Chapter 2. Data and base case considerations

2.1 The data underlying IGEM and its parameter estimates

The inter-industry accounts of the system of U.S. national accounts provide the core structure for IGEM; the details of data sources and construction are provided in Part 2 of this volume. Model parameters are estimated econometrically from a historical data base spanning the period from as early as the late 1950's to the middle of the current decade. The data base revolves around a time series of input-output (IO) tables in current and constant prices. Included are the prices and quantities of capital and labor services. These data comprise the industry-level accounting in the "new architecture" for the U.S. national accounts developed by Jorgenson (2009) and Jorgenson and Landefeld (2006, 2009). The methodology and data sources for their development are presented in much greater detail by Jorgenson, Ho, and Stiroh (2005).

The dollar values from the input-output tables are obviously the ones to use to characterize the nominal output of the industries. Our data source begins with the time series of IO tables put together by the Bureau of Labor Statistics (BLS) and the benchmark tables prepared by the Bureau of Economic Analysis (BEA). This BLS dataset comes with industry prices for the entire sample period that are based on the their producer price indices (PPI).

The details of the construction of industry output and capital, labor, energy and materials (K,L,E,M) inputs are given in Jorgenson, Ho and Stiroh (2005). Industry-level capital stock and capital input are derived from the BEA's Capital Stock Study which includes information on investment grouped into sixty different asset classes. Industry-level labor input are derived from detailed demographic and wage data in the annual Current Population Survey and decennial Census from the Bureau of the Census. The data for labor supply, household time endowment and population are developed from time series cross classified by gender, age and education.

The data for the final demand for commodities are made consistent with the benchmark input-output tables in the BLS time series. Household consumption data are taken from the National Income and Product Account's (NIPA's) Personal Consumption Expenditures series. These are related to the IO commodity classification using a bridge table like those appearing in the BEA benchmark series. In addition, the household model uses micro-level data from the BLS *Consumer Expenditure Surveys* supplemented with price information obtained from its Consumer Price Index series.

The BLS IO tables also provide data on the remaining components of final demand – investment, government purchases, exports and imports classified by commodity. The investment data from the BEA Capital Stock Study are reconciled with the IO classification via another official bridge table from the BEA benchmark series. Government purchases, in aggregate and by broad category, are derived from the annual NIPA government expenditures series. Tax rates are developed from the NIPA government series as well and, for the marginal tax rate on labor income, from published information from the Internal Revenue Service. The export and import data are taken from detailed Bureau of Census trade data and reconciled with the official NIPA goods and services trade accounts

2.2. Projections of the exogenous variables[1]

IGEM simulates the future growth and structure of the U.S. economy over the intermediate term of 25 to 30 years, after which growth is gradually slowed to achieve necessary model closure by means of a steady state. The time path of model outcomes is conditional on projections of key exogenous variables that ultimately stabilize to yield the steady state results. The most important variables are the total population, the time endowment of the working-age population, the overall government deficit, the current account deficit, labor and capital quality, world prices and government tax policies. Many of these are developed from published sources, "official" and otherwise. The remaining variables are projected from trend growth in the historical data that underlie the model and its estimation.

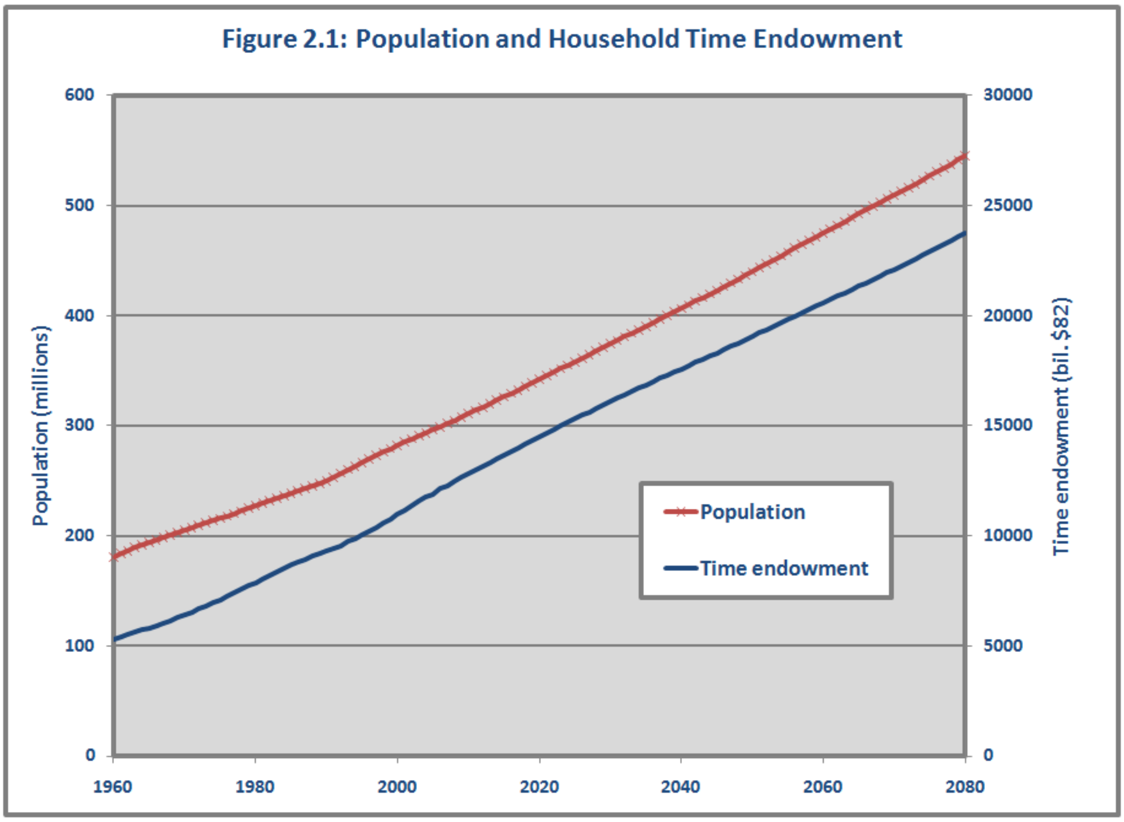
The key variable is population growth and demographic change. We take population projections from the Bureau of the Census by sex and individual year of age. During the sample period the population is allocated to the educational attainment categories using data from the Current Population Survey in a way parallel to the calculations of labor input described in Jorgenson, Ho and Stiroh (2005). Each adult is given 14 hours a day of time endowment to be used for work and leisure. This quantity

[1] The projections of this section follow the sample period from 1960-2005.

of hours for each sex-age-education category is then weighted by the labor compensation rates from our labor data base and aggregated to form the national time endowment. The index used is the translog index and the methodology is described in Ho (1989).

In making projections beyond the sample period we use the Census Bureau forecasts by sex and age. We assume that educational attainment of those aged 35 or younger will be the same as the last year of the sample period; that is, a person who becomes 22 years old in 2020 will have the same chance of having a BA degree as a person in 2000. Those aged 55 and over carry their education attainment with them as they age so, for example, the educational distribution of 70 year olds in 2010 is the same as that of 60 year olds in 2000. Those between 35 and 55 have a more complex adjustment that is a mixture of the two assumptions. This allows a smooth improvement in educational attainment that is consistent with the observed profile in 2000.

The results from this method are illustrated in Figure 2.1 together with projections for the total population. In this forecast, the population is expected to grow at 0.92% per year for the next 25 years and eventually reaches some 545 million persons by 2080. The slow improvement in educational attainment means that the time endowment grows at a modestly faster rate of 1.12% over the same 25 years.



The Kalman filter, discussed in detail in Part 2, is used to project total factor productivity (TFP) growth rates for each sector. These are curtailed post 2050 to achieve a steady state. By way of example, Figure 2.2 plots the results for selected industries, while Figure 2.3 provides historical perspective for the projections for all industries. Declining numbers for the latent TFP variable serve to reduce output prices below input prices while rising ones increase output prices above input prices.

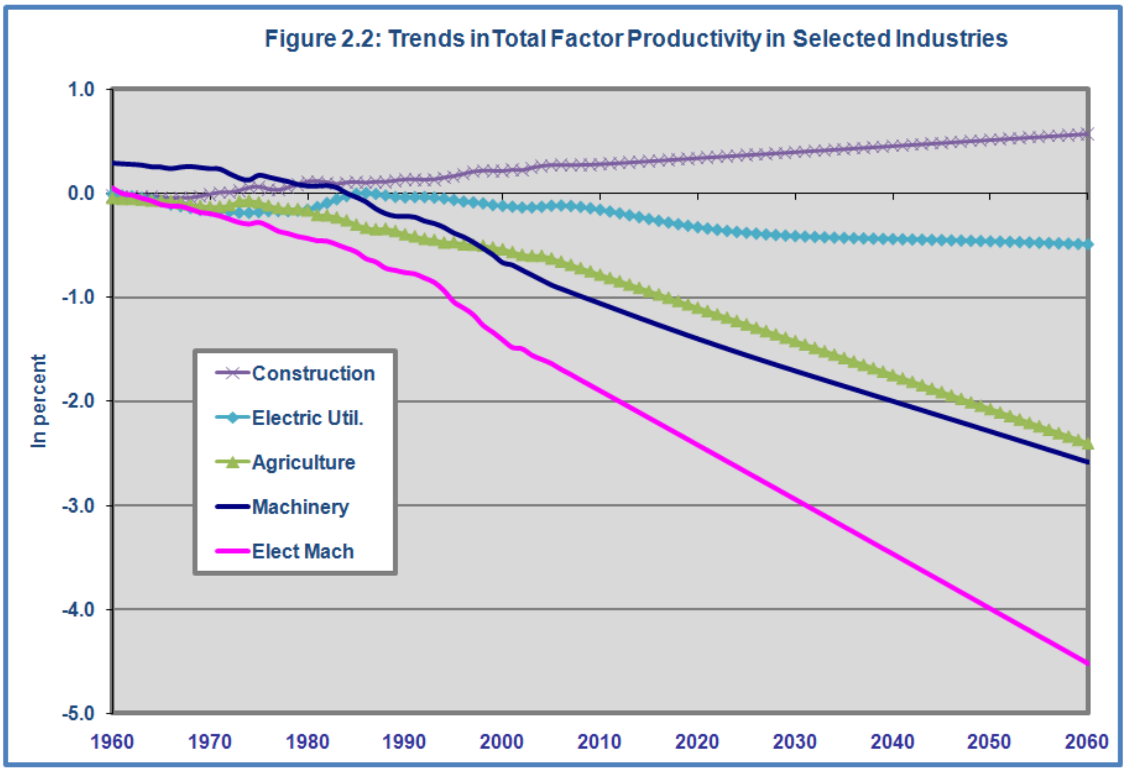


Figure 2.2: Trends in Total Factor Productivity in Selected Industries
In percent
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
Construction
Electric Util.
Agriculture
Machinery
Elect Mach

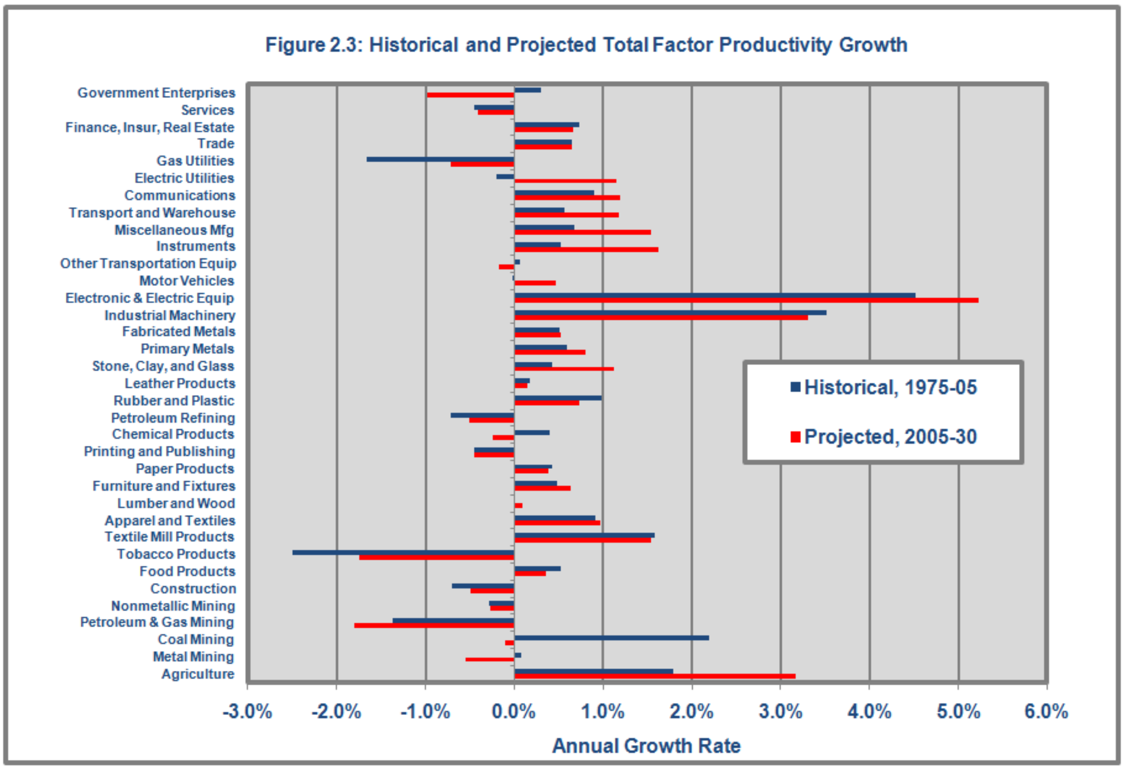


Figure 2.3: Historical and Projected Total Factor Productivity Growth
Government Enterprises
Services
Finance, Insur, Real Estate
Trade
Gas Utilities
Electric Utilities
Communications
Transport and Warehouse
Miscellaneous Mfg
Instruments
Other Transportation Equip
Motor Vehicles
Electronic & Electric Equip
Industrial Machinery
Fabricated Metals
Primary Metals
Stone, Clay, and Glass
Leather Products
Rubber and Plastic
Petroleum Refining
Chemical Products
Printing and Publishing
Paper Products
Furniture and Fixtures
Lumber and Wood
Apparel and Textiles
Textile Mill Products
Tobacco Products
Food Products
Construction
Nonmetallic Mining
Petroleum & Gas Mining
Coal Mining
Metal Mining
Agriculture
Historical, 1975-05
Projected, 2005-30
-3.0%
-2.0%
-1.0%
0.0%
1.0%
2.0%
3.0%
4.0%
5.0%
6.0%
Annual Growth Rate

A rapidly falling latent variable implies that the relative price of output is falling more rapidly so that TFP growth is more rapid. In Electric Utilities, the sample period, 1960-2005, shows the latent variable first falling, then rising, and then falling again. Beyond 2005, these projections portray, to varying degrees, steadily improving productivity in 22 of IGEM's 35 sectors. Leading the list in projected TFP growth is the Electrical Machinery, which includes computers and other high technology manufacturing. Several important sectors exhibit negative projected productivity growth, including the large Construction and Services industries and fossil fuel producers and distributors.

Projecting the factor biases, the multipliers of price-induced innovation and technical change, is accomplished in a manner identical to projecting TFP. Figures 2.4 and 2.5 show the results for Electric Utilities and Electrical Machinery, respectively. Beyond 2005 and the current decade, Electric Utilities are shown to be energy-, labor- and materials-using but capital-saving. Conversely, the high technology Electrical Machinery industry is projected to be ever so slightly capital-using and labor-, energy- and materials-saving.

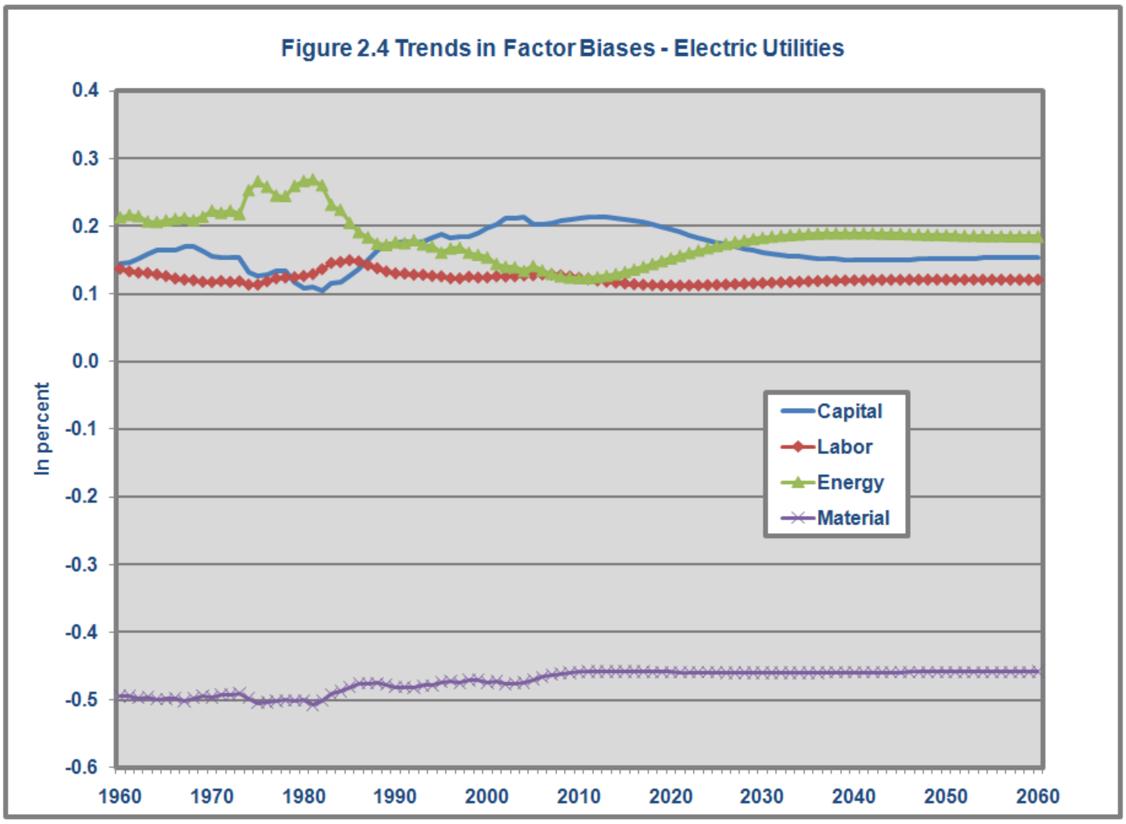
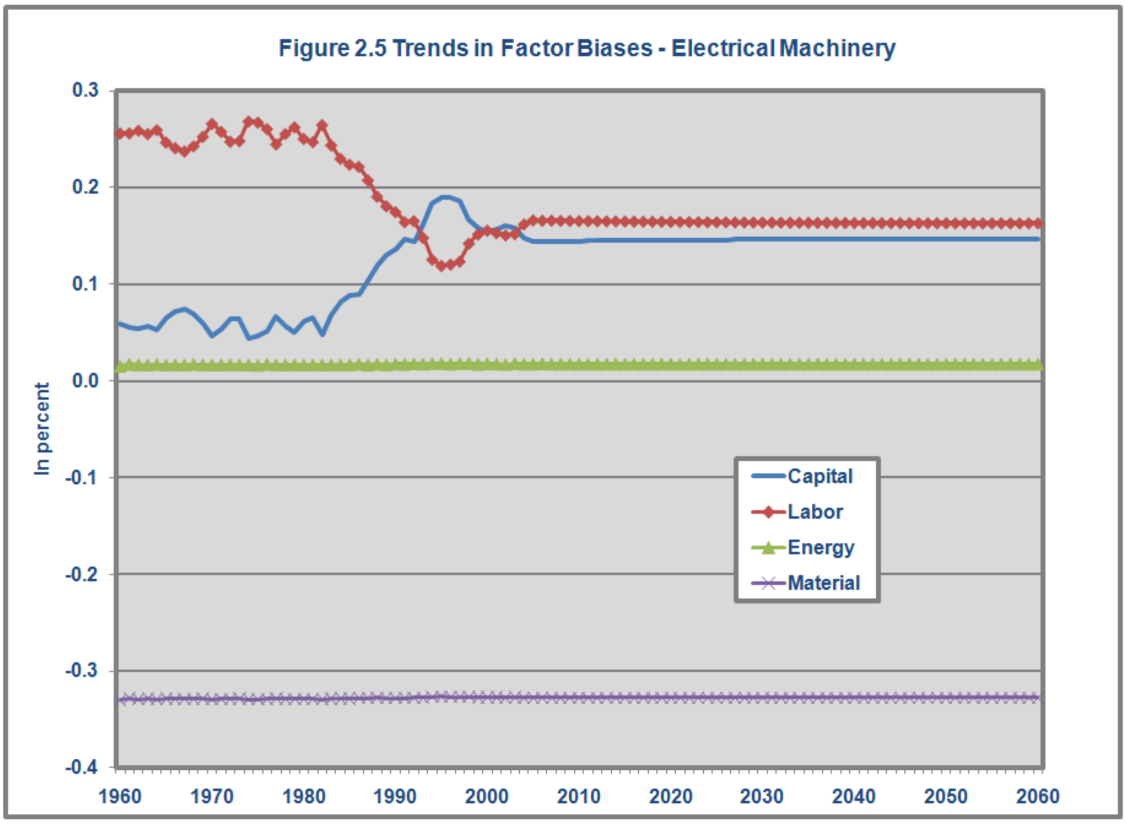
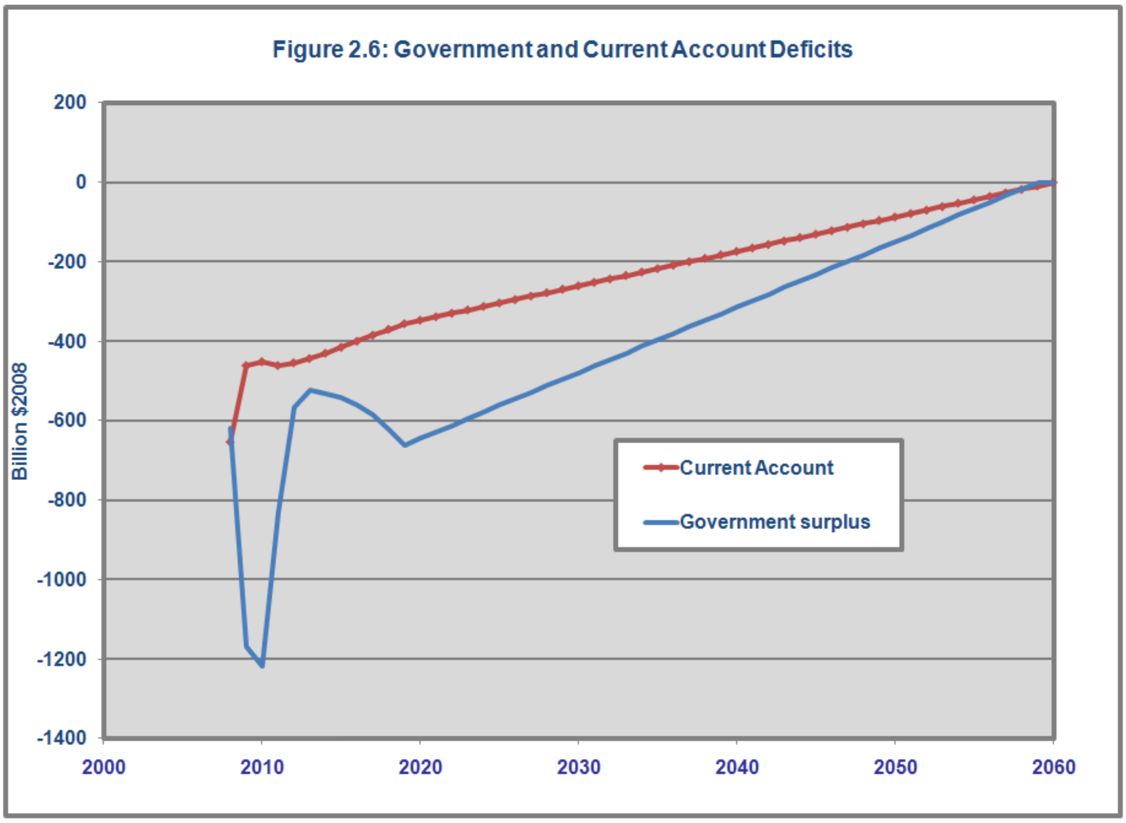


Figure 2.4 Trends in Factor Biases - Electric Utilities
In percent
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
Capital
Labor
Energy
Material



Two other important assumptions that determine the shape of the economy are the government and trade deficits. To achieve a steady-state condition, the levels of government and rest-of-world indebtedness must stabilize in the future. Illustrative base case assumptions are plotted in Figure 2.6. The government deficit follows the forecasts of the Congressional Budget Office (CBO) for the next 10 years and then is set to track to a zero balance by 2060. To the extent there are any, changes in U.S. tax policy also are taken from CBO forecasts. If there are none, tax rates are frozen at their most recent historical levels.



The current account deficit is presumed to shrink steadily so that it too reaches a zero balance by 2060. These simplifying assumptions for the two deficits allow a smooth transition path to steady state equilibrium. Timely short-run projections of rest-of-world conditions and the U.S current account deficit are occasionally available from the International Monetary Fund (IMF) or the World Bank and, when they are, they are used. While the twin deficits are determinants of long run growth as a result of their influence on base case capital formation, they are substantially less important than the demographic and productivity drivers.

World prices must also be projected but, since we do not have an explicit rest-of-the-world model, we assume that relative prices move in proportion to the productivity changes projected for the U.S. industries as described above. The exception is that we use the Energy Information Administration's (EIA's) projections of world oil prices from their most recent *Annual Energy Outlook (AEO)* instead of the U.S. productivity trends. In each case, the most recent historical prices serve as the starting points for extrapolation.

2.3 Environmental accounting in IGEM

The Inter-temporal General Equilibrium Model (IGEM) is equipped with a number of array-based "externality" variables that are conceptually and empirically defined to suit the needs of a particular analysis. Currently, there are four such variables aiding in the assessment of the benefits and costs of climate change and climate change mitigation policies. These are:

1. A composite of total greenhouse gas (GHG) emissions in millions of metric tons carbon dioxide equivalent ($MMTCO_2E$) covering all gases arising from all sources.
2. Carbon emissions arising from all sources, including fossil fuel use, in $MMTCO_2E$;
3. An approximation of the greenhouse gas (GHG) emissions in $MMTCO_2E$ arising from the economic activities covered by a particular policy initiative. For example, a policy may exempt GHG emissions originating in agriculture and emissions-generating activities in which measurement and monitoring are technically infeasible.
4. The emissions in $MMTCO_2E$ not covered by the initiative or, equivalently, the difference between the first and third of the above.

"Externalities" in IGEM are considered as joint outputs or products of the economic activities represented within its structure. These may be process related in that they arise from the creation and manufacture of a particular good or service or they may be product related in that they arise from the economy's use of a particular good or service. In either case, the annual level of each composite externality is jointly determined by the production and consumption activities that give rise to it and, in turn, these activities are associated with the processes and products of domestic industries and with corresponding U.S. imports.

IGEM's externality coefficients for the environment are derived from detailed historical data appearing in the Environmental Protection Agency's (EPA's) most recent *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. These series are sorted and aggregated to create the energy and emissions totals corresponding to the four externality variables defined above. An example is shown in Table 2.1. The totals then are expressed relative to the underlying sector-specific economic outputs that give rise to them. It is worth noting that none of the externality coefficients is trendless which further highlights the difficulties in projecting them. An example of this is shown in Figure 2.7.

In developing baseline projections, there are four inter-related issues. These are:

1. What weight should be attached to each emission factor when dealing with such aggregated sectors?
2. How should emissions coefficients change over time to reflect compositional changes within a sector?
3. To what extent should historical or anticipated mitigation be stripped from or preserved in coefficient trends?
4. To what degree are externality outcomes to be calibrated either to historical data or to "official" projections?

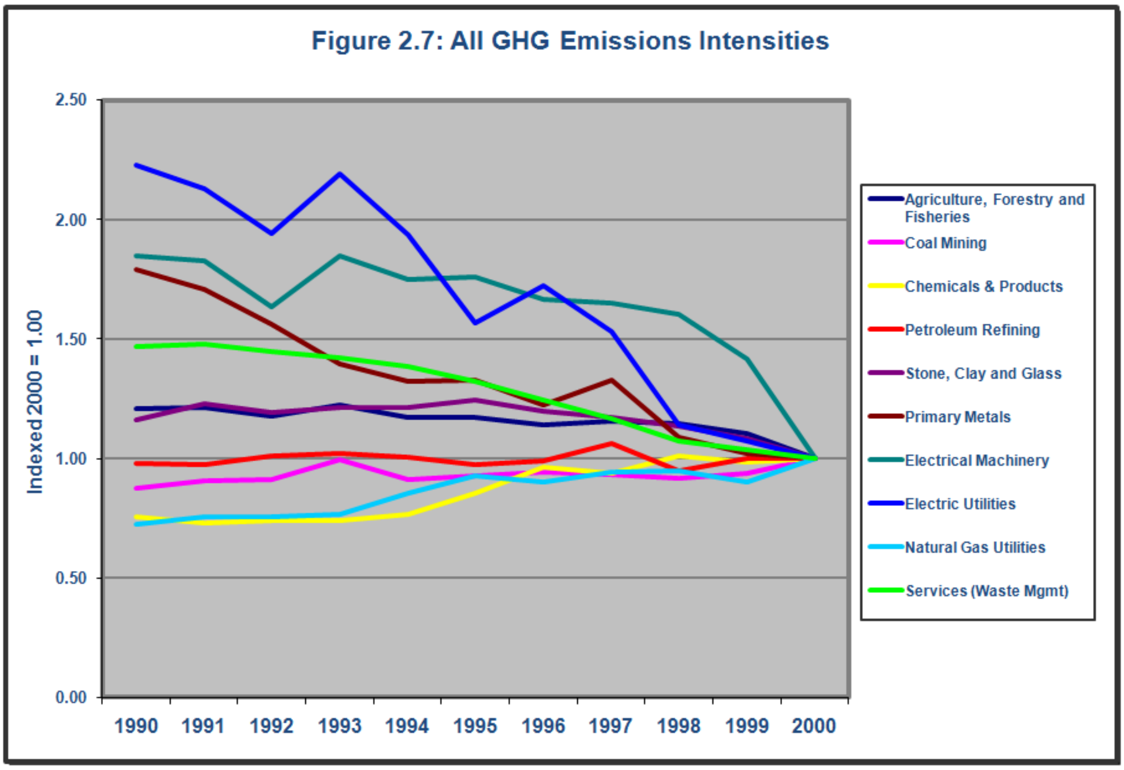
Ideally, and data permitting, analyses should be conducted for each gas and each economic activity; that is, trend first and then aggregate. This solves the problems of weighting and compositional changes and gets the baseline "right." Invariably, however, time and data are unaffordable luxuries. More often than not, aggregation occurs prior to trending. The biases that this introduces in baseline emissions paths can be overcome, however, through development and use of alternative base cases that are directionally appropriate to these biases.

Decisions on trends in mitigation are conditional on the objectives and circumstances of the particular analysis to which the model is being applied. Changes in emissions intensities are both market and policy driven. The extent to which policy driven mitigation is to be left in or stripped from the emissions coefficients depends on whether the particular policy is part of the current assessment. If it is independent then the effects of mitigation should remain; however, if the analysis is retrospective in nature and a portion of the observed mitigation is policy dependent then it should be parsed from the emissions coefficients. The process of isolating the market and policy causes of changes in emissions intensities is obviously much easier the more disaggregated are the data used in their construction.

Calibration is also a matter that depends on the particular analysis; it is generally more important in comparative assessments than it is in those in which a model analysis stands alone. Matching or tracking emissions levels, be they historical or projected, requires either calibrating the variables that drive emissions (and) or adjusting the joint production of emissions per unit of economic activity.

In recent base cases, the details of energy use (coal, oil, gas and electricity) in IGEM are made consistent with historical data and with the projections from the most recent EIA Annual Energy Outlook. Emissions are calibrated to match the levels represented in EPA's most recent emissions inventory. The emissions coefficients for fossil fuels (coal, oil and gas) are held temporally fixed while extrapolated trends, dampening to steady state, are adopted for those coefficients attached to all other economic activities (e.g., agriculture, chemicals, metal manufacturing, electricity transmission and distribution, etc.). For the future, in developing baseline emissions paths, each of the underlying relationships between emissions outcomes and their driving forces merits more analysis and evaluative scrutiny. With its diversity of detail, IGEM then could reflect more fully the payoffs from bottom-up investigations of emissions sources.

Table 2.1: Greenhouse Gas Emissions - By Gas, Activity and Sector			
		MMTCO$_2$E	
	IGEM Sector	1990	2000
CO2			
Coal			
Residential	3	2.4	1.1
Commercial	3	12.1	8.6
Industrial	3	150.3	133.8
Electricity Generation	3	1515.9	1890.5
U.S. Territories	3	0.6	0.9
Natural Gas			
Residential	31	238.8	270.3
Commercial	31	142.6	174.3
Industrial	31	421.6	473.8
Transportation	31	35.9	35.5
Electricity Generation	31	176.0	280.7
U.S. Territories	31	-	0.7
Petroleum			
Residential	16	98.3	107.8
Commercial	16	69.5	54.2
Industrial	16	394.7	392.1
Transportation	16	1422.3	1714.2
Electricity Generation	16	100.1	90.4
U.S. Territories	16	33.1	44.4
Ammonia Production and Urea Applicatio	15	19.3	19.6
Soda Ash Manufacture and Consumption	15	4.1	4.2
Titanium Dioxide Production	15	1.3	1.9
Phosphoric Acid Production	15	1.5	1.4
Carbon Dioxide Consumption	15	0.9	1.0
Cement Manufacture	19	33.3	41.2
Lime Manufacture	19	11.2	13.3
Limestone and Dolomite Use	19	5.5	6.0
Iron and Steel Production	20	85.4	65.7
Aluminum Production	20	6.3	5.7
Ferroalloys	20	2.0	1.7
Geothermal*	30	0.4	0.4
Natural Gas Flaring	31	5.8	5.8
Waste Combustion	34	10.9	18.0
CH4			
Enteric Fermentation	1	117.9	115.7
Manure Management	1	31.0	38.0
Stationary Sources - Wood residential	1	8.2	7.7
Rice Cultivation	1	7.1	7.5
Agricultural Residue Burning	1	0.7	0.8
Coal Mining	3	81.9	56.2
Abandoned Coal Mines	3	3.4	4.4
Petrochemical Production	15	1.2	1.7
Petroleum Systems	16	28.9	23.5
Mobile Sources	16	5.0	4.4
Iron and Steel Production	20	1.3	1.2
Natural Gas Systems	31	122.0	125.7
Landfills	34	210.0	199.3
Wastewater Treatment	34	24.1	28.4
N2O			
Agricultural Soil Management	1	262.8	289.7
Manure Management	1	16.2	17.7
Field Burning of Agricultural Residues	1	0.4	0.5
Stationary Sources - Coal	3	4.4	5.2
Nitric Acid	15	17.8	19.6
Adipic Acid	15	15.2	6.0
N2O Product Usage	15	4.3	4.8
Mobile Sources	16	50.7	57.4
Stationary Sources - Petroleum	16	5.5	6.1
Stationary Sources - Natural Gas	31	2.7	3.1
Human Sewage	34	12.8	15.3
Waste Combustion	34	0.4	0.4
HFCs PFCs and SF6			
Substitution of Ozone Depleting Substance	15	0.3	75.1
HCFC-22 Production	15	35.0	29.8
Magnesium Production and Processing	15	5.4	3.2
Aluminum Production	20	18.1	8.9
Semiconductor Manufacture	23	2.9	6.3
Electrical Transmission and Distribution	30	29.2	15.9
Total GHG		6128.9	7038.7
Non-covered GHG		1008.0	1093.9
Residential and Commercial		563.7	616.3
Agricultural		444.3	477.6
Covered GHG		5120.9	5944.8
Covered as Percentage of Total GHG		83.6%	84.5%
MMTCO2E - Millions of metric tons, carbon dioxide equivalent			



2.4 An illustrative IGEM base case[2]

IGEM's baseline for the economy, calibrated or not, evolves through four phases. In this illustrative example which is absent of calibration, the near term, 2000-2010, represents a continuation of recent trends and conditions. The intermediate term, 2010-2025, reflects the onset of trends to eliminate the nation's budget and trade deficits. The long term, 2025-2060, involves a systematic transition of all input variables to their zero-growth, steady-state levels. Factor biases and autonomous productivity trends stabilize. Budget and trade deficits vanish. Tax rates and foreign commodity prices become temporally invariant. Throughout each of these phases, there is a gradual slowing in the rates of population and labor force expansion and in the external forces governing productivity and factor substitution. In the case of the latter, there are still the interactions of these with IGEM's emerging patterns of relative prices and so the forces of price-induced technical change are still at work. Beyond 2060, the remaining two of

[2] The base case of this section and the emissions details of Table 2.1 in the previous section are the reference points for the policy analysis of Chapter 5.

IGEM's driving variables, population and the household time endowment, stabilize and the economy ceases to grow. This steady-state condition of zero growth is not a prediction; rather, it is an assumption of necessity for the model's solution.

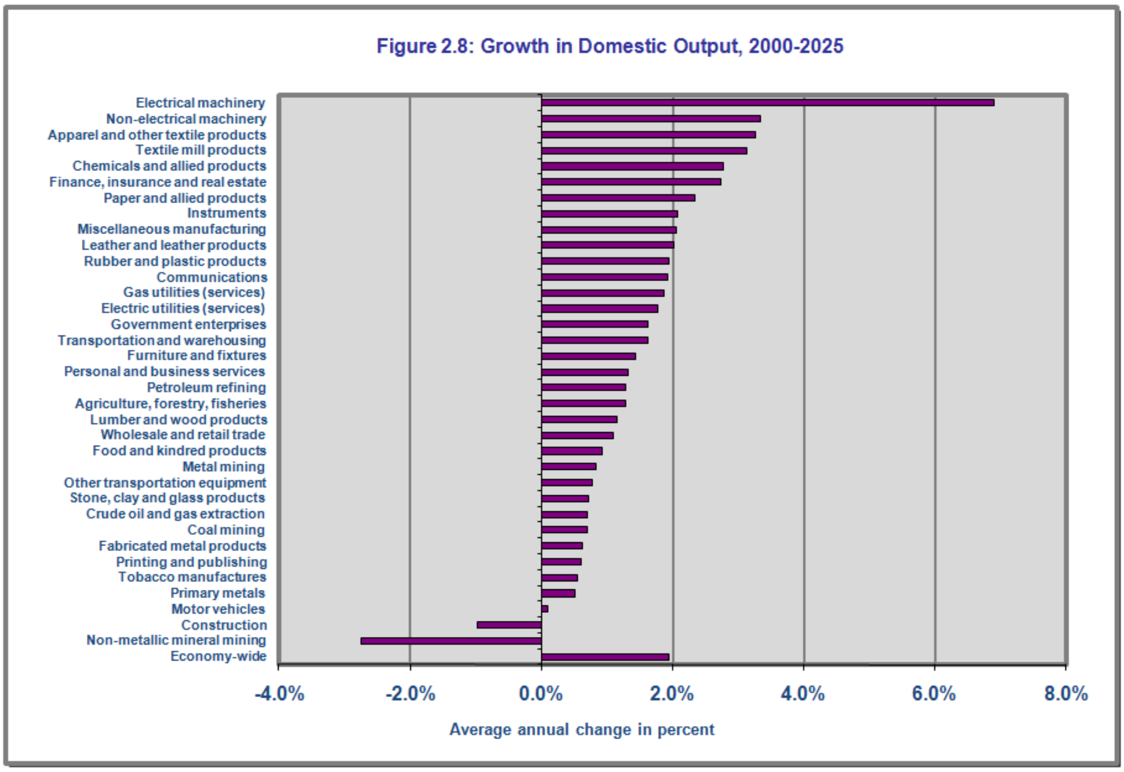
The trends above are evident in the data on aggregate spending and inputs to production shown in Table 2.2. Growth in real GDP and personal consumption is initially in the 2.5 to 3.5% range but averages less than 1.0% over the interval from 2025 to 2060. Growth in capital input, arising from gross investment net of depreciation (capital consumption), and the availability of labor follow similar patterns of declining growth over time. Finally, aggregate productivity averages slightly less than two percent, 2000-2010, just over one percent, 2010-2025, and 0.2%, 2025-2060. This last trend reflects the combined influences of the productivity projections described in Section 2.2.

Table 2.2: Characteristics of Base Case Growth - The Economy

Annual Average Growth Rates in Percent

		Projected		
	2000-10	**2010-20**	**2020-25**	**2025-60**
GDP	2.7	2.0	1.6	0.8
Household Spending	3.5	1.8	1.1	0.7
Capital Input	0.8	0.8	0.7	0.7
Labor Input	1.0	0.7	0.8	0.7
Productivity	1.8	1.2	1.0	0.2

Growth in the total output of the U.S. economy, including all intermediate goods and services as well as all final spending (GDP), averages very nearly 2.0% over the period 2000-2025. The projected industry mix, portrayed in Figure 2.8, evolves as an extension of recent market behavior. High technology manufacturing and the financial sector continue to enjoy relatively more rapid growth while the mining, metals and agricultural sectors continue to grow less rapidly. Domestic motor vehicle manufacturing and construction are among the weakest industries.



Of particular relevance to environmental policy analysis are the emerging patterns of energy use and greenhouse gas emissions. Figure 2.8 provides evidence of the changing mix of energy inputs. All of the energy sectors experience slower than average rates of growth over the period 2000-2025. Domestic oil and gas extraction and coal production are the slowest growing, natural gas and electric utility outputs are the fastest growing and growth in petroleum refinery output lies in between. As shown in Table 2.3, aggregate fossil fuel use tracks the overall economy but at a slower rate. The carbon emissions from fossil fuel use grow initially at an even slower rate reflecting the changing relative mix of energy inputs toward oil and gas and away from coal. Beyond 2010, this change in relative importance has largely occurred and the carbon emissions associated with fossil fuel use grow in line with the corresponding physical quantity.

Table 2.3: Characteristics of Base Case Growth - Energy and Emissions				
Annual Average Growth Rates in Percent				
	Historical	Projected		
	1990-2000	2000-2010	2010-2025	2025-2060
Fossil Fuel Use	1.6	1.7	1.1	0.6
GHG - Covered Activities	1.5	1.2	1.0	0.6
GHG - Total	1.4	1.2	1.0	0.5
Carbon from Fossil Fuel Use	1.7	1.5	1.1	0.6

As discussed above, the (physical) emissions coefficients for fossil fuels (coal, oil and gas) are constant over time while declining trends are adopted for the emissions coefficients attached to all other economic activities. Thus, in these latter cases, there are degrees of "autonomous" change reflected in the base case emissions projections. This is evidenced in the projections of greenhouse gases presented in Table 2.3. Greenhouse gas emissions, both covered and total, grow more slowly than fossil fuel use and the emissions from it. This is because of the structural changes in the mix of economic activities and because of the representation of observed behavior in the form of "autonomous" efficiency improvements.

Projected energy- and emissions-efficiency improvements continue well into the future but at rates that are somewhat slower than historically observed (Table 2.4). The annual reduction in the energy-intensity of real GDP averages 1.0%, 2000-2010, with emissions efficiency improvements averaging 1.2% for the carbon from fossil fuel use and 1.4 to 1.5% for total greenhouse gases. The annual rates of energy- and emissions-efficiency improvement diminish as the economy heads toward steady state, averaging 0.3%, 2025-2060. It should be noted that these diminishing rates of efficiency improvement also are consistent with the broader trends of recent history.

Table 2.4: Characteristics of Base Case Growth - Energy and Emissions Intensities				
Annual Average Growth Rates in Percent				
	Historical	Projected		
	1990-2000	2000-2010	2010-2025	2025-2060
Fossil Fuel Use	-1.6	-1.0	-0.7	-0.3
GHG - Covered Activities	-1.7	-1.4	-0.8	-0.3
GHG - Total	-1.8	-1.5	-0.9	-0.3
Carbon from Fossil Fuel Use	-1.6	-1.2	-0.8	-0.3
Trends in energy and emissions per unit real GDP				

2.5 Calibrated base paths

In the conduct of policy analysis, the scale and details of the base are important to simulation outcomes; this will be demonstrated on both the input and output sides of analysis in Chapters 4 and 5. They become even more important when multiple models are employed in a single assessment. Here, great care needs to be taken in crafting a base case that is common to all so that model results can be more reliably attributed to differing structures and responses as opposed to differing starting points and growth rates. The recently completed Energy Modeling Forum multi-model study of climate change control scenarios (EMF 22) in which IGEM participated was just such an exercise (Goettle and Fawcett, 2009).

Recent analyses of climate change initiatives conducted by the EPA for the U.S. Congress involved parallel applications of IGEM and the Applied Dynamic Analysis of the Global Economy (ADAGE) model from RTI, Inc. (Ross, 2007). In each instance, the two models were calibrated to the most recent Annual Energy Outlook (AEO) for the period of EIA's National Energy Model System's (NEMS's) coverage, 2025 or 2030, and to each other for the period through 2050. With each new initiative, there came the incentives for creating a new base case. These were prompted by new releases of the AEO and by new editions of EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (Inventory). A new Inventory required new starting points and trends for IGEM's emissions coefficients while a new set of AEO projections drove the trends in energy demand, emissions and the overall economy against which the policy was compared.

Over the last several years, three IGEM calibrations were developed. These were in support of analyses for the Climate Stewardship and Innovation Act of 2007 (S.280), the Low Carbon Economy Act of 2007 (S.1766), the American Climate Security Acts of 2008 (S.2191 and its successor S.3036) and the American Clean Energy and Security Act of 2009 (HR.2454).

The base case for S.280, S.1766 and S.2191 rely on the same Inventory (1990-2004) and AEO (2006). The base cases for S.3036 and HR.2454 share a new edition of the Inventory (1990-2006) but differ in their AEO assumptions. The base case for S.3036 is calibrated to AEO 2008 while that for HR.2454 to AEO 2009.

Once IGEM's starting year emissions levels and coefficient trends are developed from the designated Inventory, five variables are targeted to grow at AEO and ongoing-trend rates of change. These variables are real GDP and the total U.S. consumption for each of coal, oil, electricity and gas. GDP is chosen so as to have the scale of the economy comparable across models. The energy variables are chosen so as to have a common "fuel" mix with corresponding levels of emissions, emissions growth and changes in aggregate energy- and emissions-intensities. These targets are achieved via an iterative scheme involving Hicks-neutral changes in the individual productivities of the four energy sectors and a Hicks-neutral change in aggregate productivity affecting all sectors.

Iteration begins with the energy targets and then cycles between the overall economy and energy until all of the targets finally are achieved and convergence completed. Table 2.5 summarizes the results of these calibrations. The base cases clearly show a step-down in the average rate of economic growth, from 2.6% to the 2.3% range annually from 2007 through 2050. More importantly, the base cases show significant and ongoing reductions in fossil fuel consumption and greenhouse gas emissions. This has obvious implications for cap and trade climate policies in that, given these trends in the baselines, emissions reductions need not be as large to achieve a given cap and, therefore, their burdens to the overall economy will be smaller. We will return to this point in Chapter 4.

Table 2.5: Base Case Calibrations
Average annual growth rates in percent, 2007-2050

	Policy Initiative		
	S.280, S.1766 and S.2191	S.3036	HR.2454
EPA's Emissions Inventory	**1990-2004**	**1990-2006**	**1990-2006**
EIA's Annual Energy Outlook	**2006**	**2008**	**2009**
Real GDP	**2.66%**	**2.28%**	**2.35%**
Coal consumption	1.33%	1.07%	0.73%
Petroleum consumption	1.03%	0.32%	0.17%
Electrricity consumption	1.42%	0.94%	0.96%
Natural gas consumption	0.57%	0.06%	0.33%
Total greenhouse gas emissions	0.98%	0.52%	0.38%
Total CO2 emissions	1.06%	0.56%	0.40%
Domestic output by industry			
Agriculture, forestry, fisheries	2.56%	2.32%	2.40%
Metal mining	2.65%	2.11%	2.14%
Coal mining	1.33%	1.07%	0.73%
Crude oil and gas extraction	1.59%	1.38%	1.44%
Non-metallic mineral mining	0.32%	-0.15%	-0.18%
Construction	1.51%	1.07%	1.09%
Food and kindred products	2.71%	2.49%	2.62%
Tobacco manufactures	2.45%	2.18%	2.34%
Textile mill products	3.70%	3.25%	3.33%
Apparel and other textile products	3.87%	3.40%	3.52%
Lumber and wood products	3.35%	2.63%	2.67%
Furniture and fixtures	2.88%	2.43%	2.41%
Paper and allied products	3.55%	3.00%	3.07%
Printing and publishing	2.44%	1.99%	2.06%
Chemicals and allied products	3.77%	3.15%	3.20%
Petroleum refining	1.03%	0.32%	0.17%
Rubber and plastic products	3.27%	2.81%	2.85%
Leather and leather products	3.65%	3.13%	3.24%
Stone, clay and glass products	3.20%	2.61%	2.67%
Primary metals	3.03%	2.32%	2.35%
Fabricated metal products	2.67%	2.13%	2.15%
Non-electrical machinery	4.66%	4.05%	4.07%
Electrical machinery	6.76%	6.13%	6.15%
Motor vehicles	2.99%	2.32%	2.33%
Other transportation equipment	2.66%	2.13%	2.17%
Instruments	2.90%	2.59%	2.62%
Miscellaneous manufacturing	3.71%	3.16%	3.22%
Transportation and warehousing	2.45%	2.12%	2.17%
Communications	3.01%	2.63%	2.74%
Electric utilities (services)	1.42%	0.94%	0.96%
Gas utilities (services)	0.57%	0.06%	0.33%
Wholesale and retail trade	2.44%	2.06%	2.11%
Finance, insurance and real estate	3.11%	2.79%	2.88%
Personal and business services	2.46%	2.15%	2.26%
Government enterprises	2.40%	2.09%	2.17%
Domestic output economy-wide	**2.98%**	**2.54%**	**2.61%**