A 33 Equation Econometric Model Of The U.S. Economy

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ABSTRACT

The model contains 22 behavioral equations and 11 identities connecting them into an integrated model of the real U.S. economy. Behavioral equations were generally estimated applying strong instrument 2SLS to 1960-2010 data. The model includes equations for 7 components of consumption, 7 components of investment, two prime interest rate determination models based on the Taylor rule or the Keynesian LM curve, 1 export function, 2 "IS" curve functions determining GDP. In addition, behavioral models for taxes, unemployment and inflation are included. Eleven identities connect the various parts. Identification issues are resolved, and model results are robust to different time periods.

1.0 INTRODUCTION

The purposes of a large scale econometric model of the macroeconomy are to explain what *science* has to say about what makes the economy tick, rather than rely on what deductive reasoning from (what are assumed to be self evident truths (philosophy) has to say about the economy.

Second, their purpose is also to do so in a theoretically integrated manner: only relationships taken from the total set of equations hypothesized to drive the economy, and the interaction of its parts, are tested.

Finally, large scale models only *structural* equations. This ensures that only economically sensible variables are used to explain variance: no "VAR" - type lags, trend variables, etc., are used, i.e., no variables that explain variance, but are devoid of economic meaning. Occasionally autocorrelation control variables are used to explain otherwise unexplainable drift of variables over time. This helps ensure the accuracy of other coefficients in the regression model. They are used only as "place markers' to highlight areas where further work is needed to develop economic theory that explains the currently unexplained variance that (statistically useful, but non-economic) autocorrelation variables explain.

2.0 Component Parts Of The Macroeconomics Model: 22 Behavioral Equations, 11 Identities

2.1. The 22 Behavioral Equations, Econometrically Estimated:

1. C_T = Consumer Goods & Services -Total Domestically Produced & Imported
2. C_D = Consumer Goods & Services -Total Domestically Produced
3. C_I = Consumer Goods & Services -Total Imported
4. C_{Dur} = Consumer Goods & Services -Total Durable Goods
5. C_{ND} = Consumer Goods & Services -Total Non-Durable Goods

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6. C_S = Consumer Goods & Services -Total Services
7. C_{BOR} = Consumer Goods & Services -Total Consumer Borrowing
8. I_T = Investment Goods & Services -Total Domestically Produced & Imported
9. I_D = Investment Goods & Services -Total Domestically Produced
10. I_M = Investment Goods & Services -Total Imported
11. $I_{P\&E}$ = Investment Goods & Services -Total Durable Goods
12. I_{RES} = Investment Goods & Services -Total Non-Durable Goods
13. I_{INV} = Investment Goods & Services -Total Services
14. I_{BOR} = Investment Goods & Services -Total Business Borrowing
15. X = Demand for Exports
16. PR_T= Taylor Rule Interest Rate Determination Model
17. PR_{LM}= Keynesian LM Theory Interest Rate Determination Model
18. $UNEM_o$ = Okun Unemployment Determination Model
19. $UNEM_T$ = Tech. Progress Unemployment Determination Model
20. INFL = Phillips Curve Model of Determinants of Inflation
21. GDP = f(Determinants of C, I, plus G, X-M)
22. GDP = f(Determinants of C_D, I_D, plus G, X)

2.2. The 11 Identity Equations

1. $Y = C_T + I_T + G_T + NX$
2. $Y = C_D + I_D + G_D + X$
3. $C_T = C_D + C_M$
4. $C_T = C_{DUR} + C_{ND} + C_S$
5. $I_T = I_D = I_M$
6. $I_T = I_{P\&E} + I_H + I_{INV}$
7. $M_T = M_C + M_I$ = Total Imports of Consumer and Capital Goods
9. M_I = Imports of Capital Equipment and Industrial Supplies and Materials
10. NX = (X-M)
11. (M2 - M1) = Savings Components of M2

3.0. LITERATURE REVIEW: PREVIOUS LARGE SCALE ECONOMETRIC MODELS

- L. Klein & M. Evans (1968) *The Wharton Econometric Forecasting Model*
- O. Eckstein (1983) *The DRI Model of the U.S. Economy*
- R. Fair (2004) *Estimating How The Macroeconomy Works*

- J. Heim – (2008-2009) Various Papers
    - "What Determines Market Demand for Investment Goods?"
    - "U.S. Demand for different Types of Imported and Domestic Investment Goods"
    - "Consumer Demand for Durable Goods, Nondurable Goods and Services".

3.1. HOW THIS MODEL IMPROVES ON PAST WORK

- No Trend Variables Used As Explanatory Variables
- No Past Values Of The Dependent Variable Used As Explanatory Variables
- Better Scientific Methods: More Up To Date Econometric Techniques Used To Ensure No
    - Stationarity Issues
    - Identification Issues (Endogeneity)
    - Minimize Multicollinearity And Serial Correlation Issues
- Once Fully Estimated, Model Should Be Reliable For Estimating Well Beyond The Sample Period
    - (Previous, But Similar Model Estimated Using 1960-2000 Data Explained 2001-2010 GDP With Average Error Of ½ Of 1%)

4.0 SUMMARY OF METHODOLOGY USED

- Data: Taken from: Economic Report of the President 2011, Flow of Funds Accounts 2011
- Spending and Borrowing Models: Same Determinants Assumed
- "Standard Models" Used: Test All Variables Commonly Cited As Determinants of Consumption or Investment.
- Lags: Chose the lags most systematically related to the dependent variable, if theory says the variable should be included.
- 2SLS: Used to eliminate simultaneous equations bias caused by identification problems arising from endogeneity.
- Tests:
    - Hausman endogeneity tests were used to determine what needed to be instumented.
    - Wald weak instrument tests were used to ensure the instrument was a reasonable proxy for the variable it replaced.
    - Sargan "Valid Instrument" tests were used to ensure the the instrument was free of any endogeneity with the dependent variable.

Data were tested in first differences, not levels to address nonstationarity, serial correlation and multicollinearity issues. All passed augmented Dickey-Fuller Unit Root tests, except 3, which were cointegrated with the dependent variables they were used with, so nonstationarity was not a problem. Multicollinearity was reduced by approximately half, and first differencing raised almost all Durbin Watson test results considerably, markedly reducing or eliminating most serial correlation problems.

Newey West standard errors were used to correct for heteroskedasticity.

IS Curve Method was used to incorporate all the relevant equations inn the model into one to explain changes in the GDP.

5.0. SUMMARY AND CONCLUSIONS: 6.0 DETAILED REGRESSION TEST FINDINGS FOR FOUR KEY EQUATIONS IN THE MODEL

5.1 FINDINGS: IS THE PRIME INTEREST RATE DETERMINED BY THE TAYLOR RULE?

ΔPR_{REAL} = .47 Δ INFL -1.22 Δ UNEM – 1.49 Δ $M1_{REAL}$ + .00 Δ TAXES +.00 Δ Govt. Spend + AR(1)

(t=) (3.9) (-3.6) (-2.1) (0.1) (0.8) (2.1) (Eq.6.1)

R^2 =.68; DW 1.8

Note: Taxes and Government spending included because government deficit traditionally has been thought to affect the economy by raising interest rates, reducing investment. Clearly they do not seem to affect the prime rate, the economy's most important rate, at all.

5.2. THE CONSUMPTION FUNCTION (TOTAL DOMESTICALLY PRODUCED AND IMPORTED CONSUMER GOODS)

OLS Standard Consumer Spending Model, With Borrowing Included as a Determinant of Consumer Spending. (No variable found endogenous, so no 2SLS Models)

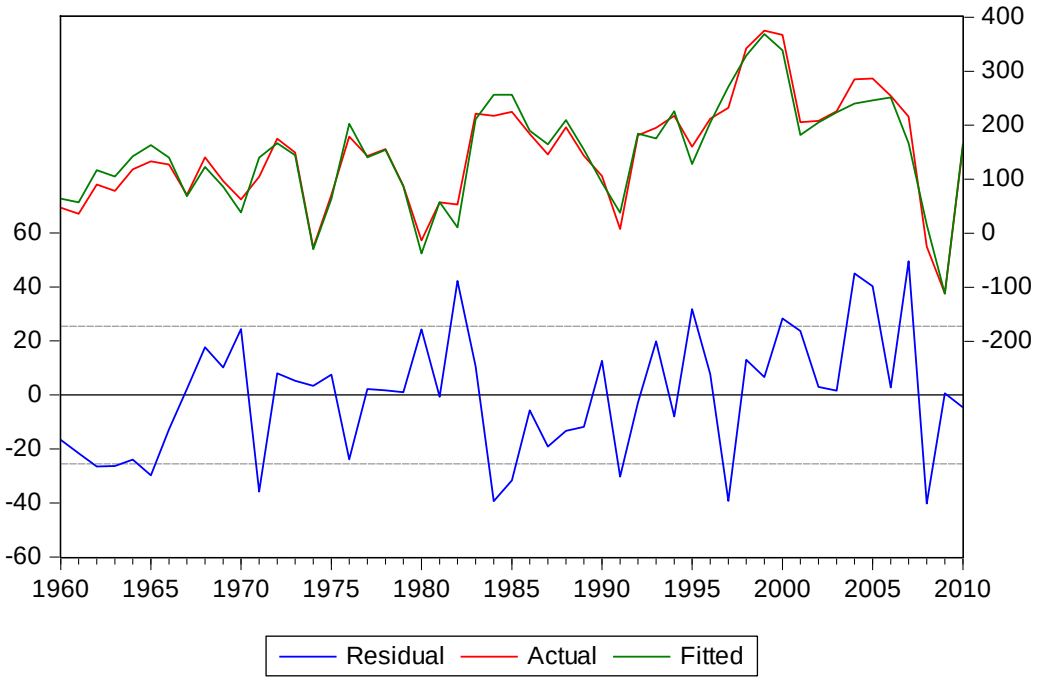
ΔC_T =.39Δ(Y-T_T) **+.51Δ(T_T) -.31Δ($G_{T\&I}$)** -10.92ΔPR +.34 ΔDJ_{-2} +3.59 ΔXR_{AV} +543.50ΔPOP_{16} -.034ΔPOP +.64ΔICC_{-1} +1.40Δ$M2_{AV}$ + **.17 ΔC_{B2}**

R^2=94.8% D.W.=1.7 MSE=25.49 (Eq. 6.2)

The explanatory power of this model is substantial. Comparisons of actual consumption 1960 -2010 and levels expected, based on the model are shown in Graph 6.2. below.

Tests for endogeneity did not find any variables endogenous with consumer spending at statistically significant levels, so no instrument development or 2SLS testing for the model was needed.

Graph 5.2.1 Actual Consumption Demand Compared To Demand Explained By The Model



5.3. DETERMINANTS OF INVESTMENT SPENDING AND BORROWING

2SLS Estimates of Determinants of Investment Spending, Using No Business Cycle Control Variable. Hausman Tests Indicate 4 Variables Endogenous With Investment Spending, So Instrumented: ACC (Wald test F= 11.5), DJ_0 (Wald F= 11.8), $PROF_0$ (Wald Test F= 6.0, but DJ_{-2} t=3.9) and POP (Wald F=13.1). Sargan Test $NR^2=4.0 < X^2_{(95,14)} = 23.7$. Hence, This is a Strong Instrument Model.

ΔI_T = +.36Δ(ACC)**+.21Δ(T_T) -.45Δ($G_{T\&I}$)** + .86ΔDEP + 5.91ΔCAP_{-1} -.23ΔPR_{-2} + .07ΔDJ_{-0} +.26Δ$PROF_{-0}$+6.95ΔXR_{AV} +.01ΔPOP + **.09 Δ(BOR_{-1})**

R^2=92.6% D.W.=2.1 MSE=34.51 (Eq. 6.3)

The explanatory power of this model is substantial. Comparisons of actual consumption 1960 -2010 and levels expected, based on the model are shown in Graph 6.3. below.

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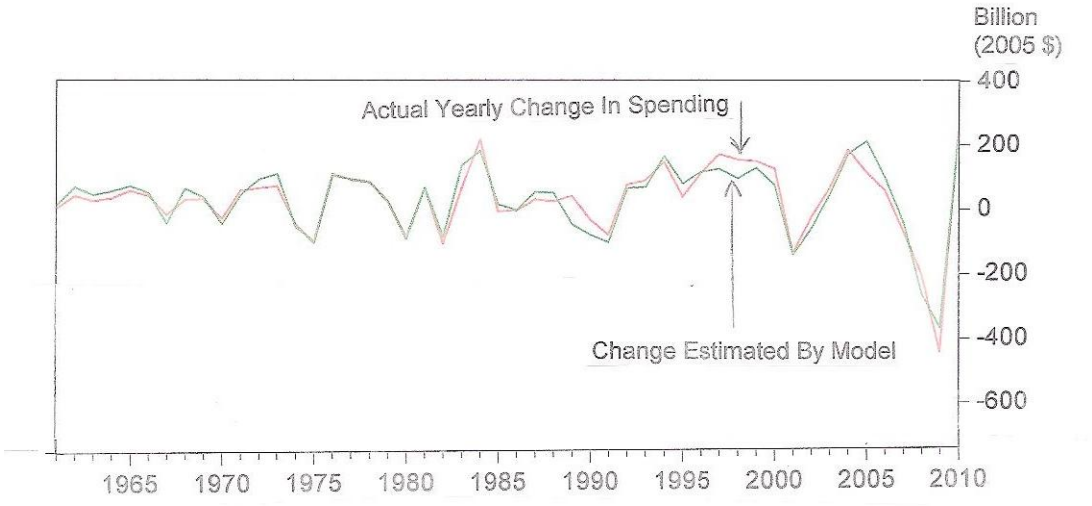
Graph 6.3.1 Actual Investment Demand Compared To Demand Explained By The Model



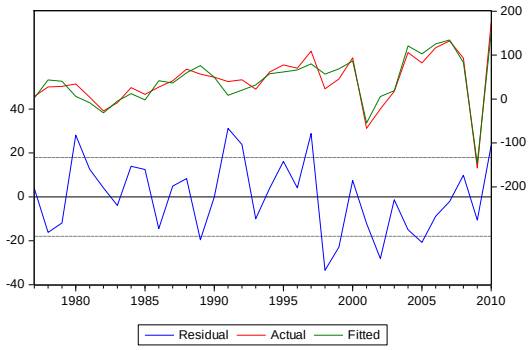
5.4. Export Demand Model

$\Delta X = 3.00E\text{-}138\ \Delta(ACC^{40}) + 2.47E\text{-}68\ \Delta(\ (TWAv_{0\ to\ -3}.For.Inc^{20})\ -7.82\ \Delta(XR_{AV0\ to\ -3}) + .59\ \Delta(M_T) + 5.14\ \Delta(PR_{RealAV\ -1\ to\ -2}) - 3.57\ \Delta INFL_{AV\text{-}1\ to\ -2})$

$R^2 = 92.6\%$; DW = 2.1 (Eq. 6.4)

The explanatory power of this model is also substantial. Comparisons of actual consumption 1960 -2010 and levels expected, based on the model are shown in Graph 6.4. below.

Graph 6.4. Actual Export Demand Compared To Demand Explained By The Model



7.0. CONCLUSIONS

Modern, large scale econometric models have what only can be described as extraordinary explanatory power. Though the 33 equation model above, estimated using 1960 -2010 data, cannot be tested (yet) to see if it explains behavior far outside the sample period, we expect it can. As noted in the introduction, the same model, re-estimated using only data up to 2000, explained yearly changes in GDP beyond 2000 with an average error of only 1/3 of 1% each year for the 10 year period 2001 - 2010. We attribute the success of the model to the huge improvements in econometric methodology made since the early models of the 1960's, and to exhaustive efforts to ensure each equation is based on good economic theory, testing contains all variables cited in the historic literature (and no others, including trend variables and lagged values of dependent variables, which explain variance, but for which there is no economic rationale).

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