not, however, a true reduced form equation because many variables are omitted, and so the coefficient estimate of the policy variable will be biased if the policy variable is correlated with omitted variables. The aim using this approach is to choose a policy variable that seems unlikely to be correlated with the omitted variables. Hall (2009) and Barro and Redlick (2011) are concerned with government spending multipliers and focus on defense spending during wars. Romer and Romer (2010) are concerned with tax multipliers and use narrative records to choose what they consider exogenous tax policy actions, i.e, actions that are uncorrelated with the omitted variables.

The CC approach does not have the problem of possible omitted variable bias in reduced form equations because reduced form equations are not directly estimated. The structural equations are estimated by some consistent technique, and the model is solved. This procedure takes into account all the nonlinear restrictions in the solution process and thus uses more information than does the reduced form approach. If the model were linear, these would be nonlinear restrictions on the reduced form coefficients; otherwise the reduced form equations are implicit.

The output multiplier for government purchases of goods is larger than for transfer payments (and taxes) in the MC model for the usual textbook reasons. Purchases of goods is a direct expenditure injection, whereas part of the transfer payments injection is saved by households. The output multiplier for government purchases of goods is 1.30 after four quarters in the MC model (simulation beginning in 2015:1).[8] (This is with the estimated interest rate rule in.) The output multiplier for transfer payments is 0.48 after four quarters. The output multipliers for tax-rate changes are similar to those for transfer payment changes since the

[8] Simulations like these can be run on my website. The MC model is denoted the MCJ model on the website.

main effect of tax-rate changes is to change disposable personal income. They are not quite the same because tax rates also affect labor force participation. Ramey (2019) reports multipliers for tax-rate changes between -2 and -3 using narrative-based times series estimates. This is completely unrealistic in the context of a SEM. Multipliers this large would require unusual consumption equations to say the least.

Regarding the quantitative importance of imports, if the import equation is turned off, the output multiplier for government purchases of goods is higher at 1.63 (versus 1.30) after four quarters, which is a large change. If the interest rate rule is turned off (but the import equation is in), the multiplier is 1.51 after four quarters. The multiplier is larger with the rule turned off because the Fed is not "leaning against the wind."

Point 9: Output multipliers for government tax and transfer payments are smaller than those for government purchases of goods.

3.7 Production versus Sales

According to the production equation in the US model, production is smoothed relative to sales [MM, 3.6.4]. The buffer between production and sales is inventory investment. The lagged stock of inventories is in the production equation with a negative coefficient. As inventories get built up, this is a drag on future production as firms try to draw down inventories. Changes in inventories are quantitatively important in the short run.

Point 10: Production is smoothed relative to sales.

3.8 Labor Demand

An empirical result that goes back to my dissertation in 1969 is that firms at times hold excess labor. At times the actual number of hours worked per worker is less than the observed number of hours paid for. Observed labor productivity is thus endogenous. It falls in recessions as output falls more than hours paid for, and it rises in expansions as output rises more than hours paid for (as firms decrease excess labor). This effect is picked up for the United States and 14 other countries [MM, 3.6.4, 3.7.2]. Labor demand depends positively on output and negatively on the amount of excess labor on hand. The endogeneity of labor productivity has important implications for research that takes productivity shocks as exogenous. They are not, at least in the short run.

Point 11: Firms at times hold excess labor, and so short run labor productivity is endogenous.

3.9 Labor Supply

The labor force participation equations in the US model include as explanatory variables an after-tax aggregate wage rate, lagged household wealth (negative effect), and the unemployment rate to account for discouraged worker effects [MM, 3.6.3]. There is a similar equation explaining the number of people holding more than one job (moonlighters). The number of moonlighters increases as the economy expands. The number of moonlighters is the difference between employment (jobs) from the establishment survey and the number of people employed from the household survey. The key result here from a business cycle perspective is that the labor force increases as the economy expands, as does the number of people holding more than one job.

Point 12: Discouraged workers move into the labor force as the economy expands, and the number of people holding more than one job increases.

3.10 Unemployment

Unemployment by definition is equal to the number of people in the labor force minus the number of people employed. Unemployment is the buffer between the labor force and employment. The demand for jobs depends on output and excess labor on hand.[9] As just noted, some people hold more than one job. The number of people employed equals the number of jobs minus the number holding more than one job. The number of people in the labor force depends on wage rates, wealth, and the unemployment rate (to pick up discourage worker effects).

Note that no markets are really "cleared" in model like the US model. There are price and wage rate equations, and the whole model is solved using these equations are all the others. The price level does not equate production and sales, and the change in inventories is the buffer. The wage rate does not equate the labor force and labor demand, and the change in unemployment is the buffer. In old fashioned terminology, one might say that inventories and unemployment are accounting for "disequilibrium" effects.

Point 13: Unemployment is the buffer between the labor force and employment.

3.11 Okun's Law

Okun's law, which is, of course, not really a law, says that, say, a one percent increase in output corresponds to a less than one percentage point decrease in the unemployment rate. There are three "leakages" between output and the unemployment rate that explain this, which are captured in the US model. First, in the short run a one percent increase in output corresponds to a less than one percent increase in jobs in the labor demand equation. The buffer is excess labor. Second, some of the increase in jobs is taken by people already employed, and so the number of people employed increases by less than the number of jobs. Third, some previously discourage workers move back into the labor force, which, other things being equal, has a positive effect on the unemployment rate.

Point 14: Okun's Law reflects short run features of labor demand, moonlighter supply, and labor force participation.

[9] I have been unable in my work to find significant wage rate effects on the aggregate demand for labor. This may be my fault, and it is an area for further research.

3.12 Investment Demand

It is common in DSGE models to aggregate housing and plant and equipment investment (residential and nonresidential fixed investment). This is problematic because the agents are different—households for housing investment and firms for plant and equipment investment. It is not realistic to assume that housing investment is determined by firms, as many DSGE models do. Housing investment is determined in the US model by an estimated household expenditure equation, as discussed above.

There is also an equation in the US model determining plant and equipment investment. The results of this work suggest that firms at times hold excess capital, just like they do excess labor. Investment demand in the US model depends on output, the amount of excess capital on hand, and cost of capital variables [MM, 3.6.4]. Capital productivity is thus endogenous.

Point 15: Firms at time hold excess capital, and so short run capital productivity is endogenous.

3.13 Physical Stock Effects

Physical stock effects are common in SEMs. If, say, the stock of durable goods is high in the previous period, this is likely to have a negative effect on durable expenditures in the current period. There are four key physical stock variables in the US model: the stock of durable goods, housing, capital, and inventories [MM, 3.6.11]. These stocks change over time due to new investment (or production) and depreciation. The fact that lagged stocks negatively affect current expenditures (or production) leads to some fluctuations in the economy. This is another reason against aggregating housing and plant and equipment investment. The stock of housing affects housing investment, and the stock of capital affects plant and equipment investment.

Point 16: Some economic fluctuations are due to changes in physical stocks of durable goods, housing, plant and equipment, and inventories.

4 Macro Events

4.1 Stagflation in the 1970s

As noted in Section 3.4, price shocks have a negative effect on output. The 1970s was a time of large OPEC oil price increases. Figure 1 is illuminating, which plots the U.S. import price deflator for 1952:1–2017:4. The big picture is simple: flat before 1970, large increases in the 1970s, roughly flat again until 2002, and somewhat rising after that. Other countries had similar experiences. Most of the increases in the 1970s were due to increases in oil prices. This led to increases in domestic prices, since the price of imports has a positive effect on domestic prices for most countries (Section 3.3 above). There was also an increase in interest rates in the 1970s as the monetary authorities reacted against inflation, which negatively affected output. But the main culprit is the increase in oil prices. It is likely that output would have fallen even if interest rates had not risen.

Point 17: Stagflation in the 1970s was triggered by oil price increases.

4.2 Output Fluctuations since 1995 due to Wealth Fluctuations

Figure 2 plots real household financial and housing wealth for 1980:1–2017:4. This figure explains a lot about the U.S. economy since 1995. Much of the boom in the economy for 1995:1–1999:4 is explained by the large increase in household wealth (in this case mostly financial wealth from the stock market boom) [MM, 5.3]. Much of the post boom slowdown for 2000:4–2004:3 is explained by the fall in wealth [MM, 5.4]. As discussed above, much of the 2008–2009 recession is explained by the fall in wealth, in this case both financial and housing wealth [MM, 5.7]. One does not need interest rate spreads, credit restrictions, and the like

Figure 1
U.S. Import Price Deflator: 1952:1-2017:4
1.0 in 2009

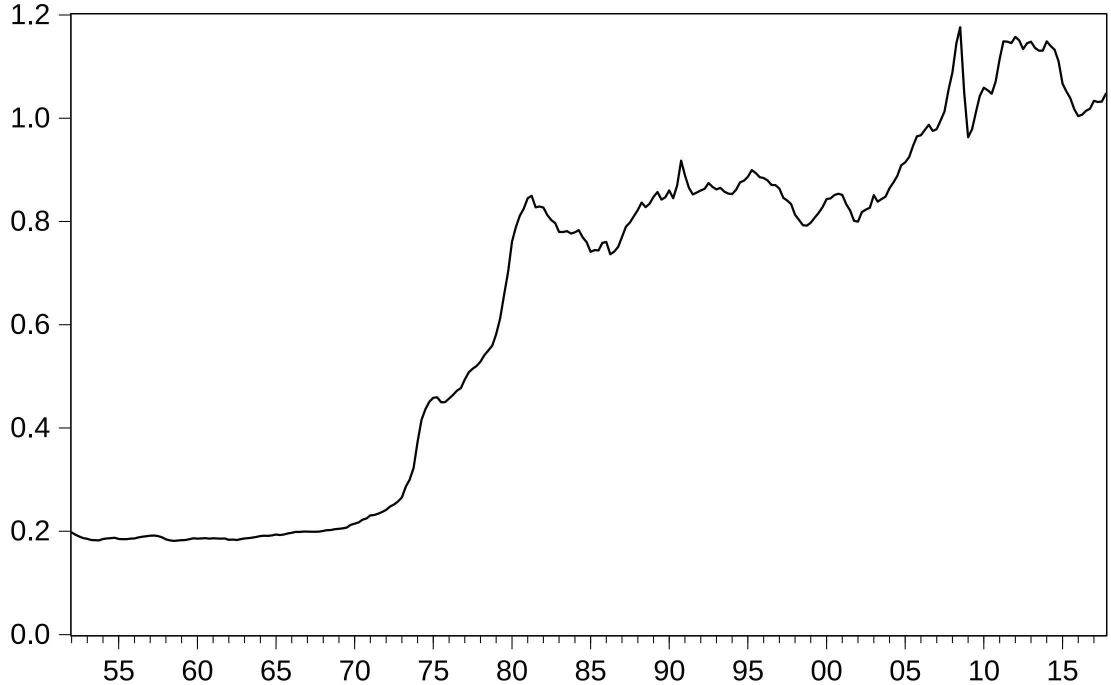
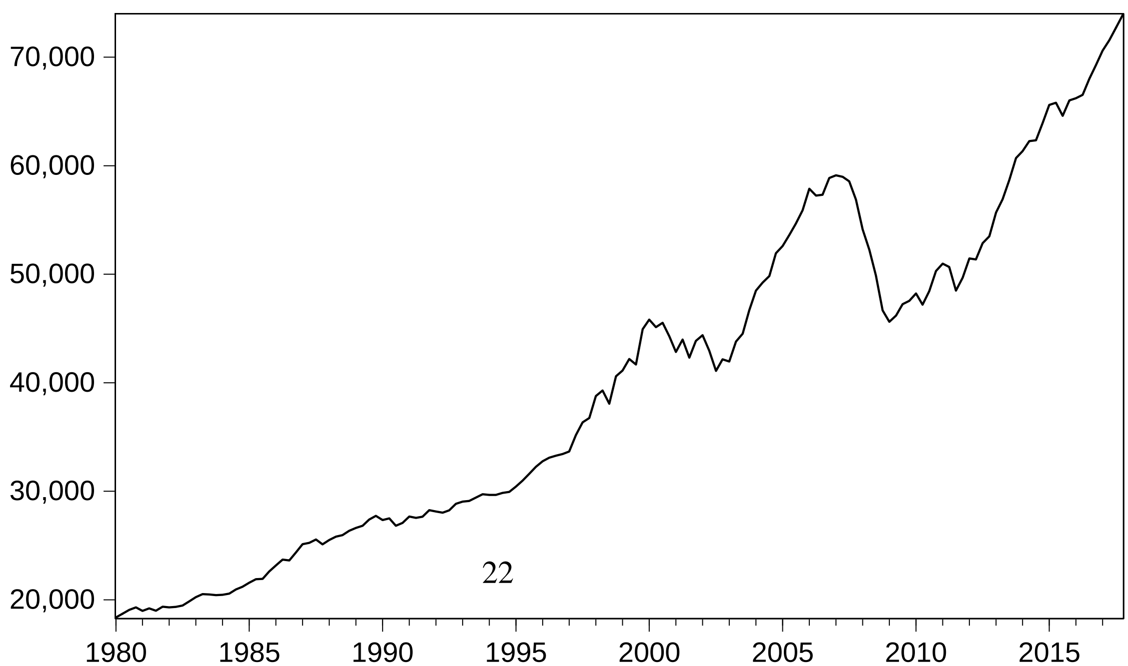


Figure 2
U.S. Real Household Wealth: 1980:1-2017:4
Millions of 2009 Dollars



to explain the recession—the fall in wealth is sufficient. Interest rate spreads are negatively correlated with the change in wealth since both are driven by unpredictable financial shocks, but my results at least suggest that the change in wealth dominates interest rate spreads (all lagged one quarter) as explanatory variables in consumer expenditure equations (Section 3.1 above).

Point 18: Much of the fluctuation in the U.S. economy since 1995 can be attributed to fluctuations in household wealth.

4.3 Slow U.S. Recovery: 2010–2017

Figure 2 shows that wealth grew rapidly from 2010 through 2017. Why then was the recovery slow in this period? The explanation is sluggish government spending—federal government purchases of goods, federal transfer payments to households, and state and local government purchases of goods [MM, 5.8]. This is an example in which it is important to take into account government fiscal policy. It is not realistic to postulate, say, an autoregressive process for government spending, as many DSGE models do.

Point 19: Much of the slow U.S. recovery between 2010 and 2017 can be attributed to sluggish government spending.

5 Conclusion

The above points are based on the use of aggregate data from 1952 on for both the United States and other countries. The structural equations in the MC model are all estimated, usually using 2SLS. The results are only approximate for many reasons. Some of the equations may have missing or wrong explanatory variables, have the wrong functional form, or be misspecified because of a changing structure. And with aggregate data the best one can hope for are good aggregate approximations. The MC model can surely be improved by more work. But given all these caveats, I would argue that the points convey useful information about how the macro economy works.

As noted at the end of Section 2, some of the points are outside the scope of most DSGE models at the moment. The models are simply not general enough. This may change with more research on the models. But it is clear that some of the points are not consistent with the current structure of DSGE models. These include the dynamics of price equations, the dominance of nominal over real interest rates in consumption equations, the contractionary effects of positive price shocks on output even if the nominal interest rate is held fixed, the existence of excess labor and capital, and the existence of discouraged worker effects. These points have empirical support, in some cases based on data across a number of countries. To account for them will require major changes in the DSGE methodology, perhaps, as some argue, so major as to lead to an end to the methodology. On the other hand, if the methodology is to continue, it would be desirable, as Wren-Lewis (2018) and Blanchard (2018) argue, for the profession to be more open to alternative approaches.

6 Comments Regarding "Where Next" in Macro

Financial Frictions

Household wealth effects appear to be quite important: Points 1 and 18. Financial frictions do not appear to add much: Section 3.1.

Relaxing Rational Expectations

This is a good idea. My experience is that the assumption of adaptive expectations works well in most cases, although there is clearly need for more research.

Heterogeneous Agents

As discussed in Section 2, adding heterogeneous agents does not see promising in macro given its use of aggregate data. We can't do what Orcutt proposed. We just have to live with summing everyone up and hoping for the best.

Improving Micro Foundations

This is also a good idea. Behind each stochastic equation specified in a SEM is some theory—the theory being used to guide the choice of right hand side variables. Improved theory may lead to better choices.

7 Appendix: Outline of a SEM

Table 1
SEM Model Outline

Household Sector: LHS variable in a stochastic equation	
C_{h1}	service consumption expenditures
C_{h2}	nondurable consumption expenditures
C_{h3}	durable consumption expenditures
I_h	housing investment expenditures
L_{h1}	labor force, males 25-54
L_{h2}	labor force, females 25-54
L_{h3}	labor force, all others 16+
L_{h4}	number of moonlighters
Firm Sector: LHS variable in a stochastic equation	
I_{f1}	plant and equipment investment expenditures
Y_f	production—value added (conditional on sales)
J_f	jobs
H_f	hours per job
P_f	price level
W_f	wage rate
Financial: LHS variable in a stochastic equation	
r	short term interest rate
R	long term interest rate
Foreign: LHS variable in a stochastic equation	
M	imports
Government Sector: Exogenous variables	
C_g	consumption expenditures
I_g	investment expenditures
Y_g	government output—value added
J_g	government
Foreign: Exogenous variable	
X	exports

Table 1 (continued)

Identities	
S_f	Firm sales
	$S_f = C_{h1} + C_{h1} + C_{h2} + C_{h2} + I_h + I_{f1} + C_g + I_g$
	$+X - M - Y_g$
I_{f2}	Firm inventory investment
	$I_{f2} = Y_f - S_f$
Y	GDP
	$Y = Y_f + Y_g$
PR_f	Firm labor productivity
	$PR_f = Y_f/(J_f \cdot H_f)$
WR_f	Firm real wage rate
	$WR_f = W_f/P_f$
E	Total employment
	$E = J_f + J_g - L_{h4}$
U	Unemployment
	$U = L_{h1} + L_{h2} + L_{h3} - E$
UR	Unemployment rate
	$UR = U/(L_{h1} + L_{h2} + L_{h3})$
Stocks:	determined by identities
	Stock of durable goods
	Stock of housing
	Stock of capital
	Stock of inventories
Price deflators for:	
	C_{h1}
	C_{h2}
	C_{h3}
	I_h
	I_{f1}
	M
	X

Table 1 (continued)

Income side—mostly identities	
	Wages: wage rates, hours worked
	Interest: r and R
	Dividends
	Profits
	Taxes: tax rates, taxable income
	Transfer payments
	Financial saving of each sector
Change in financial assets of the household sector =	
	financial saving plus capital gains or losses on stocks
Change in financial assets of the government sector =	
	financial saving plus change in some monetary items
Total wealth of the household sector =	
	financial wealth plus housing wealth

Table 2
Possible Explanatory Variables Excluding Lagged Dependent Variables

C_{h1},C_{h2},C_{h3},I_h: household expenditure variables
disposable income, lagged wealth, interest rates, age variables, lagged stocks for durables and housing expenditures
L_{h1},L_{h2},L_{h3},L_{h4}: household labor supply variables
real wage rate, lagged wealth, unemployment rate
I_{f1}: plant and equipment investment
output, excess capital lagged, interest rates
Y_f: production
sales, inventory stock lagged
J_f: jobs
output, excess labor lagged
H_f: hours per job
output, excess labor lagged
P_f: firm sector price deflator
wage rate, import price deflator, unemployment rate
W_f: firm sector wage rate
productivity, price deflator
r: estimated Fed rule
inflation, unemployment rate
R: long term interest rate
lagged values of r
M: imports
disposable income, lagged wealth, relative price of imports

Table 1 outlines a SEM model—essentially a scaled down version of my US model. It lists what I think is important to model to capture the whole economy. For the household sector there are four categories of expenditures that behave differently and should be modeled separately: expenditures on services, nondurable goods, durable goods, and housing. There are four labor supply variables that should be modeled separately: the labor force of males 25-54, females 25-54, all others 16+, and the number of moonlighters—people holding more than one job.

These are variables for which equations are specified and estimated, where theory is used to guide the choice of right hand side variables and a consistent estimation method is used. Some of the right hand side variables that I have used in the US model are discussed in the text. These eight equations are the main estimated decision equations of the household sector.

The decision variables of the firm sector are: plant and equipment investment, production, jobs, hours per job, its price level, and its wage rate. As with the household variables, these are variables for which equations are specified and estimated, using theory as a guide—the estimated decision equations of the firm sector. Again, some of the right hand side variables in the US model are discussed in the text.

The next two variables are a short term interest rate (r) and a long term interest rate (R). Possibilities of estimated equations for these two variables, which are in the US model, are an estimated rule of the Fed for r and an estimated term structure of interest rate equation for R. The level of imports is the last variable listed in the table for which an estimated equation is needed.

Four exogenous government variables are listed in the table: consumption, investment, output (value added), and jobs. Government output is compensation of employees. In practice there are a number of other exogenous government variables. Also, in models of the United States the government is usually disaggregated into state and local government and federal government.

The level of exports is also listed as exogenous in the table, although in a multicountry model like my MC model it is endogenous, determined by other countries' imports.

Eight identities are listed in the table. The first determines the total level of sales of the firm sector. It is the sum of consumption, investment, and exports less imports and government output. Imports are not sales of the firm sector, and the level of imports is subtracted because it is in consumption and investment. Government output (compensation of government employees) is also not sales of the firm sector. It is subtracted because it is in government consumption and investment. The next identity determines inventory investment. The firm sector's production is determined by an estimated equation, and so inventory investment is by definition the difference between production and sales. The next two identities define labor productivity and the real wage rate of the firm sector. GDP is the sum of firm and government output.

The last three identities pertain to the labor market. Total employment is the sum of the number of jobs in the firm and government sectors minus the number of people holding more than one job, L_{h4}. L_{h4} is a decision variable of the household sector. The number of people unemployed is equal to the labor force minus employment. The unemployment rate is unemployment divided by the labor force.

In this level of disaggregation there are four stock variables: stocks of durable goods, housing, capital, and inventories. These variables are discussed in Section 3.13. They are endogenous and determined by identities. The capital stock at the end of the period is equal to the capital stock at the beginning of the period plus investment minus depreciation. "Investment" in the case of durable goods is durable goods expenditures. These equations need estimates of depreciation, usually a depreciation rate times the value of capital lagged once. For the stock of inventories there is no depreciation. Lagged stocks are important explanatory variables in a number of the stochastic equations in the US model.

The next part of the table lists the various price deflators that are needed in the model. One possibility is to have each price deflator except the price of imports be a function of the price determined by the price equation of the firm sector, so everything runs off of P_f. In the US model these functions are taken to be exogenous, but this does not have to be the case if one has a theory of the determination of relative prices in the macro setup. The price of imports has to be taken to be exogenous in a domestic model, but in a multicountry model it is endogenous, depending on exchange rates and the prices of other countries' exports.

The next part of the table outlines very briefly the income side of a model. Things get messy very fast, and there are many identities. As noted in the text, in the US model the National Income and Product accounts and the Flow of Funds accounts are linked, where each sector's expense is some other sector's revenue. All flows of funds among the sectors are accounted for.[10] Some of the income-side variables are explanatory variables in the estimated equations. For example, tax rates and transfer payments affect disposable personal income, which is an explanatory variable in the household expenditure equations in the US model. This is a channel by which fiscal policy affects aggregate demand.

Saving flows are used in the determination of net financial wealth. The table lists the equations for the household sector and the government sector. The change in net financial wealth of the household sector, which is net financial wealth at the end of the period minus net financial wealth at the beginning of the period, is equal to financial saving plus capital gains or losses on stocks held by the household sector. For the government the change in net financial wealth is equal to government financial saving plus changes in a few monetary items. Government financial saving is, of course, almost always negative, and its net financial wealth is negative (the government debt).

The total wealth of the household sector, which plays a large role in the US model as discussed in the text, is the sum of household financial wealth and household housing wealth.

The main work in construction a SEM is specifying and estimating the stochastic equations—what to take as LHS variables and as explanatory variables. Specifications will differ depending on what theories are used, including theories about how expectations are formed. In Table 2 I have listed some of the explanatory variables in the US model, excluding possible lagged dependent variables. The theory behind these choices is in [MM, 3.1].

[10] In the US model there are six sectors: household, firm, financial, state and local government, federal government, and foreign.

For the household expenditure equations the explanatory variables are disposable income, lagged wealth, interest rates, and age variables. The age variables pick up age distribution effects. The lagged stock of durable goods is in the durable expenditure equation, and the lagged stock of housing is in the housing investment equation. The importance of lagged wealth has been discussed in the text. For the household labor supply equations the explanatory variables are the real wage rate, lagged wealth, and the unemployment rate. Lagged wealth has a negative effect on labor supply—negative income effect. The unemployment rate has a negative effect and is picking up discouraged worker effects. Household labor supply has been disaggregated into males 25-54, females 25-54, and all others 16+ because these variables have behaved quite differently in the sample period—beginning in 1954:1.

The next six equations are firm sector equations. Plant and equipment investment depends on output, lagged excess capital, and interest rates. Production depends on sales and the lagged stock of inventories. The demand for jobs and hours per job depend on output and lagged excess labor. In the price and wage rate equations, price depends on the wage rate, the import price deflator, and the unemployment rate. The wage rate and import price deflator are cost variables, and the unemployment rate is the demand variable. Clearly other measures of slack in the economy could be used. The wage rate depends on productivity and the price.

The equation for r is the estimated Fed rule. It depends on inflation and the unemployment rate. The equation for R is a term structure of interest rate equation, where R depends on lagged values of r. Finally, imports depends on disposable income, lagged wealth, and the price of imports relative to the domestic price level.

Many details have been omitted from this outline, but it presents what I think are the main macro variables to model to try to capture the whole economy. As just noted, the main work is in choosing the explanatory variables, which depends on the theory used. Theory is also important in specifying functional forms. For example, should the price and wage rate equations of the firm sector be specified in log levels or changes? The choice of LHS variables is also important. For example, it does not seem sensible to take the sum of housing investment and plant and equipment investment as a LHS variable, since one is a decision variable of the household sector and the other of the firm sector. Another issue that is important, although tedious, is to capture through identities all the flow-of-funds links among the sectors and the identities that pertain to the relationship between stocks and flows. Finally, most of the stochastic equations are in real terms, whereas the income side is nominal. Various price deflators are needed in moving from nominal to real values.

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