

Thinking Through a Forecast
or
Outlook for Investment-dependent Manufacturing in the USA to 2000

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The American economy is currently in the boom stage of its recovery from the 1990 recession. For the first time since 1987, it has posted, in 1994II, three successive quarters with growth rates of real GDP above 3.3 percent per year. Reading the business press gives a sense of euphoria. Steel demand is so strong that American steel makers -- who have spent the last decade downsizing -- are importing steel slabs for further processing. Automotive companies cannot keep up with demand. Even areas, such as Connecticut, hard hit by reduced defense spending are doing quite well, though southern California is still an exception. At such a time, it seems like spoiling the party to talk about a GDP growth rate of a scant 1.9 percent to the end of the decade. But that is all our 83-sector LIFT Inforum model can find. Nor are signs of slowdown missing from current numbers for 1994II. Consumer spending rose at only a 1.9 percent rate in that quarter. Investment growth, while still strong, was half the rate of the previous several quarters. The biggest growth was in inventory accumulation -- itself a sign that production had caught up with demand. The implications of this moderate growth for the investment-dependent manufacturing sectors is the subject of this report. Investment-dependent means here either those industries which produce capital equipment directly -- the transportation equipment and machinery industries -- and the industries which provide the materials of which these investment goods are made -- the metals and chemical industries.

If you would just like to know the projections for the output of these industries in the Inforum model for the USA, I show two tables. Table I is from the 83-sector LIFT model while Table II is from the 320-ILIAD model which gives more product detail to the LIFT forecast. They illustrate the different levels of detail which are available in the two models.

Tables like these are prone to put you to sleep unless there is something in them which is just what you are looking for, like a forecast for the output of copper. And if that happens, you are then not only wide awake but full of questions about where the forecast came from and what assumptions it makes. Suddenly you want to *think*. Inforum models are designed to help you think about any forecast. It happens that concentrating on the investment-dependent industries is a good way to bring out this capacity of the models, for they are at their best in studying indirect effects. If we were interested only in, say, the demand for bananas, we would have little need for input-output or dynamics. We would just need a projection of income and relative prices of bananas and other fruit to go to work. Moreover, since bananas are imported, the demand for them has minimal effects within the economy.

Table I. LIFT 83-Sector Industry Outputs and Growth Rates

	1993	1996	2000	93-96	96-00	93-00
Transportation equipment						
Motor vehicles	136964.3	146097.0	157544.2	2.15	1.89	2.00
Aerospace	52352.4	53327.8	59923.4	0.62	2.92	1.93
Ships, boats	7762.1	8489.6	9060.9	2.99	1.63	2.21
Other transportation equipment	5560.6	6583.5	7214.2	5.63	2.29	3.72
Machinery						
Construction, mining, oilfield equipm	9300.0	12338.9	16711.7	9.42	7.58	8.37
Metal products	92511.8	100375.9	112903.6	2.72	2.94	2.85
Engines and turbines	9096.6	8848.6	9897.0	-0.92	2.80	1.20
Agricultural machinery	8038.1	8602.1	9189.6	2.26	1.65	1.91
Metalworking machinery	12312.7	12963.1	15063.3	1.72	3.75	2.88
Special industry machinery	9874.7	10022.1	11123.3	0.49	2.61	1.70
Service industry machinery	16415.9	17290.2	19281.9	1.73	2.73	2.30
Misc. non-electrical machinery	32351.7	36370.5	43224.3	3.90	4.32	4.14
Electrical Machinery						
Electrical industrial apparatus	19805.8	21911.8	26154.3	3.37	4.42	3.97
Communications equipment, electronic	121455.6	131488.9	153457.9	2.65	3.86	3.34
TV sets, radios, phonographs	11945.9	12617.0	13598.3	1.82	1.87	1.85
Household appliances	12184.1	12653.8	13992.7	1.26	2.51	1.98
Computers	63471.1	76023.6	99960.2	6.02	6.84	6.49
Other office equipment	3052.6	2990.9	3028.0	-0.68	0.31	-0.12
Misc. electrical equipment	24109.3	26852.9	30920.6	3.59	3.53	3.55
Instruments	28661.4	32930.6	40141.3	4.63	4.95	4.81
Materials						
Chemicals (ex. fertilizers)	122042.2	132102.2	147572.3	2.64	2.77	2.71
Ferrous metals	49287.3	48866.5	49491.3	-0.29	0.32	0.06
Copper	7443.0	7578.6	7911.0	0.60	1.07	0.87
Other nonferrous metals	29452.7	31652.0	35778.2	2.40	3.06	2.78

Table II. ILIAD 320-Sector Industry Outputs and Growth Rates

	Outputs in 1977 dollars			Growth Rates		
	1993	1996	2000	93-96	96-00	93-00
Machinery						
171 Steam engines & turbines	3930.4	3967.0	4271.6	0.31	1.85	1.19
172 Internal combust engines,nec	11021.7	11563.8	13405.0	1.60	3.69	2.80
173 Farm machinery & equipment	9014.5	9939.0	10770.3	3.25	2.01	2.54
174 Lawn & garden equipment	3312.0	3600.8	3860.7	2.79	1.74	2.19
175 Construction mach & equip.	10753.7	13678.5	17711.1	8.02	6.46	7.13
176 Mining mach,exc oil field	1368.2	1790.2	2367.2	8.96	6.98	7.83
177 Oil field machinery	2927.5	4811.2	7581.1	16.56	11.37	13.59
178 Elevators & moving stairways	1252.4	1338.5	1538.3	2.22	3.48	2.94
179 Conveyers, hoists, cranes	4728.2	5177.3	5798.8	3.02	2.83	2.92
180 Indl trucks & tractors	3249.4	3488.6	3910.3	2.37	2.85	2.64
181 Mach tools, metal cutting	2545.9	2640.6	3213.2	1.22	4.91	3.33
182 Mach tools, metal forming	1309.3	1355.5	1645.4	1.16	4.84	3.26
183 Spec dies,tools,mach tools	11846.1	12699.3	14452.9	2.32	3.23	2.84
184 Power driven hand tools	1745.4	1774.5	2036.1	0.55	3.44	2.20
185 Rolling mill machinery	353.1	396.4	518.5	3.86	6.71	5.49
186 Metalworking machinery	1458.1	1640.4	1996.4	3.93	4.91	4.49
187 Food products machinery	2192.6	2249.0	2481.3	0.85	2.46	1.77
188 Textile machinery	1061.4	1026.5	1173.1	-1.11	3.34	1.43
189 Woodworking machinery	771.9	774.9	897.9	0.13	3.69	2.16
190 Paper industries machinery	1879.6	1915.5	2087.2	0.63	2.15	1.50
191 Printing trades machinery	2728.2	2883.1	3324.8	1.84	3.56	2.83
192 Special indl mach,nec	7176.6	7426.7	8096.2	1.14	2.16	1.72
193 Pumps & compressors	8484.7	9538.8	11110.3	3.90	3.81	3.85
194 Ball & roller bearings	3269.9	3610.6	4275.1	3.30	4.22	3.83

Table 2 (cont.)	1993	1996	2000	93-96	96-00	93-00
195 Blowers & fans	2302.2	2412.6	2751.1	1.56	3.28	2.54
196 Industrial patterns	650.5	686.6	735.9	1.80	1.73	1.76
197 Genl indl mach, nec	5163.1	5573.2	6818.9	2.55	5.04	3.97
198 Power transmission equipment	3789.9	4138.8	4786.2	2.94	3.63	3.33
199 Indl furnaces & ovens	1374.8	1594.0	1900.8	4.93	4.40	4.63
200 Carburetors,pistons,rings,valves	1670.3	1788.8	1933.8	2.28	1.95	2.09
201 Non-elec machinery,nec	17850.8	20083.8	23207.4	3.93	3.61	3.75
204 Scales & balances	865.4	847.9	858.4	-0.68	0.31	-0.12
206 Automatic merchandising eq.	699.7	701.6	742.2	0.09	1.40	0.84
207 Commercial laundry equipment	505.7	513.0	562.4	0.48	2.30	1.52
208 Refrig & heating equipment	16693.4	17697.3	19780.1	1.95	2.78	2.42
209 Measuring & dispensing pumps	905.0	918.2	983.1	0.48	1.71	1.18
210 Service ind mach, nec	4085.5	4243.4	4554.3	1.26	1.77	1.55
211 Instruments to measure electricity	6744.7	7691.2	9004.2	4.38	3.94	4.13
Transportation Equipment						
233 Truck & bus bodies	4523.4	4792.4	5179.1	1.93	1.94	1.93
234 Truck trailers	3323.5	3540.7	3907.4	2.11	2.46	2.31
235 Motor vehicles	136846.8	146110.1	156442.4	2.18	1.71	1.91
236 Motor vehicle pts & accessories	65885.5	71351.2	78181.1	2.66	2.29	2.44
237 Aircraft	34867.7	35922.0	40250.8	0.99	2.84	2.05
238 Aircraft & missile engines	17544.0	18850.7	22446.0	2.39	4.36	3.52
239 Aircraft & missile eq, nec	20769.6	22095.5	26260.7	2.06	4.32	3.35
240 Ship building & repairing	6797.9	6107.3	5893.3	-3.57	-0.89	-2.04
241 Boat building & repairing	5527.3	7387.4	8556.7	9.67	3.67	6.24
242 Railroad equipment	3036.1	3979.4	4134.5	9.02	0.96	4.41
243 Motorcycles,bicycles,&pts	1049.3	1076.3	1261.6	0.85	3.97	2.63
244 Travel trailers & campers	1046.1	1220.3	1277.5	5.14	1.15	2.86
245 Mobile homes	3575.0	3894.2	3717.4	2.85	-1.16	0.56
246 Motor homes	2057.3	2220.9	2349.4	2.55	1.41	1.90
247 Transportation equip,nec	1202.8	1410.4	1460.7	5.31	0.88	2.78
Chemicals						
98 Indl chem, inorganic	22238.9	24114.7	27036.2	2.70	2.86	2.79
99 Indl chem, organic	62261.6	69347.5	79993.4	3.59	3.57	3.58
100 Gum & wood chemicals	506.2	539.0	583.1	2.09	1.97	2.02
101 Agricultural chemicals	20316.0	21804.6	23000.2	2.36	1.33	1.77
102 Adhesives & sealants	4463.2	4807.8	5305.3	2.48	2.46	2.47
103 Explosives	971.9	1094.1	1304.6	3.95	4.40	4.20
104 Chemical preparations, nec	12176.9	13420.1	15202.0	3.24	3.12	3.17
105 Plastics matls & resins	27337.8	31460.5	37454.4	4.68	4.36	4.50
106 Synthetic rubber	3855.5	4158.0	4662.1	2.52	2.86	2.71
107 Cellulosic man-made fibers	920.0	914.8	903.5	-0.19	-0.31	-0.26
108 Noncellulosic fibers	11884.4	12515.6	13303.9	1.73	1.53	1.61
109 Drugs	36513.1	39259.6	42691.2	2.42	2.09	2.23
110 Soaps & cleaners	16827.6	18008.0	19320.5	2.26	1.76	1.97
111 Toilet preparations	12571.7	13404.0	14352.8	2.14	1.71	1.89
112 Paints & allied products	10226.7	10922.1	11955.9	2.19	2.26	2.23
Metals						
139 Steel mills, blast furnaces	56932.0	56324.2	56447.2	-0.36	0.05	-0.12
140 Iron & steel foundries	9754.7	10298.6	11211.8	1.81	2.12	1.99
141 Iron & steel forgings	3915.5	4039.0	4301.9	1.04	1.58	1.34
142 Misc primary metal products	3329.6	3818.9	4634.7	4.57	4.84	4.72
143 Primary copper	4405.2	4624.1	5005.2	1.62	1.98	1.82
144 Primary lead	361.8	493.5	664.7	10.35	7.45	8.69
145 Primary zinc	549.2	582.1	636.7	1.93	2.24	2.11
146 Primary aluminum	8193.5	8993.3	10230.7	3.10	3.22	3.17
147 Primary nf metals, nec	2867.7	3003.1	3281.1	1.54	2.21	1.92
148 Copper rolling & drawing	3636.7	3681.2	3825.8	0.41	0.96	0.72
149 Aluminum rolling & drawing	11745.8	13089.1	15148.8	3.61	3.65	3.63
150 Nonferrous wire and roll & draw,nec	11993.7	13601.6	16594.0	4.19	4.97	4.64
151 Aluminum castings	3633.3	3889.6	4344.9	2.27	2.77	2.56
152 Brass,bronze,copper casting	603.0	642.7	708.1	2.12	2.42	2.30
153 Nonferrous castings and forgings	2258.9	2500.3	3026.5	3.39	4.77	4.18

Investment goods, however, have a maximum of indirectness, indeed, of circularity. The demand for steel, for example, depends on the demand for machinery. The demand for machinery depends on the *growth* in the demand for all manufactured products. The demand for metalworking machinery, in particular, depends on the *growth* in the production of other types of machinery, including steel-making machinery, which depends on the demand for steel. So we are back to where we started. But we can check and scrutinize each step along the way. It is just this indirectness involving growth which the Inforum models handle especially well. Above all, it is the possibility of examining all the components that make this approach the one for the careful forecaster.

Given this indirectness and circularity, there is no logical starting place for the description of the industry-level results of these models, for each industry depends on all the others. There are, of course, some exogenous projections. In the present model, they include government spending, population size and age structure, trends in labor productivity in individual industries, exchange rates, and foreign demands, those these last depend on developments in the Inforum models of other countries, which are somewhat influenced by the USA forecasts. The government spending projections follow current trends, except that defense spending follows announced targets for further reductions. The productivity projections are determined on an industry-by-industry basis. Looked at on this basis, they appear quite reasonable, indeed, somewhat optimistic. They are, however, the fundamental determinant of the overall growth rate which still seems low to some observers.

Beyond these exogenous projections, everything depends on everything else. For the sake of having an order of presentation, however, I will take first the three of our industries which are closest to the household consumer, that is, (a) Automobiles, (b) Television sets, radios, and phonographs, and (c) Household appliances. These all depend on consumer income, and that depends on employment and productivity throughout the economy, but since we cannot explain everything in the same sentence, we will have to suppose that we know consumer income and the relative prices of consumer goods. The forecasts for the output (solid line), exports (dotted line), and imports (dashed line) of these three industries are shown in the first three sections of Plate I. For ease of comparison, each graph is drawn with the value of output in 1993 for the industry in question as 100 and with a vertical scale running from 100 to 200. The 1994 points in these graphs are pure forecasts at this time; and indeed the 1993 points have a substantial element of forecast, for the full statistical reporting for 1993 is not yet available.

The historical portions of these graphs inevitably bounce about more than do the forecasts, for they include many more influences than we could ever get into a model. The historical section of the Motor vehicles graph, in particular, shows in microcosm the macroeconomic policy of the 1980's, which is not without implications for the rest of the 1990's. After strong years at the end of the 1970's, the economy went into a cyclical slump in 1980, which hit automobiles especially hard because they are durables. (If your income is down, you can put off buying a car but not groceries.) In 1981, the Reagan tax cut was passed, which was phased into effect in 1982 and 1983. The one-time, positive stimulus of this tax cut shows up in the demand for cars in 1983 and 1984. Note, however, that import penetration rose sharply in these years. Why? Sure,

the Germans and the Japanese were making some nice cars, but that was nothing new. The real reason was that the dollar was rising making these nice cars cheaper in comparison with the American ones. And why was the dollar rising? Because that same tax cut produced huge federal deficits which brought national savings (including government's negative saving) well below national investment. The difference had to be financed by foreigners. They were attracted by high real interest rates, bought dollars in order to buy American debt, and ran up the value of the dollar. American producers first lost markets abroad and were soon struggling against imports at home. This imbalance in trade had to be -- by a fundamental identity of national accounting -- exactly equal to the excess of national investment over national savings. Once the dollar was high enough to produce the necessary trade deficit, it stabilized. And the high share of imports stabilized with it. It is extremely important, amid all the talk about faltering American competitiveness or unfair Japanese trade practices, to bear clearly in mind that the trade deficit and the financing of it by selling America to other countries is a direct consequence of the Reagan tax cut. Until tax rates have been restored or until gradual growth of the economy not matched by growth in federal spending restores balance in the federal budget, we must reckon on a continued trade deficit. Since we see neither of these developments as likely, you will notice that import penetration remains high in the forecasts. In the forecast, domestic production of Motor vehicles grows at 2.0 percent per year, very close to the GDP growth rate. Imports keep pace.

Everything said about automobiles is even more visible in Television sets, radios, phonographs, which also includes video cassette recorders. Certainly, East Asia had become competitive in these products in the early 1980's, but bad macroeconomic policy didn't help. In 1981, imports surpassed domestic makes and surged far ahead. Again, domestic sales grow at 1.9 percent out to 2000, the same as the GDP. The story is much the same for Household appliances, with the exception that exports gained rapidly in the late 1980's, ground we expect them to hold but not to expand. (As a personal note, the failure of American household appliances to take off as export items amazes me. After a year in Europe, my wife and I were more than glad to get back to our American washing machine, dishwasher, refrigerator, and stove.)

Now let us work back from the growth in these industries. The fourth graph on Plate I shows investment in equipment by the Automobile industry. We can see how the slump years of 1980 and 1981 led to a collapse in investment in 1982 and 1983, when demand was picking up. There was then a modest boom to catch up to the new level of output, which was not as low as had been expected. Once capacity caught up, spending fell in 1988 and has recovered only a little since then. The forecast shows some ups and downs but little growth. Since output is growing slowly, only replacement and modernization investment is necessary. One area likely to get attention is the ability to switch rapidly from one model to the next. Japanese makers are usually able to switch in a few days, a week at most. American plants may still require several costly months. Parallel lines and flexibly programmed robots seem to be the key.

Plate I. Motor vehicles, Radios, Household appliances

Plate II shows a series of graphs related to air transportation. The first shows the output, export, and import of airline services. Despite a decade of turmoil of deregulation, price wars, bankruptcies, closures and now union buy-outs, output follows closely and smoothly the general pattern of the economy -- a little sag during the recessions and steady growth just a hair faster than GDP in the forecast. The second graph shows that the little sag in the 1980-82 recession brought a collapse of spending in 1984. The aging fleet is now requiring replacement. Our equation, based on replacement and expansion needs, says investment should be strong by comparison to the years since 1983. Boeing and Airbus, when talking to investment analysts, say the boom will be even stronger than we show and claim to base their projections on detailed analysis of the fleets now in service. In any event, neither company seems to be worried about a lack of sales. The third graph on Plate II shows output, export, and import of the Aerospace industry. The big element present here but not reflected in the previous graphs is the rise and decline of defense spending. Again, the forecast agrees with market analysts who believe that further declines in defense spending -- which are in the model -- will be offset by civilian demand and exports. We may note in passing here the rise in imports due, in large part, to the generosity of German taxpayers to subsidize air planes for us Americans to ride around in. Finally, what about investment spending by the Aerospace industry itself? The final graph shows that it has been far more volatile than the industry's output. The big boom of the 1980's was almost exclusively connected with the military buildup under Reagan. Under Bush, the interest in high-tech terror waned, and investment in the Aerospace industry plummeted. The forecast sees a need to gradually replace aging plant.

A similar sequence for the production of electricity is shown in Plate III -- except something seems to be wrong. The extremely smooth growth in the output of electricity is accompanied by wild gyrations in investment by the utilities which produce it, but those gyrations have little impact on the output of Electrical industrial apparatus, which produces generators, transformers, and switchgear and normally claims about twenty cents of every dollar spent on investment by electrical generation. The fluctuation in investment spending is about \$10 billion, so the fluctuation in sales of Electrical industrial apparatus should be about \$2 billion, about ten percent of this industry's output. A ten-percent fluctuation from one source of demand may, of course, be offset by an opposite swing from another source. It nonetheless seems strange that there is no reflection of Utility investment in Apparatus output. I noticed this anomaly in writing this paper and included it as an example of how the interindustry framework can cause you to think. My own hunch at the moment is that the big investment was in what the utilities call "demand side management," that is, in instrumentation to reduce electrical consumption rather than to generate more.

Plate II. Air transport and Aerospace

Plate III. Electric utilities and Electric Apparatus

At this point, we have built up the forecasts of several metal-using industries: Automobiles, Aerospace, and Electrical apparatus. Let us turn now to the demand for metals. It offers a good opportunity to display what we call the "matrix listing," shown for Ferrous metals in Plate IV. This table shows the Ferrous metals row of the input-output table for five years and the growth rates of each flow between selected pairs of years. For example, we can see that the sale of Ferrous metals to Motor vehicles was 6306.6 in 1989 and is expected to decline to 6292.1 by 2004. The annual average growth rate for this flow between 1994 and 1999 is expected to be -.65. Since Motor vehicle output is increasing over this period (by 1.70 percent per year, to be exact), it is clear that the use of steel per dollar of car produced is going down, indeed, at the rather rapid rate of 2.35 percent per year. From a similar matrix listing page for Other non-ferrous metals, which is mainly aluminum, we find that this industry's sales to Motor vehicles are rising 1.75 percent per year, so the use per car is creeping up. Alcoa, the largest aluminum company, having taken the beverage can market away from the steel industry in the last ten years, is now targeting the automotive market. The new aluminum-bodied Audi is a case in point. But aluminum is more expensive than steel for a part of the same strength, so the Alcoa engineers have a steep road ahead.

Finally, we show the matrix listing concept extended to the capital flows. Plate V shows the matrix listing of Metalworking machinery. First come the sales to intermediate use, which in this case is mostly replaceable parts, cutting edges, and factory repair services. Then come the sales to capital investment by purchaser. We see here as customers some of the industries we have already studied as producers -- Motor vehicles, Aerospace, Electrical apparatus, and Iron and steel. We know that if we were a producer of Metalworking equipment and wanted to question the forecast, we could dig into it layer after layer.

As we dig into the forecast in this way, consistency is guaranteed; but of course consistency doesn't guarantee correctness. We know that the consumer behavior equations in the model are generally consistent with observed consumer behavior in the past, and similarly for investment equations, export and import equations, productivity equations, price formation equations, and all the others. We can run the model with many different assumptions and always obtain consistent results. But consumers or investors or importers or who-ever can change the way they react today. We have specific forecasts of the use of each of the 83 products per unit of each of the other 83 products. They are consistent with all we know of the past, but they may be wrong in the future. My contention, however, is not that these forecasts are right but that they can be scrutinized. And that a forecast which can be scrutinized is better than an inscrutable one.

When I was first getting into computer-based forecasting thirty years ago, there was somehow the expectation that the models might prove as infallible as the computer's arithmetic. I do not believe that those of us actually working with the models ever expected much more accuracy than we have achieved, but businesses snapped up the models uncritically and were often disappointed. If you need a forecast, you need to examine it carefully. I hope to have shown a beginning of how that can be done in the context of an Inforum model.

Plate IV: Matrix Listing for Ferrous metals

Plate V: Matrix Listing for Metalworking machinery