Validating a detailed, dynamic CGE model of the U.S.: progress report*

by

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Abstract

For many years we have been using computable general equilibrium models in Australia and the U.S. to generate detailed forecasts of output growth for commodities/industries. Our main objective is to provide realistic basecases from which to calculate the effects of policy changes. In this paper, we have started assessing our forecasting method. Using data available up to 1998, we apply the method with the USAGE model to generate "genuine forecasts" for 500 U.S. commodities/industries for the period 1998 to 2005. We then compare these forecasts with actual outcomes.

1. Introduction

Perhaps the most common reaction of policy makers/advisors when confronted with results from a detailed computable general equilibrium (CGE) model is: "how do I know these results are accurate?" This is a difficult question to answer. So far, the best answers that CGE modelers have been able to provide are in the form of back-of-the-envelope justifications. However, what is really needed is a statistical demonstration that CGE models can produce usefully accurate predictions of:

(1) changes in the commodity/industrial composition of economic activity under business-as-usual assumptions; and

(2) the effects on macro and industry variables of changes in trade and other policies.

In the context of (1), by "usefully accurate" we mean predictions that are better than those obtained by simple trends. In the context of (2), we mean predictions that are better than those obtained by surveys of opinions of industry experts. This paper describes work on issue (1).

We conduct historical simulations for 1992 to 1998 and 1998 to 2005 with a 500 commodity/industry version of the USAGE model of the U.S.[1] The historical simulations reveal movements in industry technologies, household preferences and demand and supply conditions for U.S. exports and imports.

Next we describe a method for creating benchmark or business-as-usual forecasts. The method uses extrapolations of results for industry technologies, household preferences and international demand and supply conditions revealed in historical simulations together with macro and energy predictions from several U.S. government agencies.

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* We thank Bob Koopman for his encouragement and patience with this project.

[1] USAGE is a dynamic CGE model developed at the Centre of Policy Studies, Monash University, in collaboration with the U.S. International Trade Commission. The theoretical structure of USAGE is similar to that of the MONASH model of Australia (Dixon and Rimmer, 2002). However, in both its theoretical and empirical detail, USAGE goes beyond MONASH. Prominent applications of USAGE by the U.S. International Trade Commission include USITC (2004 and 2007).

We test our forecasting method statistically by using it to produce “forecasts” for 1998 to 2005 taking as inputs results from the 1992 to 1998 historical simulation and macro and energy forecasts that were available in 1998. Results from this 1998 to 2005 forecast for outputs by 500 commodities are compared with actual outcomes for the period.

Having made a pure forecast for 1998 to 2005 (that is one using only information available up to 1998) we then conduct a series of forecast simulations in which we successively introduce the ‘truth’ for the movements in different groups of exogenous variables. We start by introducing the actual movements in macro and energy variables (that is we replace the forecast movements with the actual movements). Then we replace forecast movements in trade variables with actual movements. Next we replace forecast movements in technology and preference variables with actual movements. Finally, we set all remaining exogenous variables in the forecast simulation at their actual values. This final simulation must necessarily reproduce actual movements for all variables. The aim of the successive simulations is to start the assessment of the importance of different exogenous factors in determining the accuracy of forecasts for outputs by commodity.

The remainder of this paper is organized as follows. Sections 2 and 3 describe our forecasting method and its application in creating forecasts for 1998 to 2005 using only data available up to 1998. Section 4 contains results from the comparison of the forecasts for 1998 to 2005 with the outcomes for this period. Concluding remarks are in section 5.

2. Forecasting with the USAGE model: methodology

In common with the MONASH model of Australia (Dixon and Rimmer, 2002), USAGE is designed for four modes of analysis:

Historical, where we estimate changes in technology, consumer preferences, positions of foreign demand curves for U.S. products and numerous other naturally exogenous trade variables;

Decomposition, where we explain periods of economic history in terms of driving factors such as changes in technology, consumer preferences and trade variables;

Forecast, where we derive basecase forecasts for industries, occupations and regions that are consistent with trends from historical simulations and with available expert opinions; and

Policy, where we derive deviations from basecase forecast paths caused by assumed policies.

The focus of this paper is forecasting. However, historical analysis is also relevant because of its role in providing trends for use in forecast simulations.

2.1. Historical simulations

We have completed historical simulations for 1992 to 1998 and 1998 to 2005. These simulations quantify changes in consumer preferences and in several aspects of technologies used in U.S. industries including: intermediate-input-saving technical change; primary-factor-saving technical change; labor-capital bias in technical change; and import-domestic bias in technical change. They also quantify shifts in foreign demand curves for U.S. exports, foreign supply curves for U.S. imports and several other naturally exogenous international variables mainly concerning foreign assets and liabilities.

In an historical simulation for a particular period, we introduce as much information as possible on movements over the period in prices and quantities for consumption, exports, imports and government spending disaggregated by commodity and movements in employment, investment and capital stocks disaggregated by industry. Most of these variables are naturally endogenous. However, to give them their historical movements, we must treat them as exogenous variables. Correspondingly, we endogenize aspects of technology and preferences.

The general approach in historical simulations can be understood by reference to the treatment of household consumption. In USAGE, household consumption is explained by equations of the form:

$$x_3(i) - q = \varepsilon(i) * (c - q) + \sum_k \eta(i,k) * p_3(k) + a3com(i), \quad i = 1,\ldots,n \tag{2.1}$$

where

$x_3(i)$ is the percentage change between two years (e.g. 1992 and 1998 or 1998 and 2005) in private consumption of commodity i;

q is the percentage change in the number of households;

c is the percentage change in aggregate expenditure by households;

$p_3(k)$ is the percentage change in the price to households of commodity k;

a3com(i) is a commodity-i preference variable; and

$\varepsilon(i)$ and $\eta(i,k)$ are estimates of the expenditure elasticity of demand by households for commodity i and the elasticity of demand for commodity i with respect to changes in the price of k.

In an historical simulation we set x3(i), q, c and p3(k) exogenously at their observed values for a particular period and we deduce preference changes by allowing (2.1) to be satisfied by endogenous movements in a3com(i). The historical simulations for 1992 to 1998 and 1998 to 2005 revealed preference changes against [negative a3com(i)s] Tobacco products, Malt beverages Wine and spirits, Bowling centers and Newspapers, and preference changes in favor of [positive a3com(i)s] Boatbuilding, Luggage, Travel trailers, Sporting clubs and Cable TV.

Similarly, we deduce technology changes by introducing to an historical simulation observed changes for output quantities, input quantities and input prices and allowing input-demand equations to be satisfied by endogenous changes in technology variables. The historical simulations for 1992 to 1998 and 1998 to 2005 revealed: rapid technological progress in the production of Computers and Financial services; slow or negative technological progress in the production of Childcare services and Vet services; significant positive input-using technological change for Computers, Job training and Management services; and significant negative input-using technological change for Glass, Sawmill products and Brick and clay tiles.

2.2. Forecast simulations

The philosophy of forecast simulations is similar to that of historical simulations. In historical simulations we exogenize what we know about the past. In forecast simulations we exogenize what we think we know about the future. In historical simulations we are not attempting to attribute causes to past events. Historical simulations simply reproduce those events. Attributing causation is the role of decomposition simulations in which we explain past events in terms of changes in technology, changes in preferences and changes in other naturally exogenous variables. In forecast simulations we are not attempting to attribute causes to future events.

Forecast simulations simply give our "most likely picture" of future events. Attributing causation is the role of policy simulations in which we explain potential future events in terms of changes in naturally exogenous variables, particularly policy variables.

For the past, we know a lot about disaggregated versions of naturally endogenous variables (e.g. consumption by commodity). For the future, our views about naturally endogenous variables are restricted to a much smaller group, mainly macro variables (e.g. aggregate consumption). For macro variables we have available projections developed by expert forecasting organizations. Because we have no particular expertise in macro forecasting, and because CGE models omit some factors (e.g. the inventory cycle) that are important in macro forecasting, it is sensible for us in forming a most likely picture of the future to introduce expert macro forecasts.

Closures for historical simulations are necessarily complex and unusual. They require endogenization of vectors of naturally exogenous variables (e.g. a vector of preference variables is endogenized to accommodate the observed vector of consumption movements). Closures for forecast simulations are relatively simple. In forecast closures, endogenization of naturally exogenous variables is restricted mainly to scalar propensities (e.g. the average propensity to consume is endogenized to accommodate exogenous projections of aggregate consumption). In forecast simulations, vector shocks are applied mainly to naturally exogenous variables (e.g. technical change and preference variables are shocked with trends derived mainly from historical simulations).

The relationship between historical and forecast simulations is illustrated in Figure 2.1. The current year is denoted by t_0, the historical period is $t_0 - \tau_1$ to t_0 and the forecast period is t_0 to $t_0 + \tau_2$. As can be seen from that figure, basecase forecasts developed according to USAGE methodology build in considerable data from the past and expert macro opinion for the future.

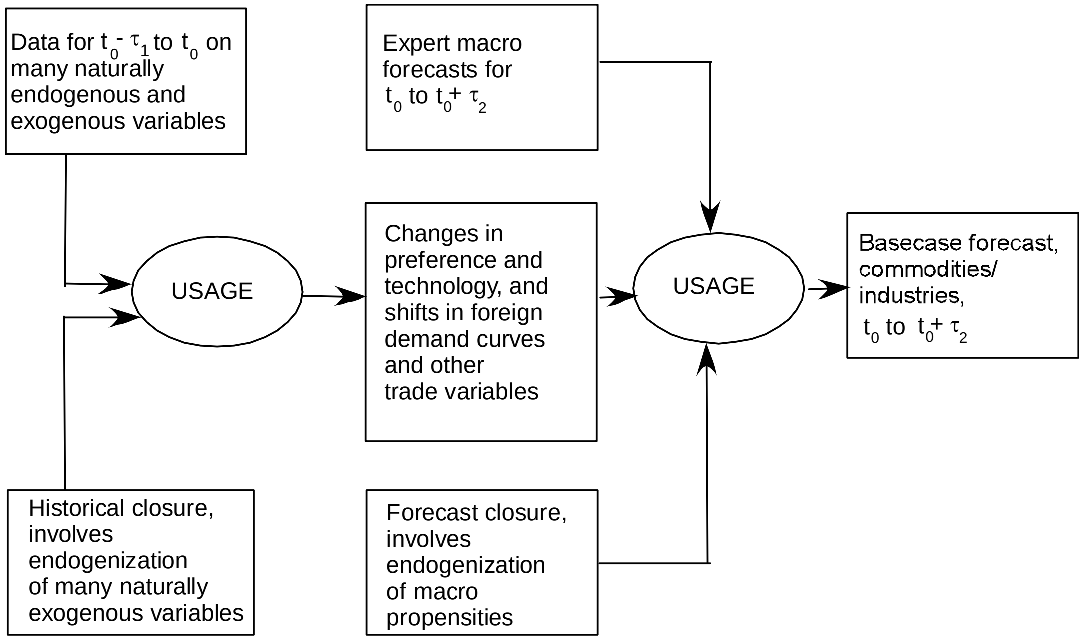
3. Setting the exogenous variables in the forecast simulation for 1998 to 2005

In this section we describe the creation of our forecast for 1998 to 2005, in which we use only information available up to 1998.

In creating a forecast for 1998 to 2005, we start with a complete dataset (values for every variable) for 1998. Then we apply shocks to exogenous variables to represent movements from their 1998 values to their forecast values for 2005. The exogenous variables receiving non-zero shocks in our 1998-2005 forecast simulation can be partitioned into the following groups:

- Macro and energy variables. As described in sub-section 3.1, the shocks for these variables are derived from forecasts made by U.S. government agencies published in or before 1998.
- Technology and consumer preferences. The shocks for these variables are described in sub-section 3.2. We rely mainly on extrapolations from the historical simulation for 1992 to 1998.
- International-trade shift variables. These include movements in: foreign demand curves for U.S. products; foreign-currency prices for U.S. imports; and preferences by households and industries for imported varieties of goods relative to domestic varieties. As described in sub-sections 3.3 and 3.4, the shocks for these variables are derived mainly from extrapolations from the 1992-98 historical simulation.
- Other variables.

Figure 2.1 Relationship between Historical and Forecast Simulations



3.1 Macro and energy variables

The macro assumptions underlying our forecasts for 1998 to 2005 are shown in the first column of Table 3.1. These forecasts were developed in 1998 by our colleagues at Tactical Global Management, relying mainly on forecasts by London Economics who in turn relied mainly on forecasts by official U.S. organizations such as the Congressional Budget Office. The second column of 3.1 shows actual outcomes for 1998 to 2005.

For energy variables, we took the 1998 forecasts from Annual Energy Outlook 1996 published in January 1996 by the Energy Information Administration (EIA) in the U.S. Department of Energy. These forecasts are shown in the first column of Table 3.2. The second column shows actual outcomes, taken from Annual Energy Outlook 2006.

3.2 Technology and consumer preferences: top-level nests

USAGE contains many technology and preference variables. Technology variables in USAGE are predominantly of the input- or output-augmenting/saving type. They are the A variables in production functions of the form:

$$0 = F_j\left(A0_{1j} * X0_{1j}, ..., A0_{nj} * X0_{nj} \,;\, \frac{X1_{1j}}{A1_{1j}}, ..., \frac{X1_{mj}}{A1_{mj}} \right) \tag{3.1}$$

where

$X0_{ij}$ is the output of commodity i by industry j; and

$X1_{qj}$ is the input of commodity or primary factor q to production in j.

A 10 per cent reduction in $A0_{ij}$ represents 10 per cent output-i-augmenting technical change in industry j. With a 10 per cent reduction in $A0_{ij}$, industry j is able to expand its output of i by 10 per cent with no change in the output of any other commodity and

Table 3.1 Percentage movements in macro variables between 1998 and 2005

	Forecast available in 1998	Actual outcome
Real private consumption	15.78	28.00
Real investment	16.43	26.09
Real public consumption	15.29	19.10
Real exports	57.32	23.76
Real imports	46.17	55.12
Real GDP	15.37	21.64
Aggregate employment	9.42	7.79
Aggregate capital stock	20.90	19.49
Ave. nominal wage rate	25.50	29.94
Consumer price level	19.02	16.16
Terms of trade	-0.26	-5.57
Dwelling investment	18.25	45.36

Table 3.2 Percentage movements in energy variables between 1998 and 2005

	Forecast available in 1998	Actual outcome
Output of electricity	0.35	7.06
Output of crude oil	-9.51	-15.85
Output of natural gas	16.04	-5.81
Output of petroleum refining	11.79	9.67
Imports of crude oil	27.71	16.44
Imports of natural gas	28.36	37.27
Imports of petroleum refining	27.59	50.30
Exports of crude oil	44.79	-72.73
Exports of natural gas	75.00	368.75
Exports of petroleum refining	44.79	28.92
Inputs of coal to electricity	12.07	12.57
Inputs of petroleum refining to electricity	-46.67	-7.27
Inputs of natural gas to electricity	61.45	57.07
Import price of crude petroleum relative to GDP deflator	12.23	309.23
Import price of natural gas relative to GDP deflator	2.38	260.89
Price of domestic coal relative to GDP deflator	-7.58	21.47
Price of domestic electricity relative to GDP deflator	-7.81	19.12
Household consumption of natural gas	3.91	6.37

no change in inputs. A 10 per cent reduction in $A1_{qj}$ represents 10 per cent input-q-saving technical change in industry j. With a 10 per cent reduction in $A1_{qj}$, industry j can reduce its input of q by 10 per cent with no change in any other input and no change in outputs. Technology variables in USAGE cover not only current production, but also the use of inputs in creating capital for each industry and the use of margin services in facilitating commodity flows between producers and users.

Preference variables are included in USAGE as A variables in the household utility function. In stylized form, utility is given by

$$U = U\left(\frac{X3_1}{A3_1}, \ldots, \frac{X3_n}{A3_n}\right) \tag{3.2}$$

where

$X3_i$ is consumption of commodity i.

A 10 per cent reduction in $A3_i$ represents a 10 per cent preference shift against commodity i. With a 10 per cent reduction in $A3_i$, households can reduce their purchases of i by 10 per cent with no change in any other purchase and no change in utility.

Nearly all of the USAGE technology and preference variables are treated exogenously in the 1998 to 2005 forecast simulation and are given the same movements (adjusted from 6 years to 7 years) that they had, either endogenously or exogenously, in our historical simulation for 1992 to1998. Technology and preference variables that were given non-zero shocks in 1998 to 2005 are listed in Table 3.3. The first of these, a1prim(j), imparts a uniform shock in industry j's production function to the A1 variables referring to primary factors. Biases in industry j's primary-factor-saving technical change are introduced via f_twistlk(j). The a0ci(i,j)s refer to shocks to the A0 variables in j's production function. In the historical simulations we have only aggregate data on the use of commodity i as a margin service and as an input to current production and capital creation. Consequently, the historical simulations reveal only a single value for commodity-i-using technical change. This is projected forward from 1998 to 2005 through shocks to the USAGE variable ac(i). The a3com(i)s refer to shocks to the A3 variables in the household utility function.

An important USAGE technology variable that is treated endogenously in the 1998 to 2005 forecast is a1primgen. This is a scalar variable. It imparts a uniform primary-factor-saving technical change across all industries. The role of endogenous movements in a1primgen can be understood in terms of the equations:

$$GDP = C + I + G + X - M \qquad \text{and} \tag{3.3}$$

$$GDP = A * F(K, L) \qquad . \tag{3.4}$$

Equation (3.3) is the GDP identity from the expenditure side and equation (3.4) represents GDP from the supply side as a function of inputs of capital and labor (K and L) and of technology (A). In our forecast for 1998 to 2005, movements in C, I, G, X, M, K and L are given exogenously via the macro scenario in Table 3.1. Thus A must be endogenous. In USAGE, the required degree of freedom for technology is provided by endogenous determination of a1primgen.[2]

[2] To give a flavor of what we have assumed with regard to technology for the forecast period, we have computed a composite technology variable for each commodity. This is shown in an appendix available form the authors. The composite variable is multi-factor-productivity growth. For commodity i, it is a weighted average of all of the A0 and A1 shocks directly affecting inputs per unit of output of commodity

Table 3.3 Shocked technology and preference variables in the 1998-2005 forecast simulation

USAGE variable	Domain[*]	Description
a1prim(j)	$j \in$ IND	Primary-factor-saving technical change in industry j
f_twistlk(j)	$j \in$ IND	Shift in industry j towards the use labor away from the use of capital
a0ci(i,j)	$i \in$ COM, $j \in$ IND	Output-i-augmenting technical change in industry j
ac(i)	$i \in$ COM	Input-i-saving technical change in production, capital creation and margin use throughout the economy
a3com(i)	$i \in$ COM	Preference shift against commodity i

[*] IND is the set of all industries and COM is the set of all commodities.

3.3 Exports

In slightly stylized form, the export demand equations in USAGE are:

$$x4(i) = z\_world + \phi(i)*[p4(i) - p4fn(i) - fep(i)] + feq\_gen, \tag{3.5}$$

and

$$p4fn(i) = pm(i) + f\_p4(i) \quad . \tag{3.6}$$

In equation (3.5),

x4(i)is the percentage change in foreign demand for U.S. commodity i;
z_world is the percentage change in the world activity level (world GDP);
p4(i) is the percentage change in the foreign-currency price of U.S. export product i in foreign countries;
p4fn(i) is the percentage change in the foreign-currency price of foreign commodities that are competitive with U.S. product i in foreign countries;
ϕ(i) is the foreign elasticity of demand for U.S. product i, treated as a parameter with value -3 for all i; and the
f terms are shifts in the foreign demand curve for U.S. product i.

In equation (3.6),

pm(i) is the percentage change in the foreign currency import price of i; and
f_p4(i) is a shift term.

Equation (3.5) could be derived from an optimization problem in which foreign users of U.S. commodities minimize costs subject to a CES constraint. Under this interpretation, ϕ(i) is the product of: (a) the elasticity of substitution applying to agents in foreign countries between U.S. and non-U.S. varieties of commodity i; and (b) the non-U.S. share in expenditure by foreign agents on commodity i.

Via equation (3.6), we can assume that the movement in the price of commodities that are competitive with U.S. commodity i in foreign countries is the same as that in the price of the relevant imports to the U.S.

Our historical simulation for 1992 to 1998 revealed movements [fep(i)] in foreign demand curves. These are extrapolated for the forecast for 1998 to 2005.

i. The actual multi-factor productivity growth for each commodity, revealed in our historical simulation for 1998 to 2005, is also shown in the appendix.

3.4 Import prices and import/domestic preferences

In our forecast simulation for 1998 to 2005, we assume for most commodities that the percentage changes in foreign-currency import prices [pm(i)] will be the same (apart from adjustment from 6 years to 7 years) as for the period 1992 to 1998. For various energy prices we use forecasts from the EIA (see subsection 3.1).

The historical simulation for 1992 to 1998 reveals shifts in consumer and industry preferences between imported and domestic varieties of the same good. These are movements in import/domestic ratios beyond those that can be attributed to movements in import/domestic prices. In the 1998 to 2005 forecast we extrapolate the observed 1992-98 shifts.

3.5. Other variables

In forecast simulations there are numerous exogenous variables apart from those discussed above. These describe: the commodity composition of public-sector demand; required rates of return on investment by industry; tax rates; population; and interest, dividend and revaluation rates applying to U.S. foreign assets and liabilities. For most of these variables we derived our forecasts for 1998 to 2005 as extrapolations of movements between 1992 and 1998. However, for required rates of return on investment we made an exception. These are volatile variables and we doubt that historical movements provide any useful guidance for the future. Thus in forecasting we assumed no change in these variables at the industry level, although we do allow for an overall uniform change to accommodate macro forecasts for wage rates, technology, employment and capital stocks.

4. Forecasting performance for 1998 to 2005

Charts 4.1A to 4.5B are scatter diagrams showing results for USAGE forecast simulations. The numbers underlying the charts are presented in an appendix available from the authors. Each chart has actual growth in the 500 USAGE commodity outputs (as revealed by the 1998 to 2005 historical simulation) between 1998 and 2005 on the horizontal axis and forecast growth made under different assumptions on the vertical axis. The nature of the forecast simulations is indicated by Figure 4.1.

Details of the Charts are as follows:

Chart 4.1A. The vertical axis shows forecast growth for 1998 to 2005 with the exogenous variables set as described in subsections 3.1 to 3.5. Chart 4.1A gives an R^2 of 0.3427. However, the chart gives the impression that a lot of this R^2 is contributed by the 4 observations (for the computer commodities) in the top right-hand corner. This is confirmed in Chart 4.1B in which these 4 observations are omitted and the R^2 falls to 0.0800.

Chart 4.2A. The vertical axis shows forecast growth generated under the same assumptions as in Chart 4.1A except that the macro and energy forecasts are set according to what actually happened. Compared with the initial forecast in Chart 4.1A, Chart 4.2A indicates that getting the macro and energy numbers right raises R^2 from 0.3427 to 0.4403. Again, Chart 4.2A gives the impression that a lot of the R^2 is contributed by the 4 observations in the top right-hand corner. This is confirmed in Chart 4.2B in which these 4 observations are omitted and the R^2 falls to 0.1822.

Chart 4.3A. The vertical axis shows forecast growth generated under the same assumptions as in Chart 4.2A except that the international-trade shift variables are set at what actually happened. Compared with the forecast in Chart 4.2A, Chart 4.3A indicates that getting the trade forecasts right raises R^2 from 0.4403 to 0.6730. When we omit the 4 observation in the top right-hand corner from the Chart 4.3A, the R^2 falls to 0.5028 (Chart 4.3B).

Chart 4.4A. The vertical axis shows forecast growth generated under the same assumptions as in Chart 4.3A except that technology and household preference variables are set at what actually happened. Compared with the forecast in Chart 4.3A, Chart 4.4A indicates that getting the technology and preference forecasts right raises R^2 from 0.6730 to 0.8784. When we omit the 4 observation in the top right-hand corner from the Chart 4.4A, the R^2 falls to 0.8396 (Chart 4.4B).

Chart 4.5A. The vertical axis shows forecast growth generated under the same assumptions as in Chart 4.2A except that technology and household preference variables are set at what actually happened. Compared with the forecast in Chart 4.2A, Chart 4.5A indicates that getting the technology and preference variables right raises R^2 from 0.4403 to 0.5557. When we omit the 4 observation in the top right-hand corner from the Chart 4.5A, the R^2 falls to 0.4136 (Chart 4.5B).

What conclusions should we draw from these charts? At first glance, our forecasting method seems unsuccessful. In Chart 4.1A, the R^2 is disappointingly low and becomes very low when we exclude the 4 computer industries (Chart 4.1B). However, in judging the forecasts, we should compare them with available alternatives.

A possible alternative, one that may appeal to macro economists and to stock exchange analysts who base much of their advice to clients on macro forecasts, is to generate commodity forecasts simply on the basis of available macro and energy forecasts. The results of doing this are shown in Chart 4.6. As in the earlier charts, the horizontal axis shows actual growth in the 500 USAGE commodity outputs between 1998 and 2005. The vertical axis shows growth rates generated by USAGE simulation on the basis of the macro and energy forecasts available in 1998. No exogenous detail is introduced for trade, technology, preference and other variables.

As can be seen from Chart 4.6, commodity output forecasts generated on the basis of available macro and energy projections alone are very weak (R^2= 0.0128). Even if we replace the 1998 macro and energy forecasts with the actual outcomes, the commodity forecasts remain weak. This is shown in Chart 4.7, which gives an R^2 of 0.0885. It appears that from the point of view of forecasting the commodity composition of U.S. output, deducing and applying historical trends for trade, technology, preference and other variables has a considerable payoff, raising the R^2 from 0.0128 in Chart 4.6 to 0.3427 in Chart 4.1A.

Another alternative forecasting method is to project commodity outputs simply on the basis of their historical growth rates. The results of such a procedure can be seen in Chart 4.8A. This is a scatter diagram showing 1998-2005 growth in commodity outputs on the horizontal axis against 1992-98 growth (adjusted from 6 years to 7 years) on the vertical axis. The R^2 for this scatter is 0.3703, slightly higher than that in Figure 4.1A for the pure forecast (0.3427). When we exclude the four computer commodities from Chart 4.8A, the R^2 falls to 0.0579 (Chart 4.8B), slightly lower than the R^2 in the corresponding chart for the pure forecast (Chart 4.1B, 0.0800).

Should we be disappointed that commodity output forecasts generated as a simple extrapolation of history give about the same degree of fit as those generated by our much more elaborate forecasting method using technology, preference and trade trends together with macro and energy forecasts prepared by U.S. government agencies? Perhaps as a first reaction we should not be too surprised. In determining the

Figure 4.1 Sequence of forecast simulations for 1998 to 2005

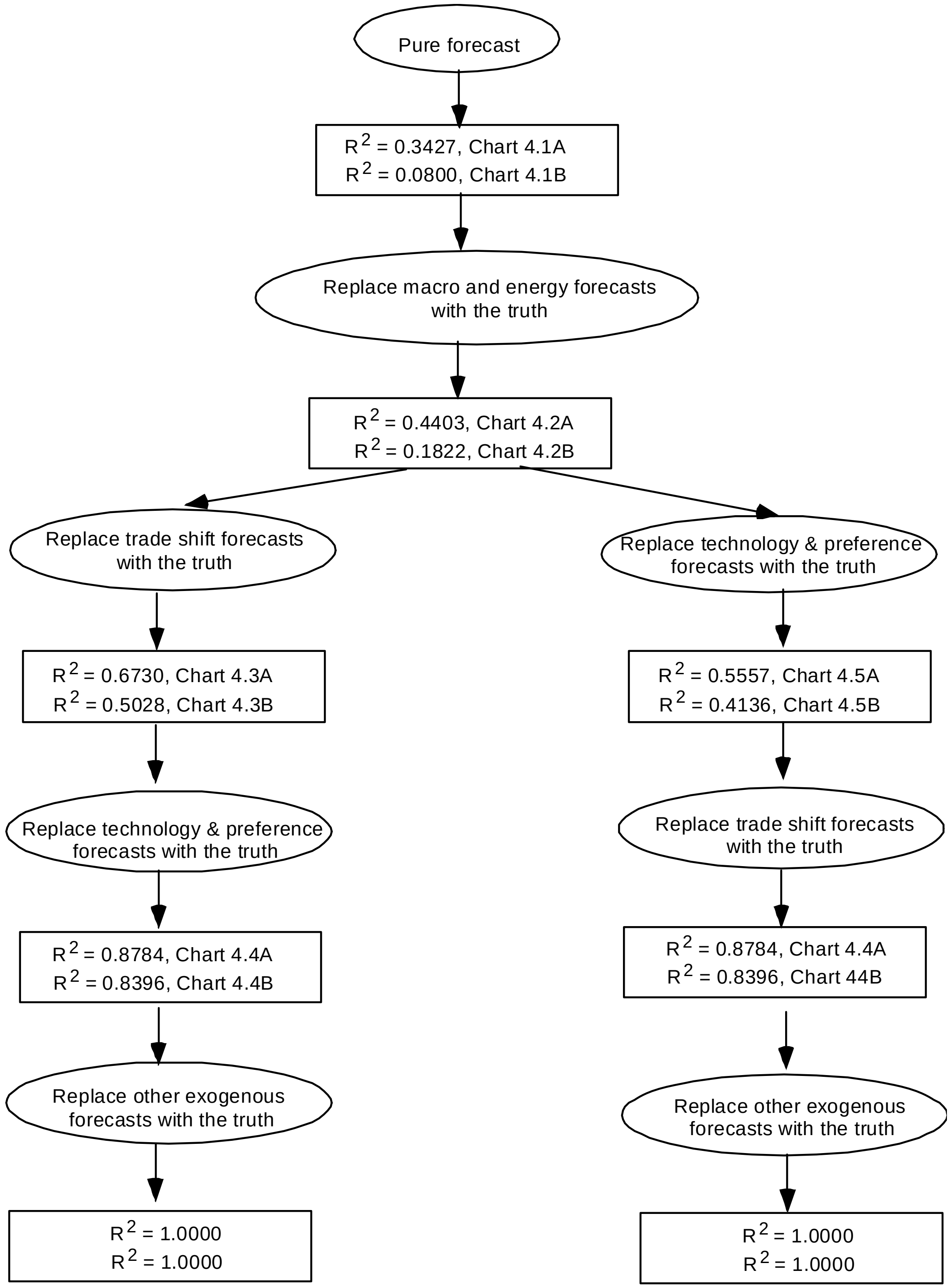


Chart 4.1A Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE pure forecast

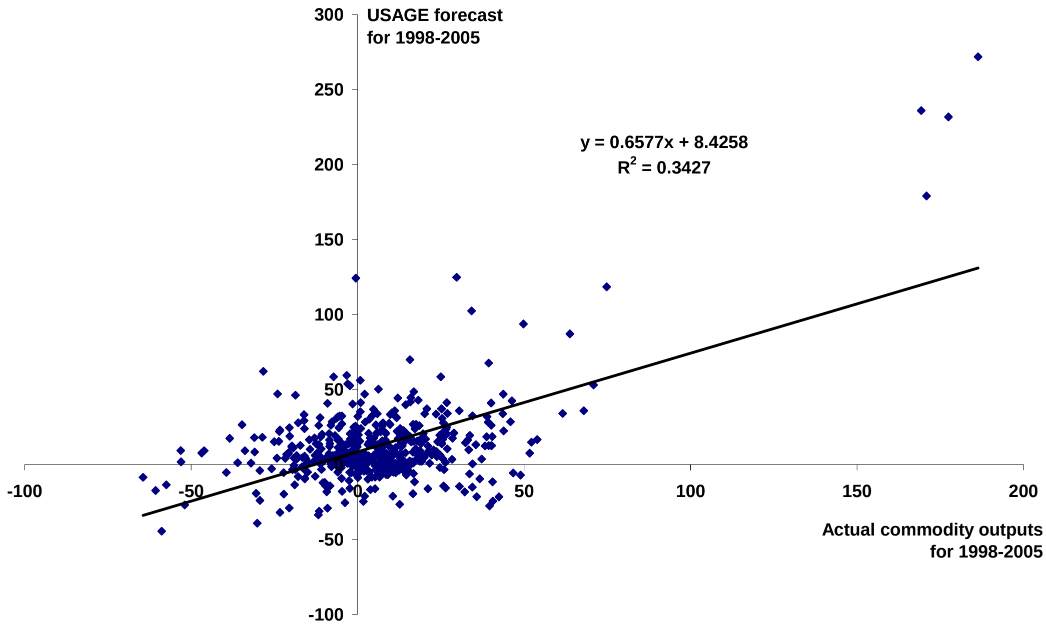


Chart 4.1B Percentage growth in commodity outputs without 4 outliers, 1998-2005: Actual versus USAGE pure forecast

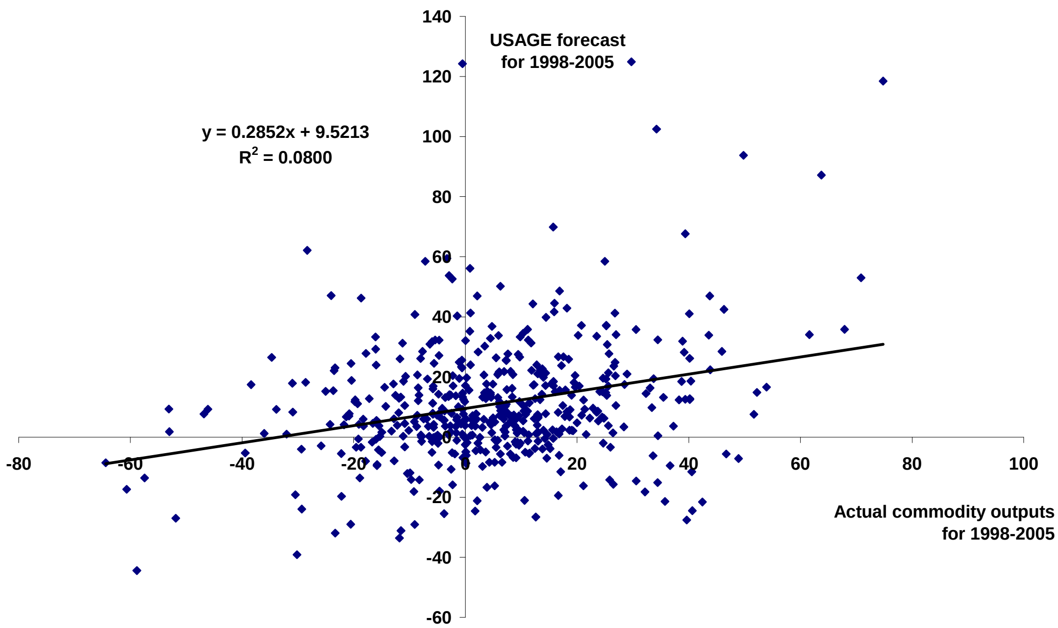


Chart 4.2A Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE forecast with truth for macro and energy variables

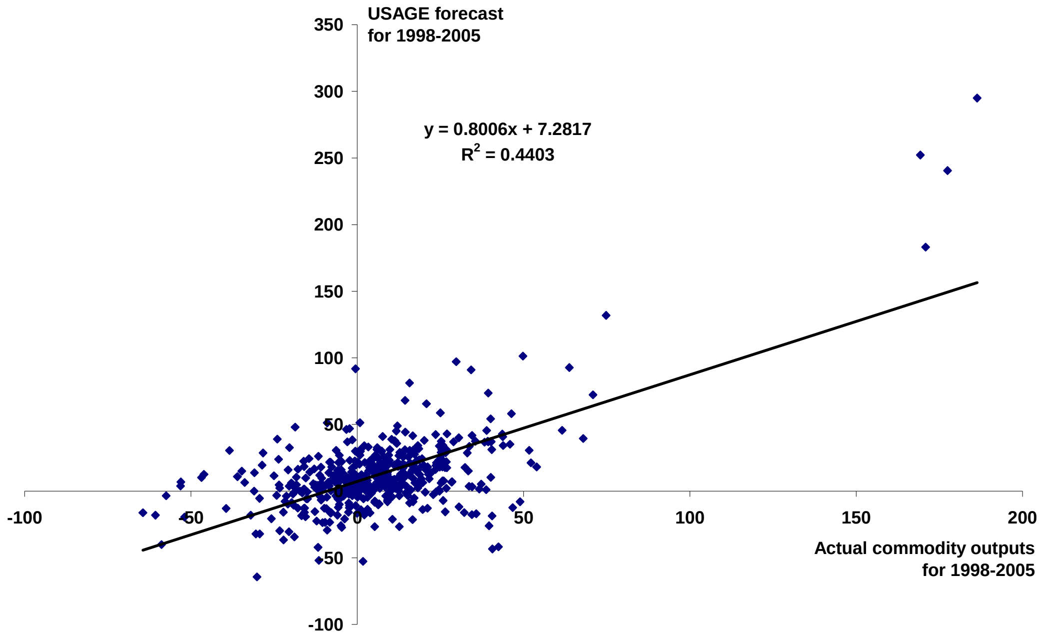


Chart 4.2B Percentage growth in commodity outputs without 4 outliers, 1998-2005: Actual versus USAGE forecast with truth for macro and energy variables

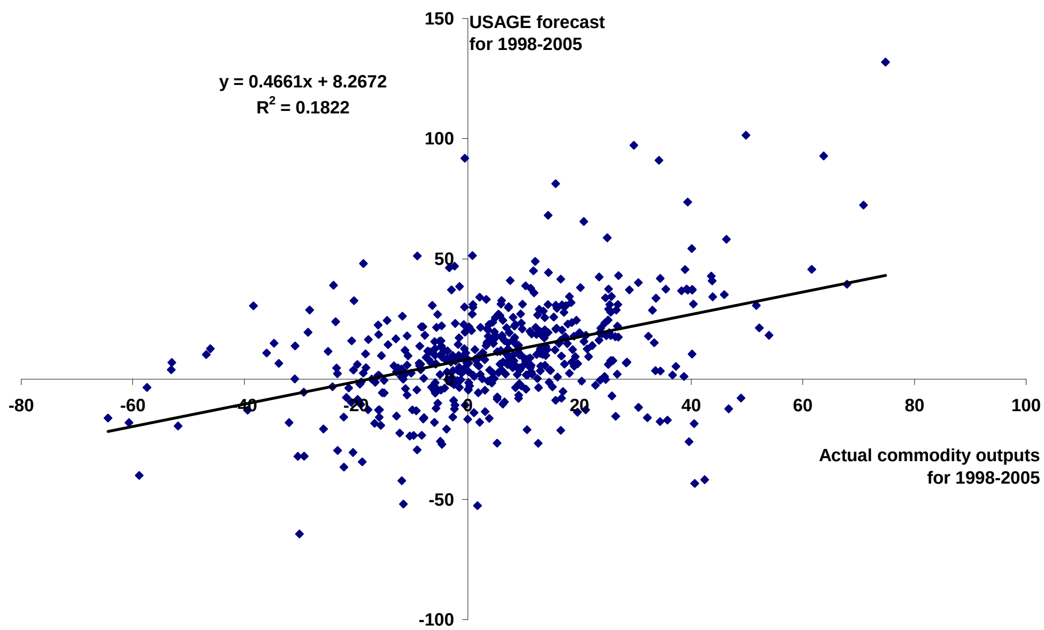


Chart 4.3A Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE forecast with truth for macro, energy and trade-shift variables

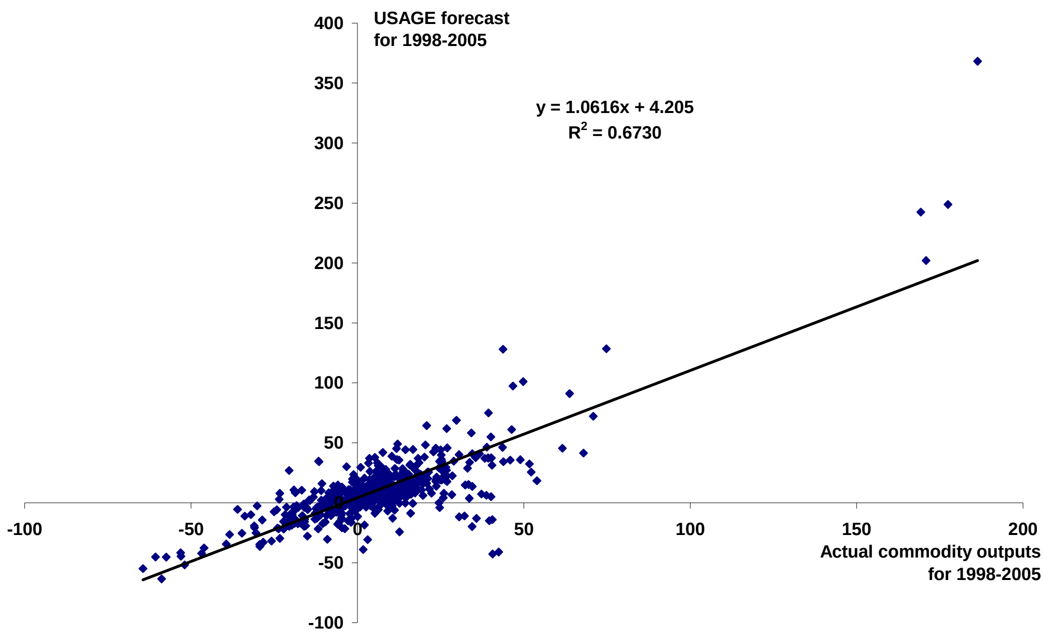


Chart 4.3B Percentage growth in commodity outputs without 4 outliers, 1998-2005: Actual versus USAGE forecast with truth for macro, energy and trade-shift variables

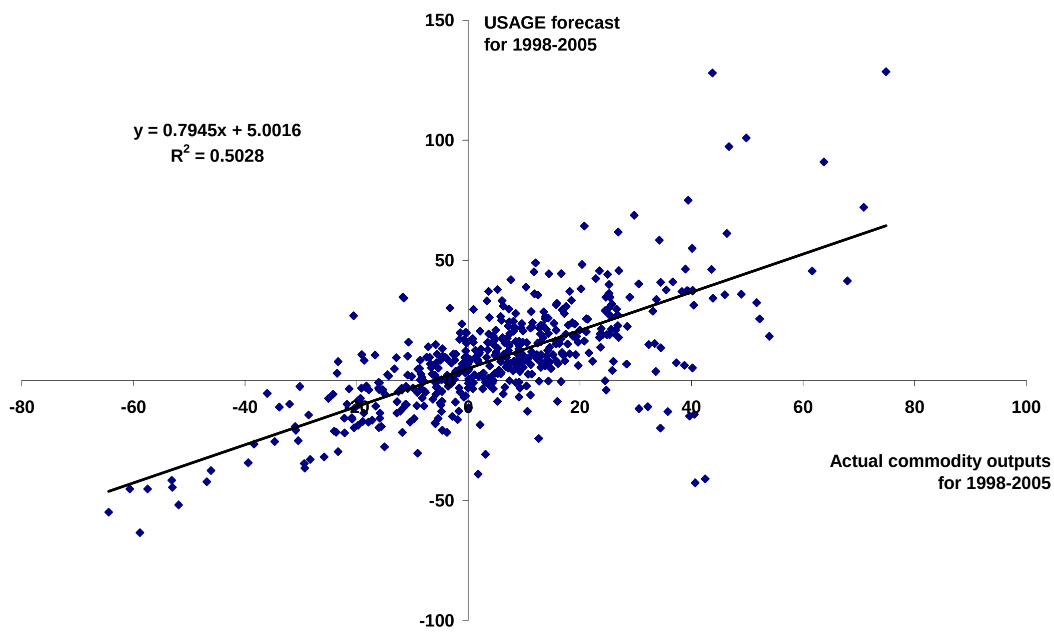


Chart 4.4A Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE forecast with truth for macro, energy, trade-shift and technology & preference variables

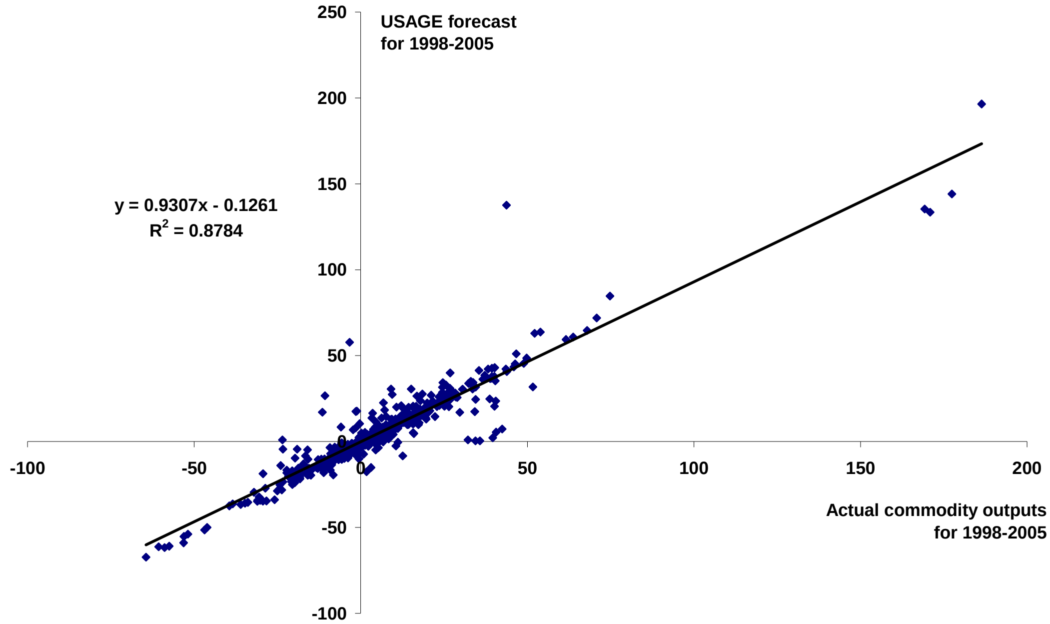


Chart 4.4B Percentage growth in commodity outputs without 4 outliers, 1998-2005: Actual versus USAGE forecast with truth for macro, energy, trade-shift and technology & preference variables

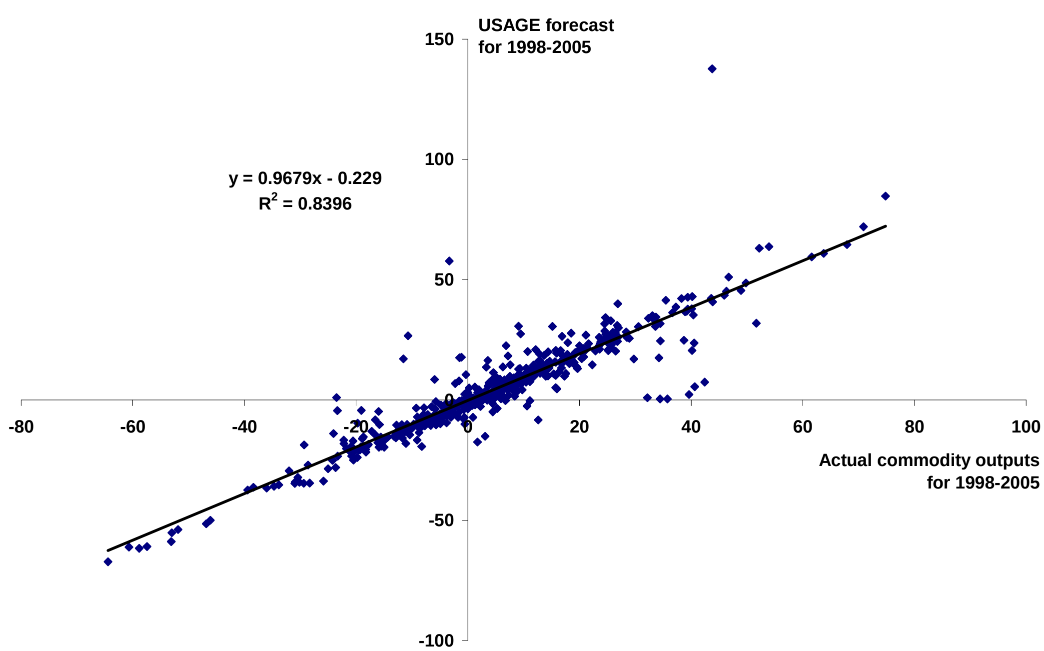


Chart 4.5A Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE forecast with truth for macro, energy and technology & preference variables

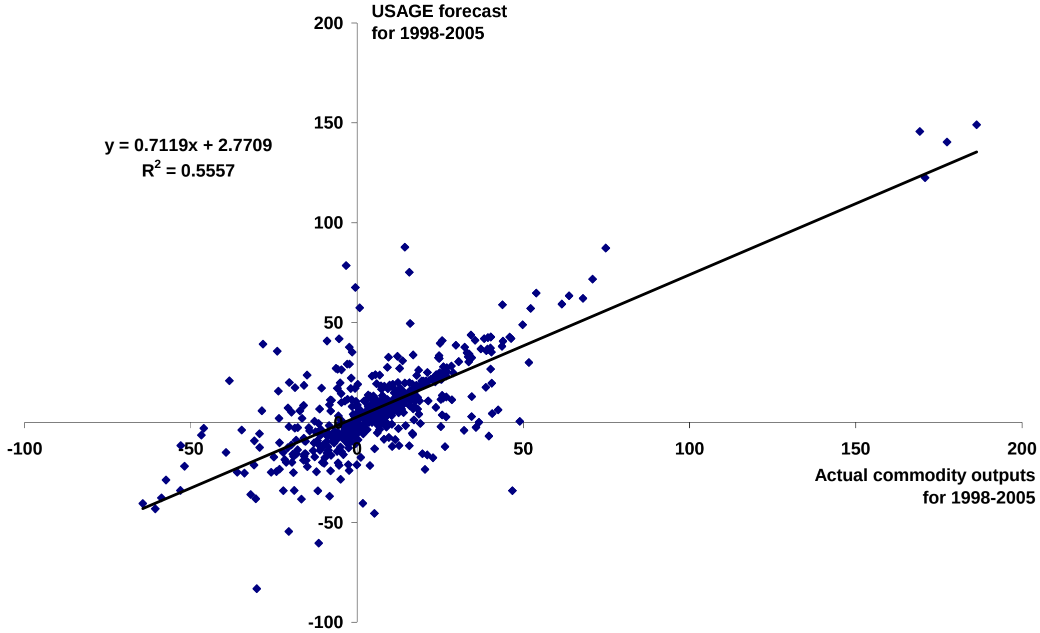


Chart 4.5B Percentage growth in commodity outputs without 4 outliers, 1998-2005: Actual versus USAGE forecast with truth for macro, energy and technology & preference variables

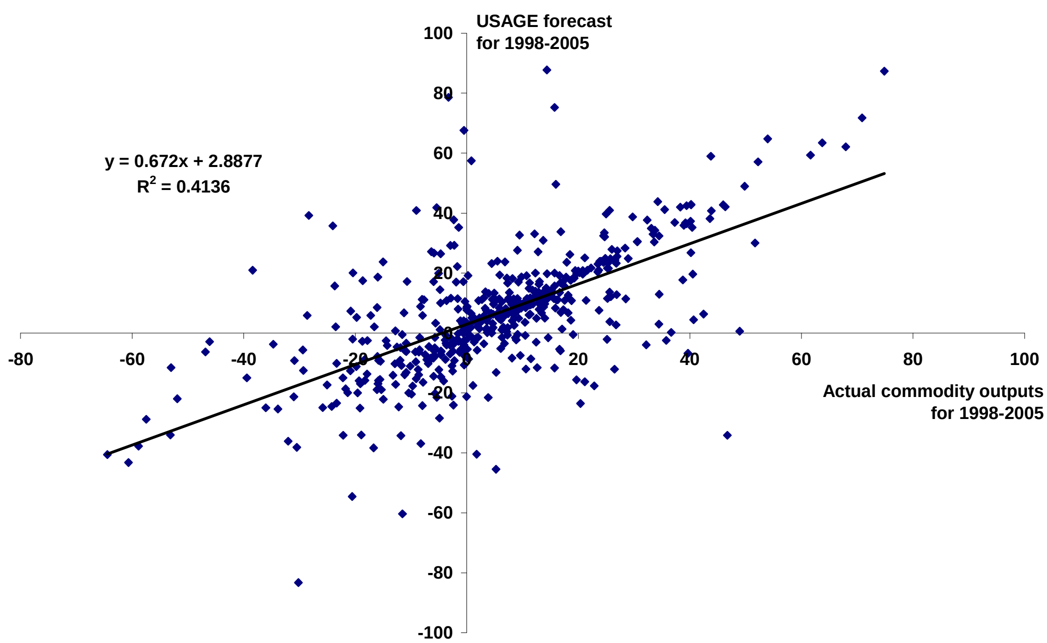


Chart 4.6 Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE forecast based only on macro and energy forecasts

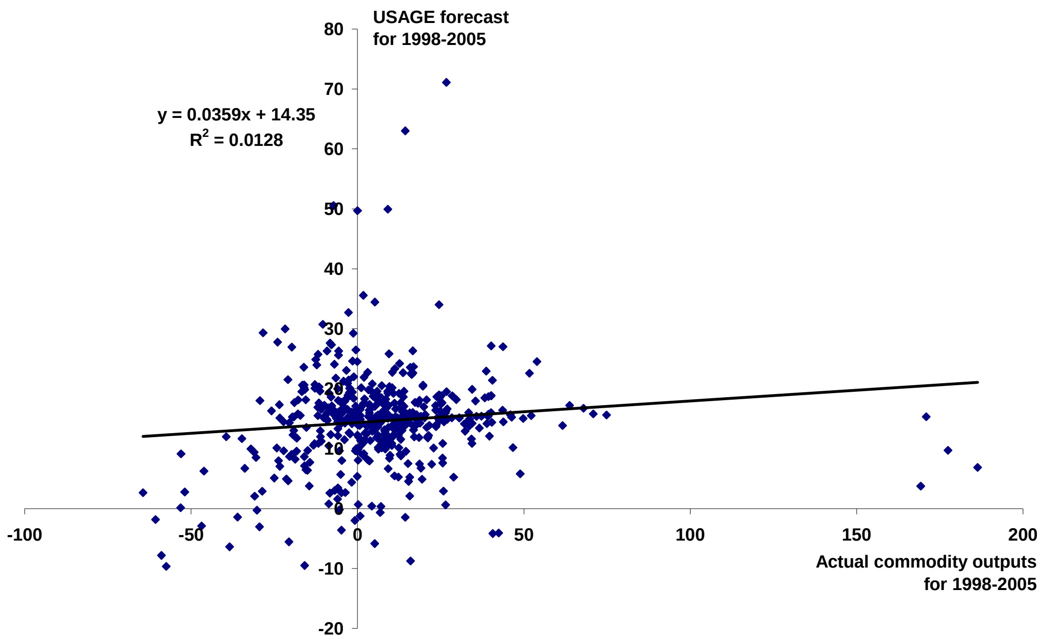


Chart 4.7 Percentage growth in commodity outputs, 1998-2005: Actual versus USAGE forecast based only on actual macro and energy outcomes

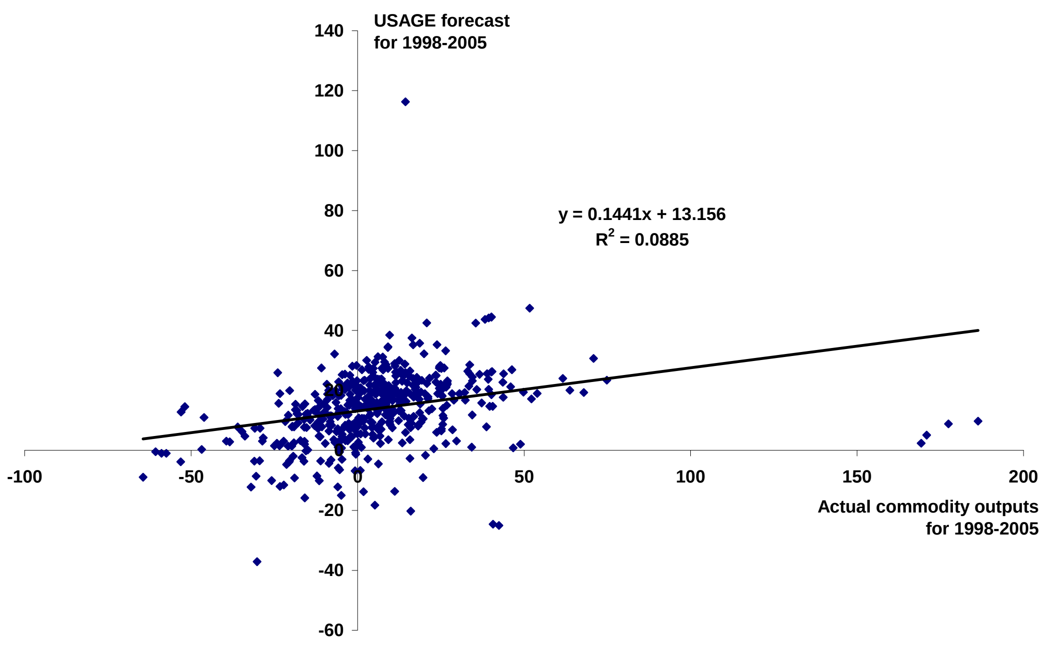


Chart 4.8A Percentage growth in commodity outputs, 1998-2005: Actual versus projection based on average annual growth rates from 1992-98

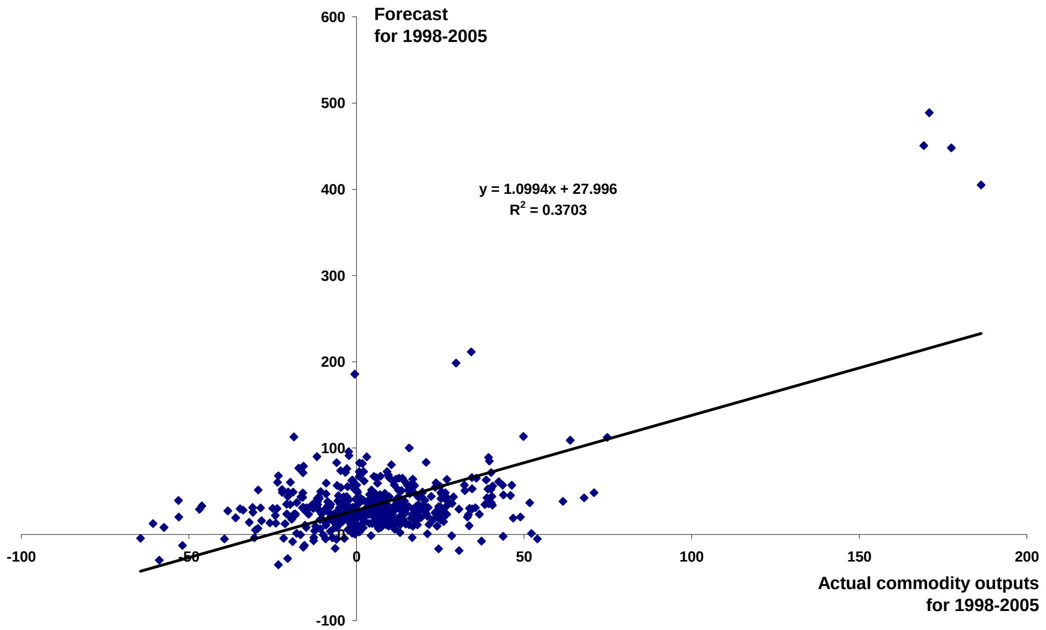
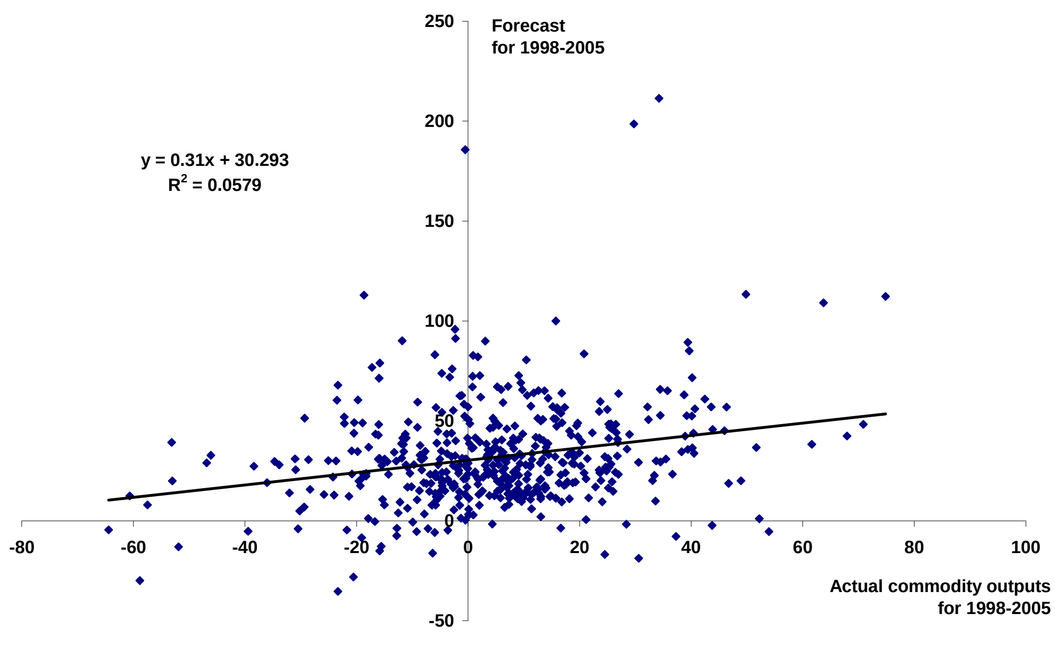


Chart 4.8B Percentage growth in commodity outputs without 4 outliers, 1998-2005: Actual versus projection based on average annual growth rates from 1992-98



commodity structure of output, what happens to technology, preference and trade variables is important. Because in our pure USAGE forecast for 1998 to 2005 we have assumed that trends in these variables are a continuation of those from 1992 to 1998, we should expect similarity between the forecast growth in commodity outputs for 1998 to 2005 and the actual growth in commodity outputs for 1992 to 1998. Thus we should expect commodity-output forecasts generated as an extrapolation of historical movements to perform about as well as our USAGE forecasts. We might have hoped that the addition of macro and energy forecasts would allow the USAGE forecasting method to out perform simple extrapolation, at least by a little bit. It appears on this occasion that the macro and energy forecasts were not sufficiently good to contribute anything to the forecasts of commodity outputs.

Although we cannot claim that the USAGE forecasting method has, at this stage, beaten simple extrapolation, we can claim that the method has potential for improvement. This is not a claim that can be made for simple extrapolation. Looking at Charts 4.1A to 4.5B and Figure 4.1, we see that the USAGE method would generate considerably better forecasts if we could find ways to create more accurate projections of macro, energy, trade, technology, preference and other exogenous variables.

Enormous resources have already been devoted by U.S. government agencies and other agencies around the world to macro and energy forecasting. Consequently, we should not expect great improvements in those areas. There may be considerable payoff from more work on technology, preference and the other exogenous variables (e.g. required rates of return on capital). A possible starting point for this work would be a review of the technology assumptions built into the forecasts for demand for labor by occupation prepared by the Bureau of Labor Statistics (BLS), see for example BLS (2008) and Dixon and Rimmer (2006). However, we think that the greatest payoff would arise from work on the trade variables.

As can be seen from Figure 4.1, getting the trade-shift variables right has a large effect on the quality of our forecasts. In the left-hand sequence of simulations in Figure 4.1, R^2 rises from 0.4403 to 0.6730 when we introduce “the truth” for trade variables and in the right-hand sequence it rises from 0.5557 to 0.8785. The importance of trade-shift variables is perhaps surprising because for most commodities import shares in the U.S. market and export shares in output are quite small: for 64 per cent of USAGE commodities the import share is less than 15 per cent and for 73 per cent of USAGE commodities the export share is less than 15 per cent.

Work on the projections of the trade-shift variables has the potential make a major contribution to the accuracy of our commodity forecasts because our present projections for trade-shift variables are performing badly. Charts 4.9 and 4.10 are scatters of export and import growth for 1998-2005 (horizontal axis) against export and import growth for 1992-98 (vertical axis). The charts show that there is no statistical relationship between trade growth by commodity in the two periods. Consequently, a forecasting method based on the assumption that trends from the first period continue into the second period is bound to fail.

We are currently conducting an audit of the trade data that we have used in the 1992-98 and 1998-2005 historical simulations. These data were derived mainly from value data at the HTS10 level. It is possible that there are mistakes in the mapping of the HTS data to the input-output classifications used in USAGE. It is also possible that our conversions from values to quantities (using quite aggregate data on import and export prices available from the Bureau of Economic Analysis) are inadequate.

Chart 4.9 Percentage growth in commodity export volumes: Actual 1998-2005 versus actual 1992-98

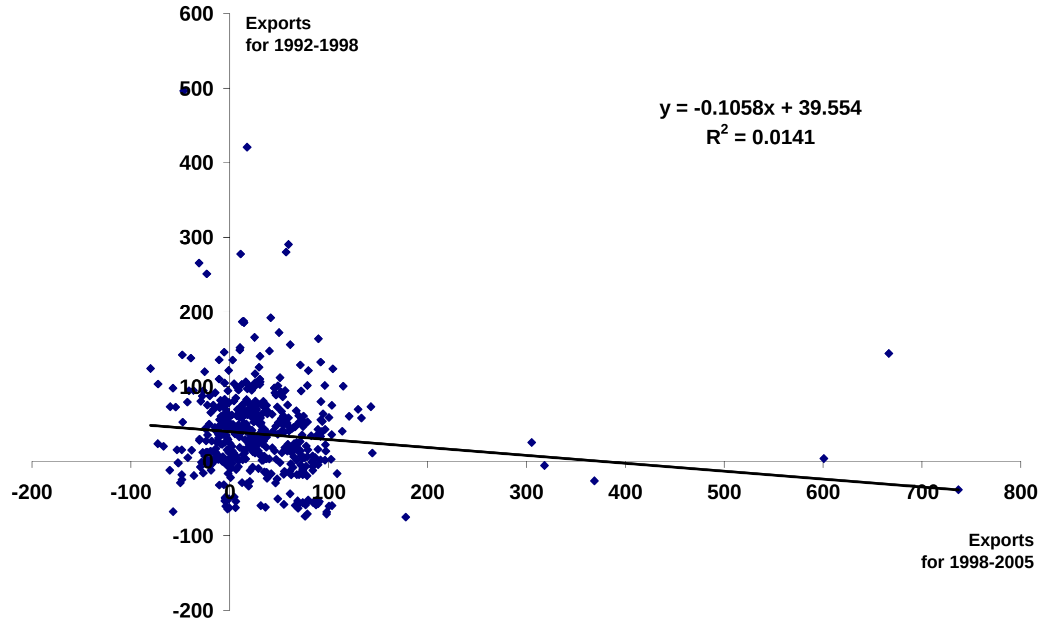
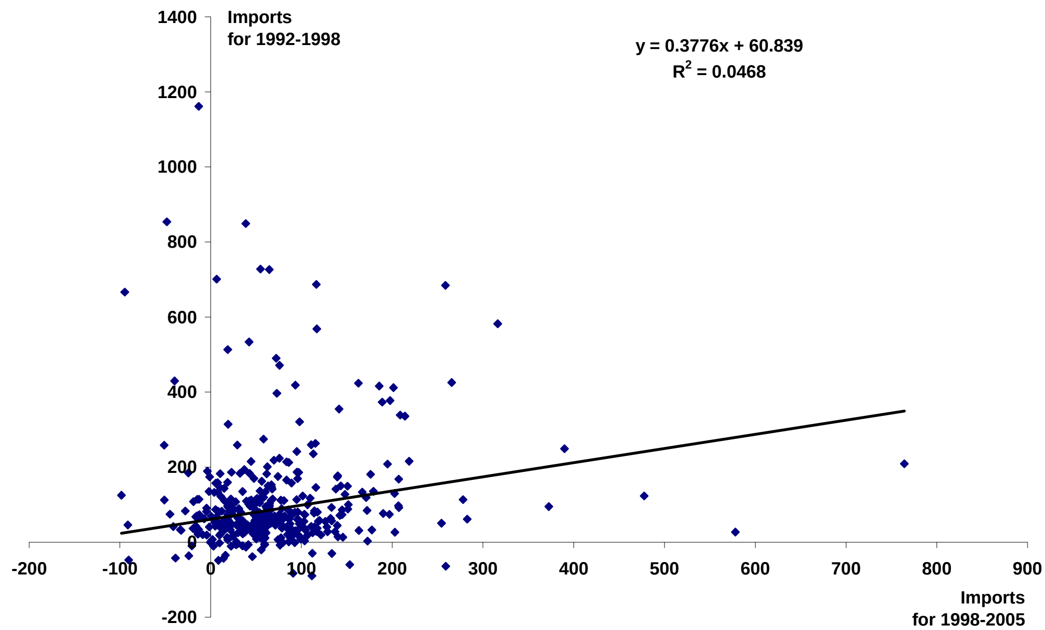


Chart 4.10 Percentage growth in commodity import volumes: Actual 1998-2005 versus actual 1992-98



While we expect to make some data improvements, we also expect to be left with many mysteries. For example, consider the case of butter. This is an easily identified commodity and we would not anticipate problems in moving from HTS10 to input-output classifications. Our current data indicate that quantity imports of butter increased by 853 per cent between 1992 and 1998 and decreased by 48 per cent between 1998 and 2005, taking the import share of butter in the U.S. market from about 2 per cent in 1992 to 13 per cent in 1998 and back to 7 per cent in 2005. Did this really happen, and if so, why? By answering such questions we expect eventually to improve our trade projections and thereby improve the capacity of the USAGE model to produce reliable disaggregated projections for U.S. commodity outputs and thus for U.S. industries.

5. Concluding remarks

For many years we have been using computable general equilibrium models in Australia and the U.S. to generate detailed forecasts of output growth for commodities/industries. Our main objective is to provide realistic basecases from which to calculate the effects of policy changes. In addition to providing basecases, forecasts derived from a detailed CGE model are of interest to planners concerned with infrastructure and training expenditures and to investors and their advisors.

CGE models have traditionally been used to answer comparative static or "what if" questions. For example, in the USITC's 2004 report on import restraints (USITC, 2004), USAGE was used to answer the question: what would happen to output and employment in different industries if all significant import restraints were removed? No attempt was made at forecasting. Literally, the question that USAGE answered was: how different would the structure of the U.S. economy have been in 1998 (the then year of the USAGE database) if there had been no significant import restraints from the way it was with significant import restraints. However, policy makers in 2004 are not interested in alternative pictures of 1998. When they are contemplating reductions in import restraints, they want to know how such a policy would affect a future year, say 2011.

There would be no problem if our best answer to the 2011 question were the same as the answer to the 1998 question. But it is not. While forecasting is difficult and problematic, the 1998 structure of the economy, or even the 2004 structure is not our best guess about the structure in 2011. When we give the economy of 2011 our best forecast, then our results for the effects of policy changes can look quite different from those derived under the implicit assumption that the future structure of the economy is the same as the past.

The importance of the basecase was recognized by the USITC in their 2007 report on import restraints (USITC, 2007). In that report, the USITC applied USAGE to calculate the effects of changes in trade policies as deviations around an explicit USAGE projection of the economy out to 2011. In this projection, the USITC built in the idea that even without reductions in protection, sensitive industries such as Textiles, Apparel and Sugar are likely to be smaller in 2011 than they were in 2005. Thus, the USITC avoided exaggerating the likely economy-wide effects in 2011 of reductions in import restraints.

In this paper, we have started assessing our method for generating basecase forecasts. Using data available up to 1998 we have applied the method to generate forecasts for 1998 to 2005. We have then compared these forecasts with outcomes for this period. The results so far are mixed. Our forecasts for the 500 USAGE commodity outputs clearly beat projections generated on the basis of macro and energy forecasts alone. On the other hand, our forecasts are no better (but not worse) than those that would be obtained by projecting commodity outputs for 1998 to 2005 by simply assuming that a continuation of average annual growth rates from 1992 to 1998.

We think that the USAGE method has considerable potential for improvement, particularly with regard to trade projections. We are currently undertaking an audit of our trade data for the periods 1992 to 1998 and 1998 to 2005. We hope to uncover imperfections in data handling and/or reasons for seemingly wild fluctuations in the growth of imports and exports of some commodities.

Further into the future we hope to investigate issue (2) identified in the introduction: the accuracy of CGE models in predicting the effects of changes in trade (and other) policies. This issue is even more difficult than assessing the validity of a basecase forecast. The problem is that during any period in which an economy is adjusting to a change in trade policies, other factors will also be operating. This point was not adequately addressed in the often-cited validation exercise by Kehoe (2005). In that exercise, Kehoe assesses the performance of various models in predicting the effects of NAFTA. He notes that the model of Brown, Deardorff and Stern predicted that NAFTA would increase Mexican exports by 50.8%. Over the period 1988 to 1999, Mexican exports went up by 140.6 per cent. Kehoe invites us to draw the conclusion that Brown *et al*. strongly underestimated the effects of NAFTA. However, what about all the other factors that affected Mexican trade volumes over these 10 years?

We plan to implement a methodology for investigating issue (2) based on the MONASH decomposition technique (see Dixon *et al.* 2000, and Harrison *et al.* 2000). This technique allows us to separate the effects of trade reforms from those of other factors, such as changes in technologies, changes in import-domestic preferences, changes in consumer preferences, changes in world commodity prices, changes in population, changes in required rates of return on capital and changes in transport costs. However, a major assumption in existing applications of decomposition simulations is that changes in trade policies do not affect industry technologies and import/domestic preferences. In a validation exercise we will need to test this assumption. Links between technologies or productivity and trade policy have been suggested by a long stream of authors including Leibenstein (1966, X-efficiency), Krueger (1974, rent seeking), Harris (1984, scale economies and imperfect competition) and Melitz (2003, reallocation of resources between firms within an industry). Links between import/domestic preferences and trade policy have been hypothesized by several authors including Feenstra (1994, variety and the "price" motivating import demands) and Dixon and Rimmer (2002, variety and the nature of import restraints).

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