The JIDEA Model of Japan

Building Macroeconomic Stabilizers and Developing the Accountant[1]

Douglas Meade

Introduction

The JIDEA (Japan Interindustry Dynamic Econometric Analysis) model has been developed by IITI (The Institute for International Trade and Investment) in partnership with INFORUM. This model is a 100 sector interindustry macroeconomic model, grounded on a database of input-output tables, final demands and value added data available annually for 1975 to 1991. Although the model is young, it is fast on its way to becoming a mature model such as the INFORUM LIFT model of the U.S. economy. Equations have been estimated for personal consumption, equipment investment, imports, exports, productivity, wages, profits, depreciation and indirect taxes. The model now includes a good number of macro variables, including disposable income, the savings rate, an aggregate wage index, the unemployment rate, as well as a number of aggregate variables used to get a bird's eye view of the industry totals. In addition to these variables, several hundred have been added in the construction of the "Accountant". This part of the model, described in more detail below, relates the SNA NIPA accounts to the I-O detail, and ensures consistency between the GDP identities, the savings-investment balance, and the external balance.

Japan is somewhat of an outlier from other OECD countries in many respects. Even though overall economic growth has slowed since the heady days of the 60s and early 70s, labor productivity growth in some manufacturing sectors has still been quite high by world standards, and this has no doubt helped Japanese firms in their successful attempts to increase market share in many industries. Since the burst of the "bubble age" from 1989 to 1990, Japan has experienced its first serious post-war recession. Even though the recession now appears to be nearing its end, GDP growth rates for the next few years are expected to remain below 3%. If the increases in manufacturing productivity continue, or spread to other industries, then slowing growth could imply much higher unemployment rates than Japan has known in the recent past. Japan is also distinguished by its high savings rate, and strong (and improving) international capital position. One could well argue that this fact is closely linked with the large trade surplus of Japan with respect to its trading partners, especially the U.S. We hope that the Jidea model will allow us to understand better the forseeable trends in productivity growth, employment, trade, savings and investment. We also want to ensure that the model is internally consistent, i.e., that it satisfies all required nominal balances in the national accounts, and that it diplays reasonable stabilization properties when hit with some kind of "shock" or change from the status quo.

This short paper will serve as a report on the recent progress with this model -- outlining what has been accomplished thus far, showing the nature of the the model at present, indicating the next steps to be accomplished, and soliciting advice and comments from the audience.

A Short Description of the Jidea Model

At present, the JIDEA model includes a complete set of equations for final demands, employment and value added by category. Table 1 shows the explanatory variables used in each equation. Personal consumption, which comprises the largest portion of GDP, is estimated on a per-capita basis, as a function of relative prices and real disposable income per capita. After consumption by commodity has been calculated, it is scaled to total spending, which is determined by disposable income and the savings rate. Equipment investment is estimated for 82 purchasing industries, as a function of lagged output, the loan rate and other variables. This investment is then passed through an investment bridge matrix (100 by 82) to obtain investment at the 100 commodity level. Imports are based on domestic demand, and relative domestic to foreign import prices. The export equations have a variety of forms, but include variables such as foreign demands, the relative price of exports to foreign price of exports, and the percent change in domestic demand by industry. Domestic demand appears in the export equations with a negative sign, indicating that when domestic demand is low, producers divert more production to exports, to try to maintain utilization of capacity.[2]

The productivity equations, discussed in more detail below, are based on a time trend, and the change in output from its peak. The output coefficient takes a different parameter depending upon

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[1] The work described in this paper was done with Mr. Yasuhiko Sasai of the International Institute for Trade and Investment

whether output is above or below the peak. The average hours worked equations are based on the same variables as the productivity equations. Both serve to smooth employment fluctuations relative to fluctuations in output. Wage rates are estimated in two stages. First, an aggregate wage function is calculated, based on changes in aggregate productivity and changes in the money supply to GDP ratio. Industry wages are then estimated based on the aggregate wage, sectoral productivity and the relative size of industry output to total output. Labor compensation by industry is then determined by multiplying industry employment by the industry wage rate. Profits are based on a time trend, percent change in output, and the ratio of the foreign to the domestic export price. This latter variable is used to model reductions in price that exporters must make to compete in foreign markets. The other value added categories, depreciation, indirect taxes and subsidies, are functions of time trends.

Recent Work

As of January 1995, all components of the "input-output" side of the JIDEA model were more or less in place. This includes the final demand categories, the value added categories, output solution, productivity and employment, and price solution. However, at this time, the dynamic properties of the model were poor -- unemployment in our base case reached 12% by the year 2000 -- due to sluggish growth in real incomes and expenditures. The profits equations had been forecast using only a simple time trend. The aggregate wage equation was also based on a time trend. No attempt had been made to compare the near-term forecast of the model after 1991 to published NIPA aggregates. Also, the savings rate had been forecast to be constant, at its 1991 level. Labor force growth had been set exogenously, based on a time trend. (This may have been partly responsible for the high calculated unemployment rates in the model forecast.) There was no data or equation in the model for average hours worked by industry, although there is evidence that this average varies pro-cyclically. The previous version of the model also did not correctly calculate domestic prices using import prices and import shares.

Since January, we have changed and improved the model in the following ways:

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[2] Presumably, they also lower the export price in order to do so. However, the export price equations currently do not take this kind of behavior into account.

Table 1 - Final Demand, Productivity and Value Added Equations

Equation	Dependent Variable	Explanatory Variables
Personal Consumption	Consumption Per Capita	Disposable Income Per Capita, Relative Price, Dummy Variables
Government Consumption	Government Consumption	Time Trend, Dummy Variables
Equipment Investment	Equipment Investment	Lagged Output, Lagged Real GDP, Oil Price, Interest Rate, Tax Rate, Dummy Variables
Imports	Imports	Domestic Demand, Relative Domestic to Foreign Import Price Ratio, Dummy Variables
Exports	Log of Exports	Log of Foreign Demands, Log of Weighted Average of Export Price to Foreign Price, Percent Change in Domestic Demand (Industry), Log of Change of Aggregate Domestic Demand, Dummy Variables
Productivity	Log of (Employment/Output)	Time Trend, Dummy Variables, Change in Output from Peak (up and down)
Average Hours Worked	Annual Hours per Worker	Time Trend, Dummy Variables, Change in Output form Peak (up and down)
Wage Rates	Wages/Employment	Aggregate Wage, Productivity, Relative Size (Industry Output/Total Output), Oil Price, Dummy Variables
Profits	Profits / Real Output	Time Trend, Dummy Variables, Change in Output, Relative Foreign to Domestic Price
Depreciation	Depreciation/ Real Output	Time Trend, Dummy Variables, Oil Price
Indirect Tax	Indirect Taxes/Real Output	Time Trend, Dummy Variables, Oil Price
Subsidies	Subsidies / Real Output	Time Trend, Dummy Variables, Oil Price

- A new version of the Pseidel price calculation routine was added, which makes use of import prices, and average import to domestic demand ratios, to calculate a domestic output price that incorporates import prices.
- The export and import price equations have been updated and revised.

- The employment and productivity equations have been revised. Now productivity is calculated on the basis of hours worked instead of the number of jobs.
- We have estimated new average annual hours equations, based on changes in output and a time trend.
- An exchange rate scalar and foreign demand scalar have been added to the model for estimating impacts of changes in the trade environment.
- We have incorporated the ability to impose import group fixes consistently into the model.
- A final demand discrepancy calculation has been incorporated into Seidel.
- The profit equation is now based on percentage change in output, and relative price of exports, as well as a time trend. This one change greatly improved the dynamic forecasting properties of the model.
- We have changed the labor force projection. This is now it is based on population projections multiplied by a forecasted labor force participation rate.
- We have experimented with relative export prices in the profits equation, with mixed results.
- We have also experimented with aggregate investment to GDP ratios, or aggregate capital stock to GDP ratios, in the productivity equations, with mixed results. These variables are highly significant, but the dynamic behavior of the model is strange. See the section below on productivity.
- Disposable income is now calculated within the accountant. The aggregate wage function is now based on productivity growth as well as money supply growth.
- We have experimented with running the model with growth rates of GDP aggregate components fixed in the near term. This imposes the recently observed slow growth on the model, but the model wants to jump after this point (1994).
- We have examined the Japanese NIPA accounts closely (SNA based), and compared with corresponding aggregates from the I-O data. At this point we have not yet been able to determine the sources of differences. Much of the accountant for Jidea has now been completed.

With these changes, the dynamic behavior of the model is much better, and we have extended the set of scenarios which the model can analyze. However, there are a number of important areas which still need to be improved, or studied further. They are discussed in the following sections.

Table 2 - Productivity Growth Rates of the Fastest Growing Japanese Industries Ranked by Growth Rate from 1975-1991

Rank	*Industry*	*75-91*	*75-80*	*80-85*	*85-90*	*90-91*	*91-95*	*95-00*
1	52 Electric computing equipment	14.25	18.14	11.60	14.22	8.19	15.44	11.34
2	50 Machinery for office and service industries	13.98	17.45	14.09	10.66	12.78	12.74	13.22
3	55 Semi-conductor devices and integrated circuits	13.11	14.65	16.48	8.95	9.29	12.45	8.78
4	54 Applied electronic equipment	11.87	16.93	11.21	9.49	1.81	13.26	8.73
5	24 Petrochemical basic products	9.99	9.30	15.84	7.48	-3.28	9.26	7.82
6	32 Plastic products	9.72	7.56	13.30	9.68	2.80	9.71	8.63
7	28 Medicaments	9.62	7.98	14.04	9.20	-2.18	9.30	8.31
8	53 Communication equipment	9.51	8.51	7.31	13.19	7.07	10.63	10.44
9	94 Car renting	8.02	7.33	3.63	13.44	6.26	8.31	8.65
10	27 Chemical fibers	7.47	18.65	4.11	1.54	-2.02	5.62	5.36
11	51 Household electric equipment	7.24	14.18	6.14	0.26	12.85	4.86	5.72
12	65 Precision instruments	6.80	11.45	5.12	3.96	6.04	6.11	5.76
13	2 Livestock raising and serieculture	6.70	9.19	8.87	2.17	6.14	6.01	5.82
14	59 Motor vehicles	6.66	9.91	4.92	6.01	2.35	6.69	6.04
15	57 Other electrical machinery	6.52	9.22	2.93	7.92	3.98	6.94	6.24
16	81 Air transport	6.47	10.33	2.99	6.98	2.10	6.31	5.93
17	92 Research and information service	6.46	3.42	3.32	12.96	4.86	8.62	8.45
18	26 Synthetic resins	6.37	11.99	2.28	6.35	-1.17	6.66	5.15
19	25 Organic chemical products	6.19	8.38	6.40	5.46	-2.19	5.90	5.44
20	35 Glass and glass products	6.05	11.32	3.30	4.16	2.84	5.73	5.09

Labor Productivity Growth

At least since 1960, labor productivity growth in many industries in Japan has been phenomenal. Measuring labor productivity as real output divided by total hours worked, calculated productivity growth is over 10% in many Japanese industries over the 1975 to 1991 period. Quite a few of these are the same industries that have been quite successful in penetrating U.S. and other world markets. Table 2 shows growth rates for selected years for the top industries, ranked by the overall 1975 to 1991 growth rate. Computers, office machinery, semi-conductors, electronic equipment, and communication equipment all have enjoyed productivity growth rates of over 9%. Other important export items, such as motor vehicles, electrical machinery and equipment and instruments have had growth rates of at least 6%. These growth rates are well above the corresponding productivity growth rates in the U.S. for the same industries.

One may reasonably wonder how long such strong growth rates can continue. Some economists argue that Japanese productivity growth rates are so high partly because Japan started off after the war with low levels of productivity relative to the U.S. As Japanese productivity levels approach or "catch up" to the limit of what is technologically feasible, productivity growth is likely to slow down. Indeed, for many of the high productivity industries, there does seem to be a slowdown beginning around 1985. The only recession year in our data, 1991, includes negative productivity growth for many of these same high growth industries, but this is probably due entirely to labor hoarding.

A set of simple labor productivity equations similar to those in the U.S. LIFT and *Iliad* models have now been estimated for Jidea. These equations are implemented as a regression of the logarithm of hours divided by real output on a time trend and changes in output from its peak level. Changes in a positive direction are represented by a variable called `Qup` and changes in a negative direction by the variable `Qdown`, as in LIFT. This approach models the effects of labor hoarding during the business cycle. When real output falls below a previous peak, employment does not fall in the same proportion, causing labor productivity to decline. When output grows again, workers may not be hired quite as fast as output increases, so labor productivity increases.

The last two columns of Table 2 show average annual productivity growth in a forecast from the model using these equations. Since the estimated time trend coefficient is generally in the same neighborhood as the average historical growth rate, the top 15 growing industries are forecast to have continuing fast labor productivity growth. Slowing output growth in the 1990s, which is being observed in Japan, coupled with continuing high rates of productivity growth, imply that the level of total employment actually falls at first, grows slightly and then falls again, leading to higher unemployment rates by 2000.

Figure 3. Growth Rates of Large Employment Industries in Japan

Ranked by Total Hours in 1991

Rank		*Industry*	*Total Hours*	*Percent of Economy*	*Productivity Growth Rate: 1975-1991*	*Regression Time Trend Coefficient*
1	74	Trade	1834562	16.3%	3.2%	2.4%
2	98	Personal services	1621966	14.4%	0.8%	0.6%
3	1	Agriculture for crops	703024	6.3%	0.9%	1.0%
4	67	Construction	591001	5.3%	2.6%	2.7%
5	95	Other business services	475061	4.2%	2.2%	1.3%
6	69	Civil engineering	448694	4.0%	2.1%	2.4%
7	79	Road transport	387420	3.5%	2.9%	2.5%
8	75	Financial and insurance	349358	3.1%	2.8%	3.9%
9	86	Public administration	334754	3.0%	2.9%	2.6%
10	66	Miscellaneous manufacturing	316615	2.8%	2.7%	2.7%
11	89	Medical service, health and social security	257222	2.3%	4.5%	4.1%
12	11	Food products	236082	2.1%	1.3%	1.4%
13	46	Other metal products	176372	1.6%	4.3%	3.9%
14	33	Rubber products	170473	1.5%	2.9%	2.9%
15	59	Motor vehicles	161900	1.4%	6.7%	6.4%

Before placing too much blame on the "high achiever" industries, however, we should determine how important they are in the aggregate economy. In 1991, all industries which had an average growth rate above 5% for the 1975 to 1991 period make up just over 9% of the total economy employment, measured in hours. To understand which industries are the most important in the aggregate economy, look at Table 3. In this table, industries are ranked in terms of size measured in total hours, and the percentage of total hours for the entire economy is shown in the second column. The third column contains the productivity growth rate for this industry from 1975 to 1991, and the last column shows the time trend coefficient estimated in the regression equation for this industry, which provides a good indication of how average productivity growth will look in the forecast. Although these growth rates would be strong by U.S. standards, they are not extremely high by Japanese standards. In fact, these largest industries seem to have average or below average growth rates. However, if overall output is growing more slowly than aggregate productivity, then employment growth will be negative.

Figure 1

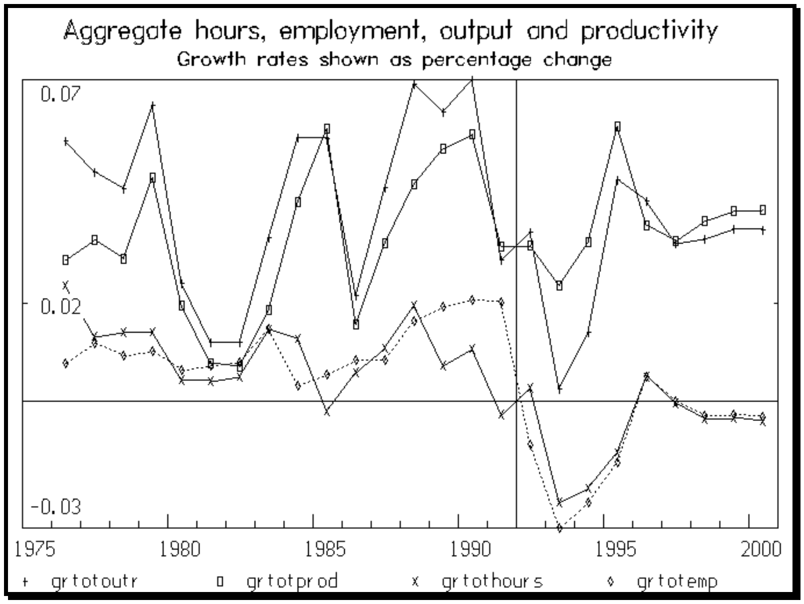


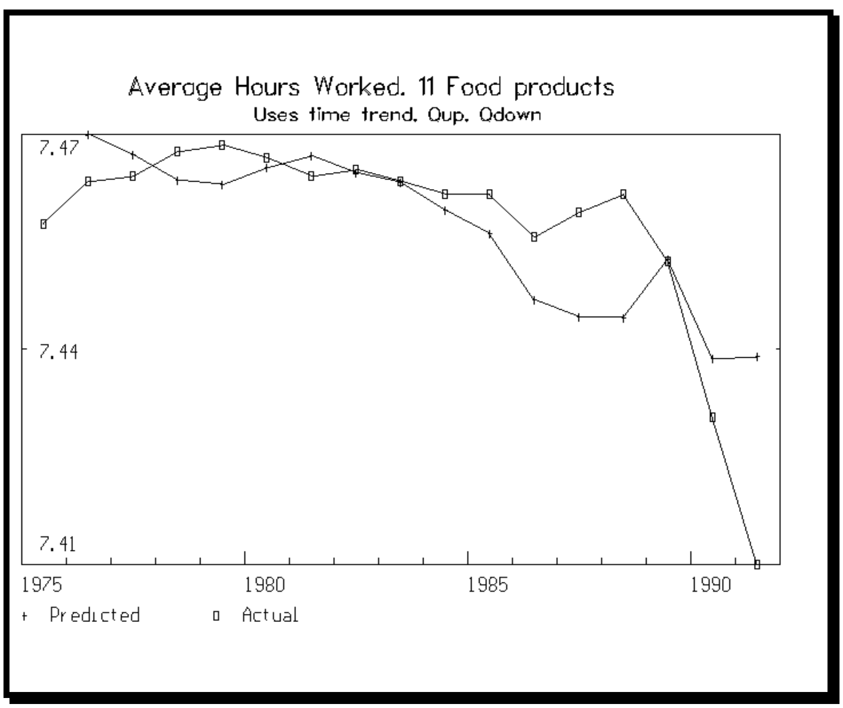
Figure 1 shows a graph of the percentage change growth rates of aggregate output, productivity, hours and employment. Two observations can be quickly made from this graph. First, the large jumps in growth rates of labor productivity seem to move with corresponding swings in the growth rates of output. Growth rates in total hours worked are much more steady. Second, for most of the historical period, labor productivity growth has been slightly less than output growth, allowing for a slow growth in total hours worked.

In the forecast, which was made with preliminary labor productivity equations, the growth rate of output slows down, especially from 1991 to 1994. Since at this point aggregate productivity growth is higher than output growth, total hours worked must shrink. One other observation which can be drawn from Figure 1 is that there should also be some smoothing due to the average hours worked per employee. Particularly in the period from 1989 to 1991, as hours growth rates are declining sharply, growth in employment is steady. Employment growth also shows less variance than hours growth in the historical period, but the 1989 to 1991 period stands out.

Noticing how strongly the aggregate productivity growth moved in response to output growth, the coefficients on the `Qup` and `Qdown` terms were constrained. Since the dependent variable in the productivity equation is really the inverse of productivity (hours/output), a positive relationship between output and productivity translates into a negative expected sign for `Qup` and `Qdown`. The `Qup` parameter was softly constrained to -0.5, and the `Qdown` parameter to -1.0. This was done for the following reasons. First, I observed that in the unconstrained regressions, the `Qup` parameter generally wanted to be smaller than the `Qdown` parameter. Second, looking at the aggregate graph, productivity growth seemed to respond more quickly to falling output growth than to rising output growth. This would mean that firms tend to resist reductions in employment in downturns more than they resist increases in hiring in upturns. This seems reasonable, and it also improves the behavior of the hours forecast.

In order to capture the employment smoothing effects of the hours worked relationship, a similar equation for the average hours worked by industry (using `Qup`, `Qdown`, etc.) was estimated but none of the coefficients have been constrained. In order to be procyclical, and therefore smooth out the employment movements relative to hours, the signs on the coefficients should all be positive. However, they were left free to pick up the differential effects of `Qup` and `Qdown`. In the last few

Figure 2



years, average hours worked per employee have declined drastically in many industries. Therefore, the equation usually has a rather large error in the last year of estimation. Figure 2 illustrates the problem with a regression plot from one of the average hours equations. Average hours in the food industry is stable until after 1989, after which they drop suddenly in 1990 and 1991. This pattern shows up again in industry after industry. This may be an effect of the rise and decline of the "bubble economy" in Japan. Up until 1991, employment growth in Japan was still fairly strong, as if it were taking a while for Japanese firms to realize that output growth was slowing. When growth did decline, rather than lay off workers, firms reduced hours worked, perhaps in the hope that output growth would recover later.

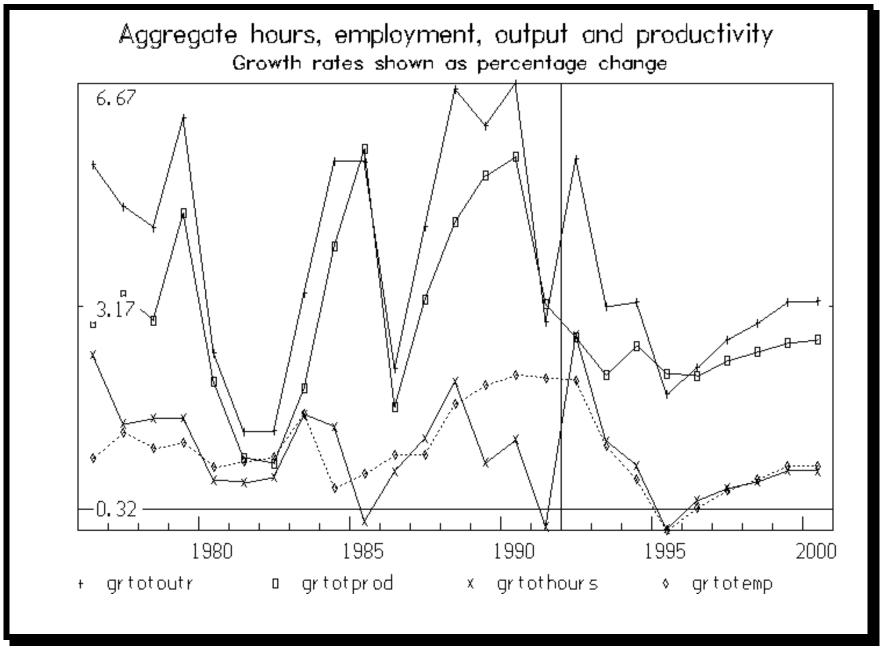
To keep the forecast of average hours worked from having a large jump in the first year, a value for rho of .8 was imposed on all of the equations. Figure 3 shows a forecast of the growth rates of the same variables as in Figure 1, after using the new productivity and average hours equations, and fixing the 4 largest employment sectors to have slower productivity growth. Now productivity growth stays below output growth on average, allowing for positive growth in hours worked. The average hours function is also successful in smoothing the growth of employment.

A Low, Stable Unemployment Rate?

The Japanese economy is famous for maintaining a low unemployment rate, which has remained between 2% and 3% for much of the post-war period. However, the Jidea model initially had no built in stabilizers which were adequate for maintaining a stable unemployment rate. The addition of the percentage change in output term in the profits function helped stabilize the model quite a bit, as did the addition of a savings rate equation, described below. The work described in the previous section also helped to make overall employment growth smoother.

In addition to this work, we decided to have a closer look at the labor force growth, by modeling labor participation rates as a percentage of total population. Many have criticized the measurement of unemployment in Japan because of the treatment of women in the labor force. A typical Japanese woman, even with a college degree, is expected to be a temporary member of the labor force.

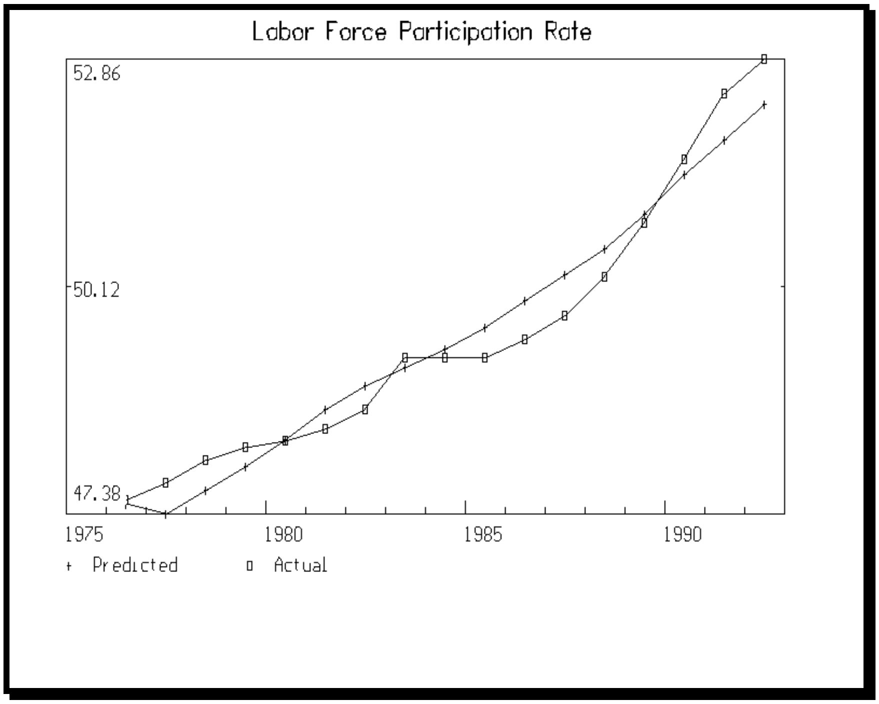
Figure 3



When she gets married and has children, she is expected to devote her time to raising a family. Later, when the children grow up, she may return to work, but her employment security is more conditional and uncertain than that of a man. When a firm needs to reduce its work force, it may first respond by asking many of the women workers to leave. In the Japanese employment data, these women are then treated as leaving the labor force entirely. Therefore, they never count amount the "unemployed". As a result, labor force growth is also procyclical, leading to a further smoothing of the reported unemployment rate in comparison with the level of total employment.

A number of variables representing the strength of economic growth were tried in the labor participation equation, including the percent change in disposable income, the percent change in real GDP and the unemployment rate. Only the unemployment rate was significant. The best dynamic behavior of the labor force participation rate so far was obtained with an equation that used the current value and two lagged values of the unemployment rate, with the total of the coefficients constrained to be -.5. Figure 4 shows the regression fit of the labor force participation equation, and the equation estimation results are shown below it. This equation only picks up some of the cyclicality of the labor force participation rate. Without the constraint, it fit much better, but this made the model unstable, as the sum of coefficients on the unemployment rate came to -1.2. In this case, changes in

Figure 4



Labor Force Participation Rate

```
SEE   =       0.32 RSQ   = 0.9591 RHO =   0.77 Obser  =   18 from 1975.000
SEE+1 =       0.21 RBSQ  = 0.9465 DW  =   0.45 DoFree =   13 to   1992.000
MAPE  =       0.54
```

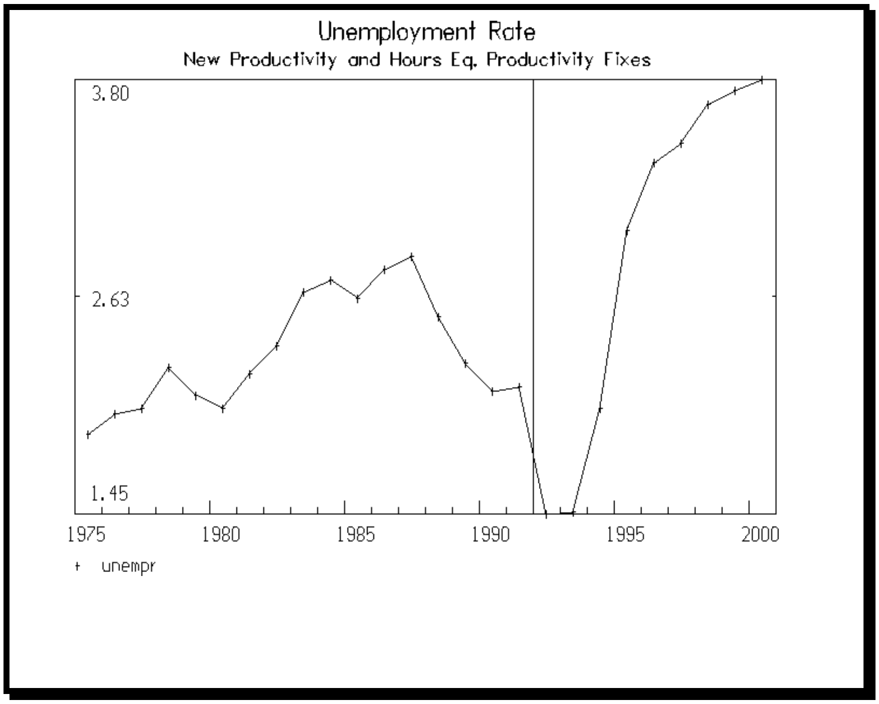
Variable name	Reg-Coef	Mexval	t-value	Elas	NorRes	Mean
0 labpar	- - - - - - - - - - - - - - - - - - - -					49.42
1 intercept	23.03250	286.6	13.687	0.47	26.19	1.00
2 unempr	-0.11071	11.6	-1.816	-0.01	24.48	2.27
3 unempr[1]	-0.22569	3.6	-0.988	-0.01	24.34	2.19
4 unempr[2]	-0.21999	3.7	-1.001	-0.01	20.39	2.07
5 timet	0.33036	351.6	16.139	0.56	1.00	83.50

the unemployment rate would be more than compensated for by changes in the labor force participation rate. The forecast of the unemployment rate with this participation equation in the model is shown in Figure 5.

The Projection of the Japanese Savings Rate

Japan has one of the highest combined savings rates of any of the OECD countries. This is an important factor in the positive external balance, and also helps to provide a cheap source of funds for domestic and foreign capital investment. One of the largest components of total savings is personal

Figure 5

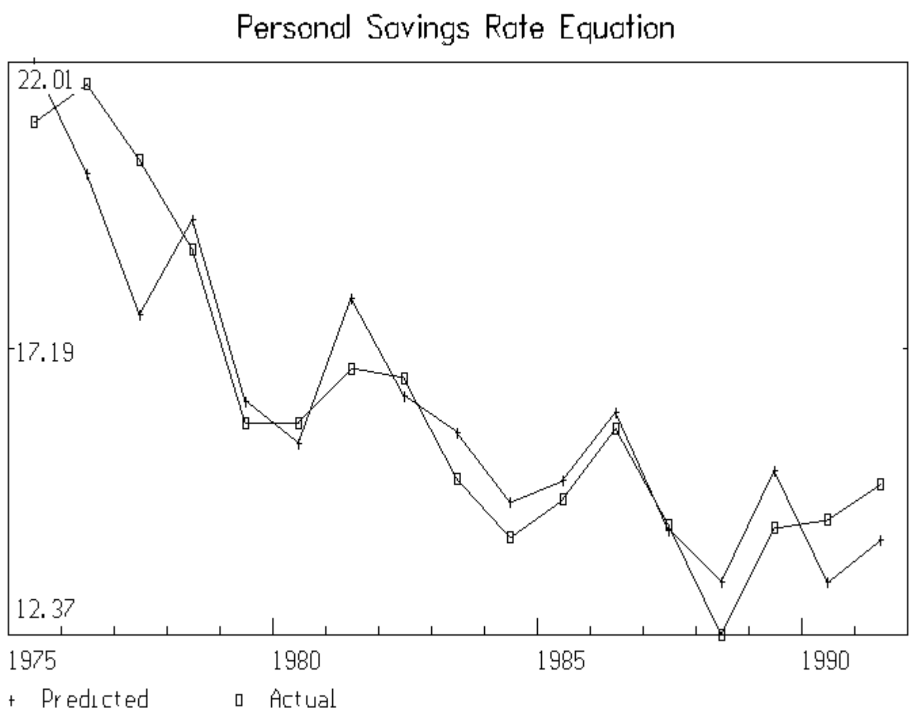


savings, which generally comprises 50 to 60 per cent of the total. The personal savings rate, defined as personal savings divided by disposable income, has fallen from a level of about 20% in 1975 to about 15% in the early 1990s. Can we explain this drop in the savings rate with the same factors that have been successfully used in the U.S. and in other countries? Can a savings rate equation so estimated contribute to the stability of the model?

Three variables that have been successful in explaining the personal savings rate in the U.S. are: the unemployment rate; the change in disposable income; and the share of motor vehicles in total personal consumption. The savings rate is generally negatively correlated with the unemployment rate. When workers are temporarily unemployed, they tend to draw down on savings to smooth their consumption. In addition, higher unemployment rates signify a weaker economy, which tends to cause consumers to be more cautious. Another useful variable is the percentage change in disposable income. Transitory changes in disposable income tend to be saved, also due to consumption smoothing. Finally, the share of consumption of motor vehicles in total consumption is a useful variable. Consumers consider durables in general, but especially autos, to be a substitute for savings. This is due to two reasons. First, consumers do not consider the purchase of a durable item such as a car to be "consumed" in the year it is bought, but rather it is consumed over time. Second, one purpose of savings is often to save for the purchase of large, expensive durable items.

The graph in Figure 6 and the regression table below it show the results of estimating the savings rate equation with these three variables. The unemployment rate is included with a lag, to reduce simultaneity. The fit is very close, and we may be led to believe that these variables are ideal for the

Figure 6. Personal Savings Rate Equation Without Constraints

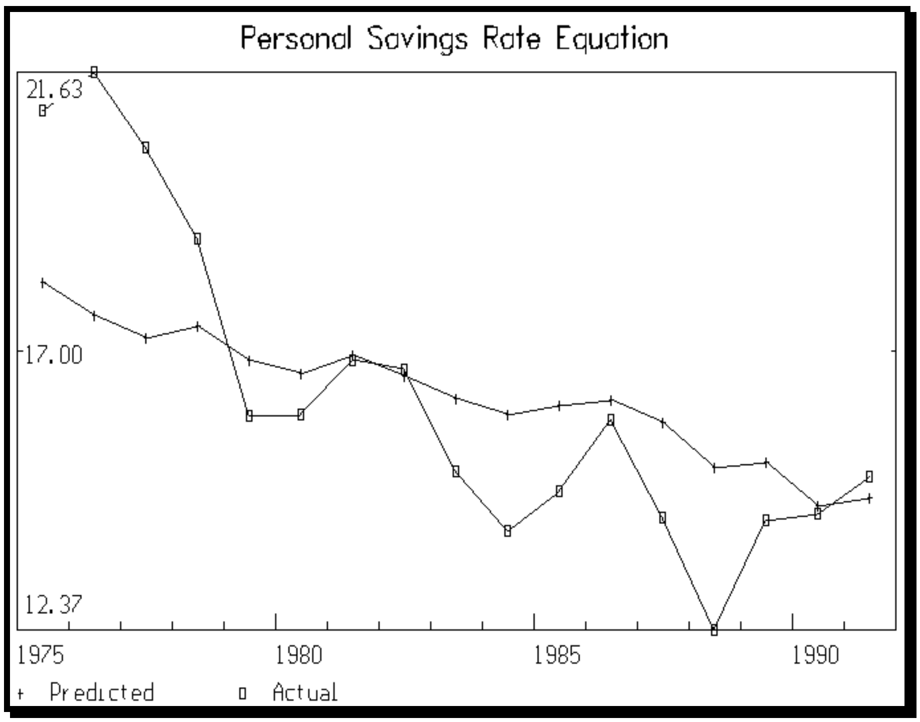



```
Personal Savings Rate Equation
  SEE   =       1.00 RSQ   = 0.8520 RHO =   0.15 Obser  =   17 from 1975.000
  SEE+1 =       0.99 RBSQ  = 0.8178 DW  =   1.69 DoFree =   13 to   1991.000
  MAPE  =       4.81
    Variable name           Reg-Coef  Mexval t-value  Elas   NorRes     Mean
  0 savrat                - - - - - - - - - - - - - - - - - - - - -    16.28
  1 intercept               23.95077   535.7  22.634   1.47    6.76      1.00
  2 unempr[1]               -2.93713    84.8  -5.602  -0.40    3.13      2.19
  3 pcdisincr                0.62815    35.2   3.280   0.13    2.70      3.49
  4 motvshare               -2.92668    64.4  -4.706  -0.21    1.00      1.17
```

explanation of the savings rate within the model. However, look at the coefficients on the lagged unemployment rate (-2.9) and the motor vehicles share (-2.9). These are rather large, and one might expect them to lead to an unstable model.

In fact, the equation in Figure 6 was tried in Jidea, but the model gyrated wildly, following a zag

Figure 7. Personal Savings Rate Equation With Constraints




```
                      Personal Savings Rate Equation
SEE   =       1.82 RSQ   = 0.5084 RHO =   0.81 Obser  =   17 from 1975.000
SEE+1 =       1.24 RBSQ  = 0.3950 DW  =   0.39 DoFree =   13 to   1991.000
MAPE  =       8.44
  Variable name           Reg-Coef  Mexval t-value  Elas   NorRes      Mean
0 savrat                - - - - - - - - - - - - - - - - - - - - -     16.28
1 intercept               19.32040   307.5  15.057   1.19    2.63      1.00
2 unempr[1]               -0.57873    39.1  -3.684  -0.08    1.64      2.19
3 pcdisincr                0.09722     0.3   0.315   0.02    1.63      3.49
4 motvshare               -1.80657    27.7  -3.027  -0.13    1.00      1.17
```

pattern. If unemployment in the previous year were high, this would cause the savings rate to be much lower, which would cause consumption in the current year to be high. Then the unemployment rate in the current year would be much lower, due to the extra consumption demand. In the following year, the low unemployment rate would cause the savings rate to be much higher, thus choking off consumption. If the current year value of the unemployment rate was used in the savings rate equation, the model would often not converge.

Therefore, the sign on the lagged unemployment rate was softly constrained to about .5, yielding the equation shown in Figure 7. The estimated equation results are show in the table below the graph. This is the equation now used in the model, which gives it much more stable macroeconomic behavior.

Creating an Accountant for the JIDEA, Using the Japanese System of National Accounts (SNA)

The "accountant" in an INFORUM model is a set of calculations which derive the tables of the national accounts, relating quantities in these tables to aggregates or individual sectoral variables from the I-O model, or deriving them in separate econometric equations. Many of the calculations in the accountant are simple identities. Finally, many variables can be calculated by the modeling technique of "behavioral proportions".[3]

Why is an accountant desirable? In the first place, it enables us to create tables that match those seen in the national accounts. Many users of economic forecasts are accustomed to viewing the economy in terms of the national accounts tables, and can more easily relate to the results of a model forecast when it is presented in that way. To the extent that the I-O calculations do not match the corresponding NIPA variables exactly, discrepancies can be calculated to translate from the I-O to the NIPA. A second reason is that the accountant may generate some variables which are necessary in the calculation of detailed industry equations. For example, personal disposable income can be calculated from the household disbursements and receipts account, as the sum of compensation, property income and transfer payments, minus taxes, transfers to others and social insurance contributions. This allows for the direct modeling of the effects of a change in the income tax rate on

[3] See the paper by Clopper Almon presented at this conference, entitled “Identity-Centered Modeling in the Accountant of SNA-Based Models”.

disposable income as well as the effects on the government surplus or deficit. Finally, the accountant can help to enforce consistency on the model, by showing the state of various balances which should be satisfied. For example, the savings estimated from each of the 5 sectors of the SNA add up to total savings. This total savings is then used in the savings-investment balance to determine net foreign lending. Finally, net foreign lending is related to the current account surplus, which can be independently calculated from the external balance account. If the current account surplus calculated from one identity is different from that calculated from the other identity, then this implies that the model is inconsistent.

The Annual Report on National Accounts was made available to us on a CD-ROM produced by the Economic Planning Agency (EPA). This data set consists of .WK1 files of the main tables of the national accounts, with English titles. A NIPA G databank was created, using the *123ToG* program. Most of the series in this bank are available from 1980 to 1993, although some begin in 1970.

Table 4. Relation Between GDP Components in the I-O and the NIPA

Item	***I-O***	***NIPA***	***Discrepancy***
GDP by Expenditure Category			
Consumption expenditure of households and non-profit	188,313.4	188,759.5	446.1
Consumption expenditure of government	30,106.0	30,685.3	579.3
Gross domestic public investment	22,287.6	21,648.2	-639.4
Gross domestic private investment	63,626.8	66,391.3	2,764.5
Change in stocks	2,015.3	2,158.8	143.5
Exports of goods and services	47,544.7	46,307.1	-1,237.6
(less) Imports of goods and services	37,618.2	35,531.6	-2,086.6
Gross domestic product	**316,275.5**	**320,418.7**	4,143.2
GDP by Income Category			
Labor compensation	171,446.8	173,892.0	2,445.2
Operating surplus	81,320.5	81,500.7	180.2
Consumption of fixed capital	43,478.2	43,615.4	137.2
Indirect taxes	23,631.6	24,899.7	1,268.1
(less) Subsidies	3,601.7	3,649.9	48.2
Statistical discrepancy		160.9	160.9
Gross domestic product	**316,275.5**	**320,418.7**	4,143.2

The Japanese SNA is organized in a fairly typical manner. The domestic macroeconomy is divided into five major sectors: households (including private unincorporated non-financial enterprises), general government, private non-profit institutions serving households, financial institutions and non-financial incorporated enterprises. For each sector there is a table showing disbursements and receipts, in billions of Yen. A system of names for the series in the G bank was developed that was logical and easy to remember. For example, the name for personal saving by households is "savhop", formed from the general code for savings ("sav") combined with a code for the household sector ("ho"), followed by a "p" to indicate it is on the payments side of the account. In addition to the domestic accounts, there is the rest of world account, which is required for all accounts to be in balance.

For each sector, there is also a separate savings and investment account, but we have only worked with the consolidated savings and investment account for all five sectors. The external balance account shows the balance of receipts and payments from foreign transactions. Once the above accounts have been calculated, the components of the national income table can also be calculated.

Before presenting some of the calculations of the accountant, it may be useful to discuss the differences between GDP according to the I-O tables, and GDP in the national accounts. Table 4 shows the corresponding expenditure and income components from the I-O accounts and the NIPA accounts for 1985, which is the base year of the I-O tables, and the base year of Jidea. From this table one can readily see that the GDP from the NIPA is larger than that of the I-O by more than 4 trillion yen, which is a little more than 1%. This difference is comprised mostly of investment and imports on the expenditure side, and by labor compensation and indirect taxes on the income side. Note that the I-O accounts show another category in both final demand and value added, called Consumption expenditures outside households, but that this is not included in GDP. This category represents items like business lunches and other perquisites that should logically be treated as intermediate purchases.

In order to forecast the GDP components as measured by the NIPA, a discrepancy is calculated in the last year of available I-O data, and this is added as a constant throughout the forecast. If the I-O calculations yield current dollar GDP estimates for the expenditure side and for the income side that are equal, then the NIPA discrepancy-adjusted GDP estimates will also be equal. If the two versions of GDP are equal, and we have the rest of our identities right, then all of the balances should be satisfied in the model forecast.

Table 5 shows the 5 current income accounts in the Japan SNA for 1985, as well as the relation with the rest of the world. This table is a key one for understanding some of the balances which must hold. Note that to make the use of the table easier, I have moved some items from the receipts to the disbursements side, and vice-versa. For example, direct taxes collected by government (38484.9) are paid by households (21248.2), non-financial (13706.8) and financial (3529.9). By placing the direct taxes receipts of the government on the disbursements side as a negative, we can verify on the right margin that total taxes collected are equal to total taxes paid, since the margin is zero. This is also true for fees, fines and penalties, which is also collected from households, non-financial and financial institutions. Social security contributions are collected from households and paid to the government, and vice-versa with social security benefits. Social assistance grants go to households, but are paid by government and non-profits.

What about the rows which do not have zero for the row total? Other balances appear in this

Table 5. Current Income Accounts in the SNA
All Values in Billions of Yen, for 1985

Item	*Household*	*Government*	*Non-financial*	*Financial*	*Non-profit*	*From Rest of World*	*To Rest of World*	*Total*
Final consumption expenditure	186234.6	30685.3			2524.9			219444.8
Property income payments	11985.4	14317.9	33628.0	72122.5	900.5	5457.7		138412.0
Net casualty insurance premiums	1728.6	10.6	1082.3	66.3	18.6			2906.4
Casualty insurance claims				2906.5				2906.5
Subsidies		3649.9						3649.9
Direct taxes	21248.2	-38484.9	13706.8	3529.9				0.0
Compulsory fees, fines and penalties	194.1	-338.5	116.1	28.3				0.0
Social security contributions	26184.5	-26184.5						0.0
Current transfers to private NPOs	2526.4	1128.6			-4305.6			-650.6
Unfunded employee welfare contributions	57.7	8.3	46.8	0.9	1.8			115.5
Current transfers n.e.c. to residents(?)	14806.0	301.1	717.0	387.6				16211.7
Current transfers n.e.c. to ROW		90.3					355.0	445.3
Saving	34421.0	13654.8	10115.9	-485.5	375.5			58081.7
Total Disbursements	299386.5	98764.3	59412.9	78556.5	5555.1			
Compensation of employees	173815.3					-310.7	387.4	173892.0
Operating surplus	40890.3		49749.8	-9139.4				81500.7
Property income receipts	31316.6	8369.4	8524.4	84723.4	1234.6		4243.8	138412.2
Casualty insurance claims	1726.1	10.1	1092.0	65.1	13.2			2906.5
Net casualty insurance premiums				2906.5				2906.5
Social security benefits	28960.3	-28960.3						0.0
Social assistance grants	7691.0	-5957.2			-1733.8			0.0
Indirect taxes		24899.7						24899.7
Unfunded employee welfare contributions	57.7	8.3	46.8	0.9	1.8			115.5
Current transfers n.e.c. from residents(?)	14929.2	456.8						15386.0
Current transfers n.e.c. from ROW		12.3				101.9		114.2
Total Receipts	299386.5	98764.5	59413.0	78556.5	5555.2			

Table 6. Summary of Transfer Disbursements and Receipts
All Values in Billions of Yen, for 1985

Item	*Value*
Current transfers n.e.c to residents	16211.7
Current transfers n.e.c. to rest of world	192.2
Current transfers to private NPOs	3655.0
Total transfer disbursements	20058.9
Current transfers n.e.c. from residents	15386.0
Current transfers n.e.c. from rest of world	367.3
Current transfers received from NPOs	4305.6
Total transfer receipts	20058.9

table, some more obvious than others. For example, total property income payments (138412.0) must be equal to total property income receipts, if the rest of the world is included. Property income consists of dividend, rental and interest income. In some of the sectors these are displayed separately, but in others they are not. Therefore, we cannot determine the balance for dividends or interest *per se*, but only at the total property income level. Note that the rest of world property income receipts and payments are part of the exchange of factor income, which also appears in the external balance. Total casualty insurance claims (2906.5) are equal to total casualty insurance premiums. In addition, the financial sector contains an entry for these items which offsets the total, since it is the sector which processes insurance. Unfunded employee welfare contributions are small, and receipts are equal to payments for each sector.

The next set of items consists of transfer payments of one form or another, and as you might imagine, total transfers received must equal total transfers paid. However, the identity is not immediately obvious from this table. Transfers to non-profit organizations (NPOs) are smaller than recorded receipts of transfers by NPOs, by 650.6 billion yen. Although not shown explicitly, this difference is made up by differences in transfers paid and received to residents and the rest of the world (ROW). Table 6 shows that current transfers to residents, rest of world, and non-profits must equal total transfers from residents and the rest of the world.

Table 7. Consolidated Savings and Investment Account
All Values in Billions of Yen, for 1985

Item	*Value*
Gross domestic fixed capital formation	88039.5
Increase in stocks	2158.8
Net lending to the rest of the world	11517.5
Gross accumulation	101715.8
Saving	58081.7
Consumption of fixed capital	43615.4
Capital transfers from the rest of the world (net)	-142.2
Statistical discrepancy	160.9
Finance of gross accumulation	101715.8

The other items on the table which haven't been netted out to zero in some way include items which enter on either the expenditures or income side of the GDP account, or in the savings-investment account. On the disbursements side are total consumption expenditure, which includes personal household and non-profit consumption, and government consumption. The disbursements side of the account also shows total savings, which enters into the savings-investment balance. On the receipts side of the table, total compensation of employees, total operating surplus and indirect taxes are included in the income side of GDP, and subsidies from the disbursement side of the table enter

Table 8. External Balance Account
All values in billions of yen, for 1985

Item	*Value*
Exports of goods and services	46307.1
Compensation of employees from the rest of the world	310.7
Property income from the rest of the world	5457.7
Other current transfers from the rest of the world	101.9
Total current receipts	52177.4
Imports of goods and services	35531.6
Compensation of employees to the rest of the world	387.4
Property income paid to the rest of the world	4243.8
Other current transfers to the rest of the world	355.0
Surplus of the nation on current transactions	11659.7
Disposal of current receipts	52177.5

the income side of GDP as a negative.

The savings and investment account, shown in Table 7, combines information from the GDP account and from the current income accounts. Gross domestic fixed capital formation and increase in stocks are taken directly from the expenditure side of GDP. Consumption of fixed capital and the statistical discrepancy come from the income side of GDP. Finally, total saving is the row total of savings of all sectors from the current income account. The two items remaining can be determined as a residual, and represent the net international capital position.

The net total of these two items must be equal by definition to the surplus on current transactions, shown at the bottom of Table 8 (11517.5-(-142.2)=11659.7). Imports and exports from this table come directly from the GDP accounts. Rest of world compensation of employees, property income, and current transfers have all been discussed above. The current account surplus calculated in this table as a residual should equal the corresponding item in the savings and investment account. This provides a good check on the consistency of the model.

The strategy used in modeling the SNA accounts in Interdyme was to begin with the GDP accounts, relating each item to the corresponding item from the input-output accounts by discrepancy. The next step was to estimate the components of the 5 current income accounts. In this stage, first an estimate was made for the totals for property income, casualty insurance claims, and transfers. Then the individual components were estimated as proportions of the total. For example, total property income payments was estimated in a simple regression on GDP and the interest rate. This total was then divided up into the many component payments and receipts by ratios, which could be controlled in the forecast through the use of fixes. Usually the largest item in the set was derived as a residual, removing the burden of requiring projected shares of payments and receipts by sector to sum to one.

Table 9. External Balance Account
Jidea Model Forecast

External Balance, on Current Transactions
(Thousand million Yen)

	1990	1991	1993	1994	1995	2000
	----	----	----	----	----	----
Exports of goods and services	45919.9	46810.0	53329.9	57287.8	60234.8	88038.3
Compensation of employees from the rest of t	447.2	441.0	520.4	525.6	530.9	558.1
Property income from the rest of the world	18072.8	19325.8	16860.7	18164.8	18811.0	24214.2
Other current transfers from the rest of the	148.8	163.4	149.3	155.8	159.0	185.8
Current receipts	64588.7	66740.2	70860.3	76134.0	79735.7	112996.5
Imports of goods and services	42871.8	38529.0	35712.7	36677.3	38161.4	58338.1
Compensation of employees to the rest of the	313.4	350.1	319.4	322.6	325.9	342.6
Property income to the rest of the world	15274.5	16227.2	12681.1	13661.9	14147.9	18211.8
Other current transfers to the rest of the w	491.3	462.2	660.2	688.8	703.0	821.5
Surplus of the nation on current transaction	5637.6	11171.7	21486.8	24783.3	26397.5	35282.5
Surplus calculated from capital account.	5637.6	7964.6	24237.6	22521.7	22579.6	16943.7
Difference in surplus calculated two ways	0.0	3207.1	-2750.8	2261.6	3817.9	18338.8
Disposal of current receipts	64588.7	66740.2	70860.3	76134.0	79735.7	112996.5

A key objective in the calculation of the current income accounts is the calculation of personal disposable income, which is defined in this framework as final consumption expenditures plus saving. Disposable income is calculated by identity, as the sum of all receipts minus the sum of all disbursements not including consumption and savings. Savings is then calculated using the savings rate equation, and subtracted from disposable income to yield total consumption. This total consumption is then divided by the average consumption deflator to form a control for total real consumption. At this point, total consumption by commodity from the individual equations is scaled to equal the real control total.

In each of the other accounts, savings is determined as a residual. Savings added up over all sectors is then used in the savings and investment balance. In this balance account, the various small items that haven't already been calculated are estimated either as simple regressions or as behavioral proportions. Net lending to the rest of the world is determined as a residual. Finally, in the external balance account, the surplus on current account is determined as a residual. In the *Compare* table for this account, a check total is also printed to determine how close the current account surplus from this account is to the corresponding total from the savings and investment account. Table 9 shows such a table made with the current version (1.6) of Jidea. You can see from this table that all of the required identities are not yet satisfied, for the surplus on current account calculated from the savings and investment balance is quite different from that calculated from the external balance. The problem starts already in 1991, which is odd, since this is the last year of I-O data, and Jidea should be producing actual values for this year. Figure 8 shows the same data, but it is clear that the two numbers really being to diverge after 1993, which is the last year of NIPA data.

One source of the problem is that current price GDP as calculated on the expenditure side of the model drifts away from GDP as calculated on the income side. This is shown in Figure 9. In an I-O model with one price, this would not be possible. If we take the familiar output and price dentities:

$$\mathbf{p}' = \mathbf{p}'\mathbf{A} + \mathbf{v}' \qquad \mathbf{q} = \mathbf{A}\mathbf{q} + \mathbf{f}$$

$$\mathbf{p}'\mathbf{q} = \mathbf{p}'\mathbf{A}\mathbf{q} + \mathbf{v}'\mathbf{q} \qquad \mathbf{p}'\mathbf{q} = \mathbf{p}'\mathbf{A}\mathbf{q} + \mathbf{p}'\mathbf{f}$$

which implies that $\mathbf{v}'\mathbf{q} = \mathbf{p}'\mathbf{f}$. In other words, the basic input-output identities assure that current price GDP is equal, either as the sum of current price final demands, or as the sum of value added. However, in Jidea there are four prices: the domestic output price $\mathbf{p}_q$, the import price $\mathbf{p}_m$, the export price $\mathbf{p}_x$, and the price for other domestic demand $\mathbf{p}_o$. The output price is calculated as:

$$\mathbf{p}_q = \mathbf{p}_m\mathbf{A}_m + \mathbf{p}_q\mathbf{A}_d + \mathbf{v}$$

where $\mathbf{A_m}$ is the intermediate imports matrix, and $\mathbf{A_d}$ is the intermediate domestic matrix. In the forecast, the import and export prices are calculated by regression, based on the domestic output price. The price for other domestic demand is calculated as a residual. In other words, calculate nominal other domestic demand as:

$$\mathbf{p}_o\mathbf{o} = \mathbf{p}_q\mathbf{q} - \mathbf{p}_x\mathbf{x} + \mathbf{p}_m\mathbf{m}$$

Calculate $\mathbf{o}$ in real terms as:

$$\mathbf{o} = \mathbf{q} - \mathbf{x} + \mathbf{m}$$

Then the deflator for other domestic demand can be calculated by division. What is wrong with this approach? It appears that the price of intermediate demand is not treated correctly. It seems that the correct way to calculate the price of other domestic demand would be to calculate **o** without intermediate included. Specifically, calculate:

$$\mathbf{p}_o\mathbf{o} = \mathbf{p}_q\mathbf{q} - \mathbf{p}_x\mathbf{x} + \mathbf{p}_m\mathbf{m} - \mathbf{p}_m\mathbf{A}_m\mathbf{q} - \mathbf{p}_q\mathbf{A}_d\mathbf{q}$$

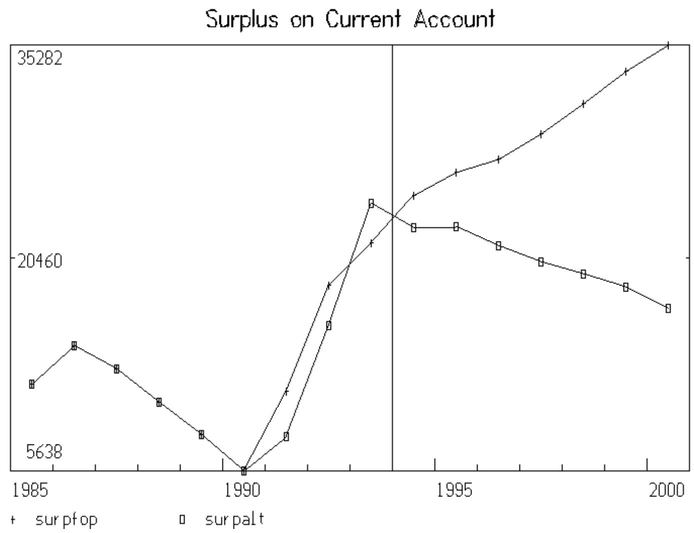
and

$$\mathbf{o} = \mathbf{q} - \mathbf{x} + \mathbf{m} - \mathbf{A}\mathbf{q}$$

This approach has not been tried yet, but it appears to be the correct one. Calculating the deflators for other domestic demand in this way should yield GDP calculations on the expenditure and income sides that are consistent. Hopefully, this will also bring the other identities into consistency.

ortions. Net lending to the rest of the world is determined as a residual. Finally, in the external balance account, the surplus on current account is determined as a residual. In the *Compare* table for this account, a check total is also printed to determine how close the current account surplus from this account is to the corresponding total from the savings and investment account. Table 9 shows such a table made with the current version (1.6) of Jidea. You can see from this table that all of the required identities are not yet satisfied, for the surplus on current account calculated from the savings and investment balance is quite different from that calculated from the external balance. The problem starts already in 1991, which is odd, since this is the last year of I-O data, and Jidea should be producing actual values for this year. Figure 8 shows the same data, but it is clear that the two numbers really being to diverge after 1993, which is the last year of NIPA data.

Figure 8. Surplus on Current Account, Calculated Two Ways



Where Do We Go From Here?

At this point, the JIDEA model is a complete macroeconomic interindustry model of the Japanese economy. It contains detailed equations for final demand components, employment and value added components, as well as the integrated output and price solution. The solution for imports is done within the context of the Seidel algorithm for calculating output, and the industry price solution makes use of import prices. In addition, the macroeconomic part of the model is rich in content, embodying the 5 sectoral SNA receipts and expenditure accounts, as well as the identities relating savings and investment to the capital account with respect to the rest of the world. The nominal identities in the model are close to enforcing the savings-investment identities with respect to the external balance, and the small discrepancy should soon be fixed. The macroeconomic properties of the model have been much improved through the addition of stabilizers which tend to return the model to a reasonable level of unemployment.

However, the model has still no undergone no thorough simulation testing, and we have no observations on how it responds to various macroeconomic shocks, such as an oil price shock, or a productivity shock. Whether or not the macroeconomic behavior of the model is reasonable in the face of such shocks will be our next area of investigation.

Figure 9. GDP from Expenditure Side Compared to GDP from Income Side