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THE ECONOMIC IMPACT OF THE NATIONAL RETAIL SALES TAX

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Final Report to Americans For Fair Taxation

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INTRODUCTION AND SUMMARY

The purpose of this report is to analyze the economic impact of substituting the National Retail Sales Tax (NRST) for individual and corporate income taxes, the Medicare, Social Security, and FUTA payroll taxes, and the estate and gift taxes.[1] I consider a revenue neutral substitution-one that leaves the government deficit unchanged. Finally, I focus on the impact of this fundamental tax reform on economic growth over the next quarter century.

I have summarized my conclusions in a series of charts:

1. The revenue neutral substitution of the NRST for existing taxes would have an immediate and powerful impact of the level of economic activity. The first chart gives a projection of GDP under current tax law. The second chart shows that GDP would increase by almost 10.5 percent in the first year. This increase would gradually decline to a little under 5.4 percent over the next twenty-five years.
2. Taxation of consumption would induce a radical shift in the composition of economic activity-away from consumption toward investment. The third chart shows that real investment would initially leap by a staggering 76.4 percent and then gradually fall to about 15 percent higher than under existing taxes. The third chart reveals that real consumption would initially decline by 9.1 percent. However, consumption would

[1] The NRST is described in detail by Laura Dale (1996)

overtake the level under existing taxes within five years and grow rapidly under the NRST.

3. Holding net foreign investment constant, the fourth chart shows that exports would jump b 26.4 percent under the NRST, while imports would rise only modestly. This is the consequence of excluding exports from the tax base while including imports. The initial export boom would gradually subside, but exports would ultimately remain more than 13.3 percent above the level under the current tax system, while imports would fall a modest 0.9 percent below this level.
4. As a consequence of the elimination of taxes on capital income, individuals would sharply curtail consumption of both goods and leisure. In addition, the implied subsidy to leisure time would drop to zero under the NRST; under the existing tax system this is equal to the marginal tax rate on labor income. The fifth chart shows that the NRST would generate dramatic growth in the capital stock and a sharp initial rise in the labor supply that would gradually decline over time.
5. Since producers would no longer pay taxes on profits or other forms of capital income under the NRST and workers would no longer pay taxes on wages, prices received by producers, shown in the sixth chart, would fall by an average of twenty percent. The seventh chart shows that industry outputs would rise by an average of twenty percent with substantial relative gains for investment goods producers.
6. In the long run producers' prices, shown in the eighth chart, would fall by almost thirty percent under the NRST. In addition, the shift in the composition of economic activity toward investment and away from consumption would drastically redistribute economic activity among industries. The ninth chart shows that production would rise in all industries, but the increase in production of investment goods would be relatively greater.

7. The imposition of the NRST would produce a sharply higher tax rate on consumer goods and services, but the tenth chart shows that the initial consumption tax rate would be twenty-three percent at both federal and state and local levels or only 18.4 percent at the federal level. This would gradually rise over time, but remain below thirty percent or 23.8 percent at the federal level.

8. The impact of the NRST on consumer welfare is the wealth equivalent of the gains in aggregate consumption represented in the third chart. The eleventh chart shows that this increase in consumer welfare is equivalent to an immediate gain of 1.59 percent in the national wealth.

9. The distributional impact of the NRST can be summarized by the wealth equivalent of the change in equity. The eleventh chart shows that the loss in equity is 1.29 percent of the national wealth, while the gain in efficiency is 2.88 percent of wealth. The efficiency gain greatly outweighs the equity loss, leading to the net increase in consumer welfare.

10. The effects of the NRST on typical families is helpful in interpreting the gain in efficiency. The impact on lifetime family consumption for an average nonfarm family of size four, living in the Northeast, headed by a white male 35-44 years old is equivalent to an immediate increase in family wealth of 2.43 percent.

11. The twelfth, thirteenth, and fourteenth charts show across-the-board gains in lifetime family consumption among households of different sizes, ages, regions of residence, races, farm vs. nonfarm residence, and male vs female head. These charts also show the impact on families with twice the average standard of living and half this standard. The gain for a family with a higher standard of living is equivalent to a 2.55 percent increase in family wealth, while the gain is 2.31 percent for a family with a lower standard of living, so that gains in efficiency must be weighed against modest loses in equity.

IMPLEMENTATION OF A CONSUMPTION TAX

In *Hearings on Replacing the Federal Income Tax,* held by the Committee on Ways and Means in June 1995, testimony focused on alternative methods for implementing a consumption tax. The consumption tax base can be defined in three alternative and equivalent ways. First, subtracting investment from value added produces consumption as a tax base, where value added is the sum of capital and labor incomes. A second definition is the difference between business receipts and all purchases from other businesses, including purchases of investment goods. A third definition of the tax base is retail sales to consumers. This is the definition that underlies the NRST.

The three principal methods for implementation of a consumption tax correspond to these three definitions of the tax base:

1. The subtraction method. Business purchases from other businesses, including investment goods, would be subtracted from business receipts, including proceeds from the sale of assets. This could be implemented within the framework of the existing tax system by integrating individual and corporate income taxes, as proposed by the U.S. Treasury (1994). In this approach all business would be treated as partnerships or "sub-chapter S" corporations. The second step would be to allow full expensing of investment goods purchases in the year of acquisition. If no business receipts were excluded and no deductions and tax credits were permitted, the tax return could be reduced to the now familiar postcard size, as in the Flat Tax proposal of Majority Leader Dick Armey and Senator Richard Shelby (1995).[2] Enforcement problems could be reduced by drastically simplifying the tax rules, but the principal method of enforcement, auditing of taxpayer records by the Internal Revenue Service, would remain.

[2] Economists will recognize the Flat Tax proposal as a variant of the consumption-base value added tax proposed by Robert Hall and Alvin Rabushka (1995).

2. The credit method. This method is used in Canada and all European countries that impose a value added tax. Business purchases produce a credit against tax liabilities for value added taxes paid on goods and services received. From the point of view of tax administration the credit method has the advantage that both purchases and sales generate records of all tax credits. In Canada and many European countries the value added tax replaced an earlier and more complex system of retail and wholesale sales taxes. The credit method would require substantial modification of collection procedures, but decades of experience in Europe have ironed out many of the bugs.
3. National retail sales tax. Like existing state sales taxes, a national retail sales tax would be collected by retail establishments, including service providers and real estate developers. The actual collections could be subcontracted to existing state agencies. Enforcement procedures would be similar to those now used by the states. To defray the costs of collection at the retail and state government levels, the NRST would rebate 0.25 percent of the tax base to retailers and another 0.25 percent to state agencies.

The crucial point is that all three methods for implementing a consumption tax could be based on the same definition of the tax base. This greatly simplifies the tax economist's task, since the economic impact would be the same for all three approaches. This leaves important issues to be resolved by other tax professionals, including tax lawyers who would write the legislation and the implementing regulations and tax accountants who would translate the laws and regulations into accounting practice and advise economic decision-makers about their implications.

DEFINITION OF CONSUMPTION

From the economic point of view the definition of consumption is straightforward. A useful starting point is Personal Consumption Expenditures (PCE) as defined in the U.S. national income and products accounts. However, the taxation of services poses important administrative problems reviewed in the U.S. Treasury (1984) monograph on the value added tax. First, PCE includes the rental equivalent value of the services of owner-occupied housing, but does not include the services of consumers' durables. Both are substantial in magnitude, but could be taxed by the "prepayment method" described by David Bradford (1986). In this approach taxes on the consumption of the services would be prepaid by including investment rather than consumption in the definition of the tax base.

The prepayment of taxes on services of owner-occupied housing would remove an important political obstacle to adoption of the NRST. All current owner-occupiers would be treated as having prepaid all future taxes on the services of their dwellings. This is equivalent to excluding not only mortgage interest but also returns to equity from the tax base. Equity returns would be taxed at the sale of residence without a corresponding purchase of residential property of equal or greater value.

Under the prepayment method purchases of consumers' durables by households for their own use would be subject to tax. This would include automobiles, appliances, home furnishings, and so on. In addition, new construction of owner-occupied housing would be subject to tax, as would sales of existing renter-occupied housing to owner-occupiers. These are politically sensitive issues and it is important to be clear about the implications of prepayment as the debate proceeds. Housing and consumers' durables must be included in the tax base in order to reap the substantial economic benefits of putting household and business capital onto the same footing.[3]

[3] See, for example, my testimony before the Committee on Ways and Means of June 6, 1995

Any definition of a consumption tax base will have to distinguish between consumption for personal and business purposes. On-going disputes over exclusion of home offices, business-provided automobiles, equipment, and clothing, and business-related lodging, entertainment and meals would continue to plague tax officials, the entertainment and hospitality industries, and holders of expense accounts. In short, substitution of the NRST for the existing tax system would not eliminate all the practical issues that arise from the necessity of distinguishing between business and personal activities in defining consumption.

A closely related issue is whether government output should be taxed as part of the NRST. For efficient allocation of economic activity private and public consumption must be treated on the same basis. For example, Express Mail and Federal Express provide similar delivery services and should be taxed in the same way. Similarly, government purchases should be taxed in order to facilitate comparisons between government spending on consumption and private consumption foregone. The same argument can be applied to government payrolls, since the government can hire people to provide the services it requires or purchase these services from the private sector. Finally, government investment should be taxed by the same "prepayment" method outlined above for private purchases of housing and consumers' durables.

PROVISIONS OF U.S. TAX LAW

In order to analyze the impact of changes in taxes, the growth of the U.S. economy must be simulated with and without changes in these policies.[4] The first step is to generate a simulation with no changes in policy to obtain the *base case*. The second step is to change the exogenous variables of the model to reflect a proposed policy change. This produces a simulation of the *alternative case.* Finally, the two simulations are compared in order to assess the effects of the change in policy.

[4] The solution method is described in Wilcoxen (1988), Appendix E. Methods for solving intertemporal general equilibrium models are surveyed in detail by Wilcoxen (1992).

Obviously, the representation of the existing tax system in the base case is critical to this comparison.

The existing U.S. tax system can be represented by introducing the characteristic features of tax law into the cost of capital.[5] U.S. tax law distinguishes among assets employed in three different legal forms of organization-households and nonprofit institutions, noncorporate businesses, and corporate businesses. Income from capital employed in corporate business is subject to the corporate income tax, while distributions of this income to households are subject to the individual income tax. Income from unincorporated businesses-partnerships and sole proprietorships- is taxed only at the individual level. Income from equity in household assets is taxed. Capital utilized in all three forms of organization is subject to property taxation.

Although income from equity in the household sector is not taxed, property taxes and interest payments on household debt are deductible from income for tax purposes under the individual income tax. The value of these tax deductions is equivalent to a subsidy to capital in the household sector. Interest payments to holders of household debt are taxable to the recipients. Capital gains on household assets are effectively excluded from taxable income by provisions that exclude capital gains on owner-occupied housing when they are "rolled over" into the same form of investment.

Income from noncorporate equity is treated as fully distributed to equity holders, whether or not the income is actually paid out. Interest payments to holders of debts on noncorporate businesses are also taxed. Property taxes and interest payments are treated as deductions in defining noncorporate income for tax purposes. Revenue is also reduced by capital consumption allowances. Before 1987 tax liability was also reduced by an investment tax credit proportional to investment expenditures. Capital gains on noncorporate assets are subject to special treatment.

[5] The incorporation of provisions of U.S. tax law into the cost of capital is based on Jorgenson and Yun (1991b), Chapter 2, Jorgenson and Yun (1990, 1991a) have employed the results in analyzing the impact of the Tax Reform Act of 1986. The cost of capital in nine countries is compared in a volume edited by Jorgenson and Landau (1993).

Property taxes and interest payments are treated as deductions from revenue in defining corporate income for tax purposes. Revenue is also reduced by allowances for capital consumption. At the individual level distributions of corporate income in the form of interest and dividends are subject to taxation as ordinary income. Interest payments on corporate bonds are also taxable to the recipients. Capital gains realized from the sale of corporate equities are subject to special treatment.

The special treatment of capital gains arises from the three separate features of U.S. tax law. First, capital gains are taxed only when they are realized and not when they are accrued. This makes it possible to defer tax liability on capital gains until assets are sold. Second, capital gains have been given favorable treatment by including only a fraction of these gains in income defined for tax purposes. Finally, capital gains taxes on assets received as part of a bequest are based on their value at the time of the bequest. Capital gains assured prior to the bequest are not subject to tax.

DISTRIBUTIONAL IMPACT

Daniel Feenberg, Robert Mitrusi, and James Poterba (1996) have shown that the "demogrant" feature of the NRST produces greater progressivity in the distribution of the tax burden. This makes it unnecessary to consider additional policies to enhance progressivity as part of a shift to NRST. However, a very important limitation of this finding is that the impact is purely "static" and does not include the dramatic gains in the level of economic activity and changes in the composition of this activity.

The standard approach to evaluating the distributional impact of tax policy focuses on "static" changes in the size distribution of income, that is, changes in the distribution with no impact on the overall level of income. This is the methodology employed by the Office of Tax analysis at the Department of the Treasury and the Joint Committee on Taxation of the Congress. The approach of Poterba and his colleagues is a very substantial improvement over the OTA/JCT methodology,

since it focuses on consumption rather than income. The rationale is that consumption provides a better measure of lifetime changes in the standard of living.

The issue that must be addressed is how to translate a "dynamic" analysis of the impact of the NRST into a measure of effects on consumer welfare. The most transparent effect of tax reform is a rise in the level of the gross domestic product (GDP). However, the effects on the composition of the GDP-consumption vs. investment, exports vs. imports, and capital vs. labor-are also important. A further dimension for disaggregation is to analyze the impact on different industries. This takes place through changes in the relative prices and corresponding changes in industry outputs.

The impact of the NRST on consumer welfare is best measured by changes in lifetime consumption; these can be summarized in terms of equivalent changes in the national wealth. Lifetime consumption is a convenient device for summarizing the effects on aggregate consumption and the most natural measure of consumer welfare in a "dynamic" analysis of tax reform. Consumer welfare can be decomposed between efficiency and equity. Efficiency is a summary measure of the level of lifetime consumption, while equity captures the distribution among households.

KEY ASSUMPTIONS

Substitution of the NRST for existing taxes would be the most drastic change in federal tax policy since the introduction of the income tax in 1913. It should not be surprising that the economic impact I have summarized above would be truly staggering in its dimensions. In order to comprehend the magnitude of this impact it is important to draw attention to the key assumptions that underlie the simulations I have presented.

The first assumption relates to fiscal federalism or the role of state and local governments. Since state and local income taxes usually employ the same bases as the corresponding federal taxes, it is reasonable to assume that substitution of NRST for taxes at the federal level would be followed by similar substitutions at the state and local level. For simplicity I consider the economic impact of substitution at all levels simultaneously. Since an important advantage of a fundamental tax reform is the possibility, at least at the outset, of radically simplifying tax rules, it does not make much sense to assume that these rules would continue to govern state and local taxes, even if the NRST were substituted for federal taxes.

The second assumption is the economic impact of tax reform on the federal deficit. Nearly two decades of economic debate over this issue has failed to produce resolution. No doubt this dispute could continue well into the next century and occupy the next generation of fiscal economists, as it has the current generation. An effective device for insulating the discussion of fundamental tax reform from the budget debate is to limit consideration to deficit neutral proposals. This device was critical to the eventual enactment of the Tax Reform Act of 1986 and is, I believe, essential to progress in understanding the economic impact of NRST.

The third assumption is to hold net foreign investment constant, while allowing exchange rates to adjust. It might appear that elimination of taxes on capital income would reduce net foreign investment by providing foreigners with incentives to acquire assets in the U.S. and domestic

residents incentives to sell foreign assets. However, the export boom that would follow introduction of NRST could require a substantial increase in net foreign investment. Since there is no way to assess the relative importance of these two forces within the modeling framework, the best approach is to assume they will balance out.

APPENDIX

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Intertemporal general equilibrium modeling provides a natural framework for economic analysis of the impact of taxes.[6] The organizing mechanism of these models is an intertemporal price system balancing demand and supply for products and factors of production. This price system links the prices of assets in every time period to the discounted value of future capital services. This forward-looking feature is combined with backward linkages among investment, capital stock, and capital services in modeling the dynamics of economic growth. Alternative time paths of economic growth depend on taxes through their impact on capital accumulation.

In Jorgenson and Wilcoxen (1990a) we have presented a highly disaggregated intertemporal model for analyzing the impact of tax policies. We employ an econometric model of production originated by Jorgenson and Fraumeni (1981). This includes systems of demand functions for inputs and a model of endogenous productivity growth for each of thirty-five sectors of the U.S. economy. We also incorporate and econometric model of aggregate consumer behavior based on the exact aggregation approach of Jorgenson, Lau, Stoker (1982). This dispenses with the notion of a representative consumer employed in previous models and includes a system of demand functions for commodity groups.

Our model preserves the key features of more highly aggregated models. One important dimension for disaggregation is to introduce a distinction between industries and commodities in order to measure tax impacts for narrower segments of the economy. This captures differences

[6] The classix formulation of intertemporal general equilibrium theory is by Lindahl (1970). A detailed survey of this theory is presented by Stokey and Lucas (1989).

among industries in responses to tax changes. A second dimension for disaggregation is to distinguish among households by standard of living and demographic characteristics. This makes it possible to model differences in responses to tax-induced price changes and is useful in examining distributional effects.

To analyze the impact of alternative tax policies we introduce models of the demand for different types of capital services for each of thirty-five industrial sectors of the U.S. economy and the household sector. These models depend on tax policies through measures of the cost of capital for each type of capital services presented by Jorgenson and Yun (1991b). These measures of the cost of capital incorporate the characteristic features of U.S. tax law. The concept of the cost of capital makes it possible to represent the economically relevant features of highly complex tax statutes in a very succinct form. The cost of capital also summarizes information about the future consequences of investment decisions required for current decisions about capital allocation.

AN OVERVIEW OF THE MODEL

In Jorgenson and Wilcoxen (1993) we describe the econometric implementation of an intertemporal general equilibrium model of the U.S. economy. In this section we outline the model, emphasizing features that are critical in assessing tax policy impacts. We have constructed submodels for each of four sectors of the U.S. economy-business, household, government, and the rest of the world. Since tax policies affect industries in very different ways, we begin our presentation with the business sector.

Producer Behavior

Modeling the response of producers to changes in tax policies requires distinguishing among industries with different capital intensities. Accordingly, we have subdivided the business sector into the thirty-five industries shown in Table 1. Each of these corresponds, roughly, to a two-digit industry in the Standard Industrial Classification. This level of industrial disaggregation makes it possible to measure the impact of alternative policies on relatively narrow segments of the U.S. economy. We have also divided the output of the business sector into thirty-five commodities. Each one is the primary product of one of the industries. Many industries produce secondary products as well; for example, the textile industry produces both textiles and apparel, so that we have allowed for joint production. Each commodity is allocated between to intermediate demands by other industries and deliveries to final demands by households, governments, and the rest of the world.

We represent the technology of each industry by means of an econometric model of producer behavior. In order to estimate the unknown parameters of these production models we have constructed an annual time series of inter-industry transactions tables for the U.S. economy.[7] The data for each year are divided between a *use* table and a *make* table. The use table shows the quantities of each commodity-intermediate inputs, primary factors of production, and noncompeting imports-used by each industry and final demand category.[8] The make table gives the amount of each commodity produced by each industry. In the absence of joint production this would be a diagonal array. The organization of the use and make tables is illustrated in Figures 1 and 2; Table 2 provides definitions of the variables appearing in these figures.

[7] Our data integrate the capita accounts described by Jorgenson (1990b) with an accounting system based on the United Nations (1993) System of National Accounts. Details are given by Wilcoxen (1988), Appendix C.
[8] Noncompeting imports are imported commodities not produced domestically.

Table \ Definitions of the Industries

Number	Description
1	Agriculture, forestry and fisheries
2	Metal mining
3	Coal mining
4	Crude petroleum and natural gas extraction
5	Nonmetallic mineral mining
6	Construction
7	Food and kindred products
8	Tobacco manufactures
9	Textile mill products
10	Apparel and other textile products
11	Lumber and wood products
12	Furniture and fixtures
13	Paper and allied products
14	Printing and publishing
15	Chemicals and allied products
16	Petroleum refining
17	Rubber and plastic products
18	Leather and leather products
19	Stone clay and glass products
20	Primary metals
21	Fabricated metal products
22	Machinery, except electrical
23	Electrical machinery
24	Motor vehicles
25	Other transportation equipment
26	Instruments
27	Miscellaneous manufacturing
28	Transportation and warehousing
29	Communication
30	Electric utilities
31	Gas utilities
32	Trade
33	Finance, insurance and real estate
34	Other services
35	Government enterprises

Figure 1: Organization of the Use Table

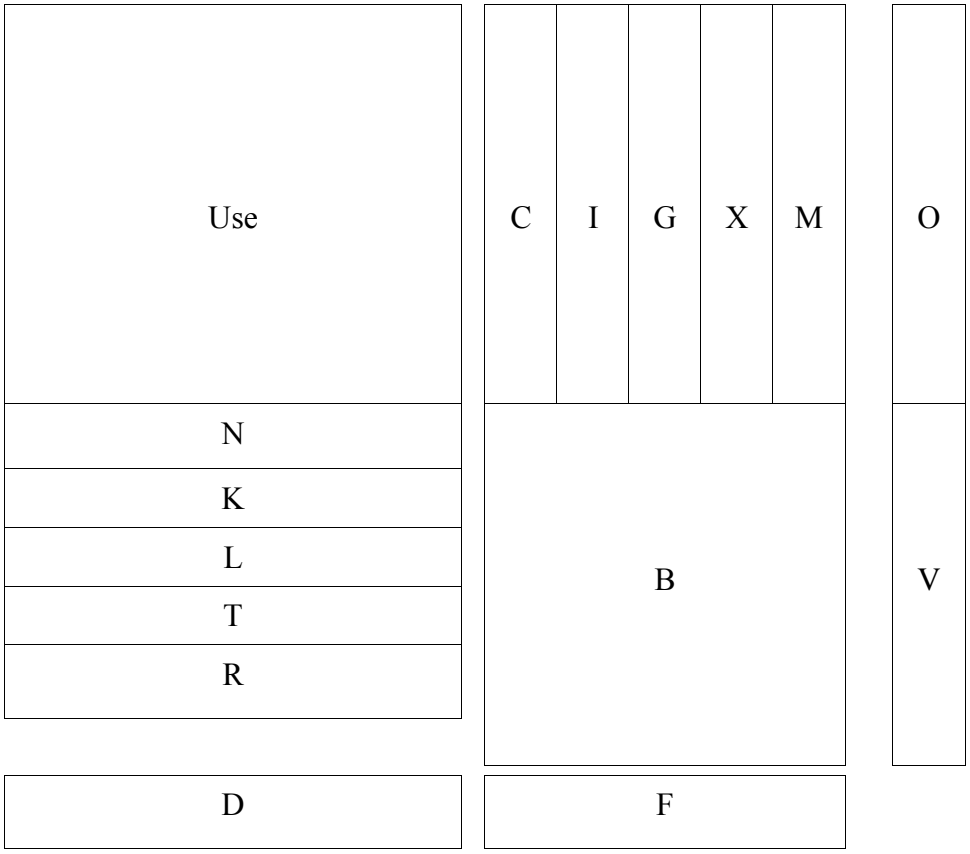

Figure 2: Organization of the Make Table

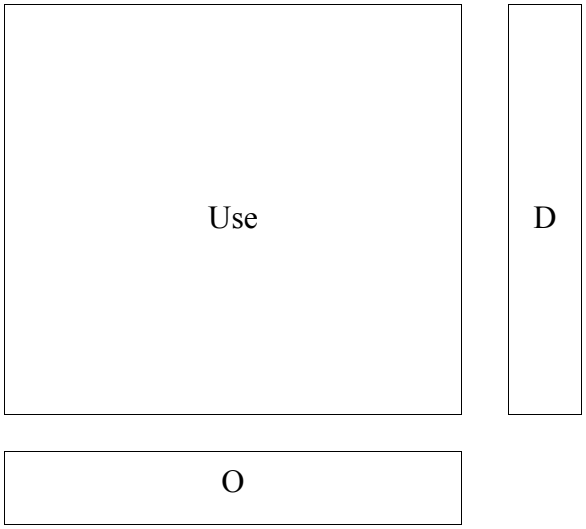

Table 2. Make and Use Table Variables

Category	Variable	Description
Industry-Commodity Flows:		
	USE	Commodities *Used* by Industries (use table)
	MAKE	Commodities Made by Industries (make
Final Demand Columns:		
	C	Personal Consumption
	I	Gross Private Domestic Investment
	G	Government Spending
	X	Exports
	M	Imports
Value Added Rows:		
	N	Noncompeting Imports
	K	Capital
	L	Labor
	T	Net Taxes
	R	Rest of the World
Commodity and Industry Output:		
	O	Commodity Output
	D	Industry Output
Other Variables:		
	B	Value Added Sold Directly To Final Demand
	V	Total Value Added
	F	Total Final Demand

The econometric method for parametrizing our model stands in sharp contrast to the calibration method used in previous general equilibrium modeling of tax policies. Calibration involves choosing parameters to replicate the data for a particular year.[9] Almost all general equilibrium models employ the assumption of fixed "input-output" coefficients for intermediate goods, following Johansen (1960). This allows the ratio of the input of each commodity to the output of an industry to be calculated from a single use table like the one presented in Figure 1; however, it rules out substitution among intermediate goods, such as energy and materials, by assumption. It also ignores the distinction between industries and commodities and rules out joint production.

The econometric approach to parametrization has several advantages over the calibration approach. First, by using an extensive time series of data rather than a single data point, we can derive the response of production patterns to changes in prices from historical experience. This is particularly important for the analysis of tax policies, since these policies have changed substantially during our sample period and tax rates have varied widely. The calibration approach imposes responses to these changes through the choice of functional forms rather than econometric analysis of empirical evidence.

A second advantage of the econometric approach is that parameters estimated from time series are much less likely to be affected by the peculiarities of the data for a particular time period. By construction, parameters obtained by calibration are forced to absorb all the random errors present in the data for a single benchmark year. This poses a severe problem when the benchmark year is unusual in some respect. For example, parameters calibrated to the year 1973 would incorporate into the model all the distortions in energy markets that resulted from price controls and the rationing of energy during the first oil crisis. Econometric parametrization greatly mitigates this problem by reducing the influence of disturbances for a particular time period.

[9] Jorgenson (1986) describes the econometrics of producer behavior. Mansur and Walley (1984) present the calibration approach.

Empirical evidence on substitutability among inputs is essential in analyzing the impact of tax policies. If it is easy for industries to substitute among inputs, the effects of these policies will be very different than if substitution were limited. Although calibration avoids the burden of data collection required by econometric estimation, it also specifies the substitutability among inputs by assumption rather than relying on empirical evidence. This can easily lead to substantial distortions in estimating the effects of tax policies.

Consumer Behavior

The substitution of a consumption tax for an income tax would affect relative prices faced by consumers. However, this substitution would have different impacts on different households. To capture these differences among households, we have subdivided the household sector into demographic groups that differ by characteristics such as family size, age of head, region of residence, race, and urban versus rural location. We treat each household as a consuming unit, so that the household behaves like an individual maximizing a utility function.

We represent the preferences of each household by means of an econometric model of consumer behavior. Our models of consumer behavior incorporate time series data on personal consumption expenditures from the annual inter-industry transactions tables for the U.S. economy represented in Figure 1. The econometric approach for parametrization enables us to derive the response of household expenditure patterns to changes in prices from historical experience. Empirical evidence on substitutability among goods and services by households is essential in analyzing the impact of alternative tax policies. If it is easy for households to substitute among commodities, the effects of these policies will be very different than if substitution were limited.

The econometric approach to modeling consumer behavior has the same advantages over the calibration approach as those we have described for modeling producer behavior.[10] An additional

[10] Jorgenson (1990a) summarizes the econometrics of consumer behavior

feature of our models of consumer behavior is that they incorporate detailed cross section data on the impact of demographic differences among households and levels of total expenditure on household expenditure patterns. We allow patterns of individual expenditure change as total expenditure varies, even in the absence of price changes. This captures an important characteristic of household expenditure patterns usually ignored in general equilibrium modeling.

Finally, we aggregate over individual demand functions to obtain a system of aggregate demand functions. This makes it possible to dispense with the notion of a representative consumer. The system of aggregate demand functions allocates total expenditure to broad groups of consumer goods and services. Given prices and total expenditure, this system allows us to calculate the elements of personal consumption column in the make table of Figure 1. We employ the model to represent aggregate consumer behavior in simulations of the U.S. economy under alternative tax policies.

To determine the level of total expenditure we embed our model of personal consumption expenditures in a higher-level system that represents consumer preferences between goods and leisure and between saving and consumption. At the highest level each household allocates *full wealth*, defined as the sum of human and nonhuman wealth, across time periods. We formalize this decision by introducing a representative agent who maximizes an additive intertemporal utility function, subject to an intertemporal budget constraint. The allocation of full wealth is determined by the rate of time preference and the intertemporal elasticity of substitution. The representative agent framework requires that intertemporal preferences must be identical for all households.

We model the household allocation decision by assuming that full consumption is an aggregate of goods and leisure and allocating this consumption between personal consumption expenditures and leisure time. Given expenditure on goods and services and its distribution among households, this model then allocates personal consumption expenditures among commodity groups. Finally, the income of the household sector is the sum of incomes from the supply of capital

and labor services, interest payments from governments and the rest of the world, all net of taxes, and transfers from the government. Savings are equal to the difference between income and consumption, less personal transfers to foreigners and nontax payments to governments.

Investment and Capital Formation

Our investment model, like our model of saving, is based on perfect foresight or rational expectations. Under this assumption the price of investment goods in every time period is based on expectations of future capital service prices and discount rates that are fulfilled by the solution of the model. In particular, we require that the price of new investment goods is always equal to the present value of future capital services.[11] The price of investment goods and the discounted value of future rental prices are brought into equilibrium by adjustments in future prices and rates of return. This incorporates the forward-looking dynamics of asset pricing into our model of intertemporal equilibrium.

In each of the thirty-five industrial sectors and the household sector the demand for capital services is first subdivided between corporate and noncorporate subsectors. Within each of these subsectors the demand for capital is further subdivided between short-lived assets-structures, inventories, and land. The prices for these different types of capital services reflect provisions of U.S. tax law for taxation of capital income in corporate, noncorporate, and household sectors. These prices also include tax provisions that affect short-lived and long-lived assets differently, such as depreciation allowances and investment tax credits.

For tractability we assume there is a single capital stock which can be reallocated among industries and final demand categories costlessly. Under this assumption changes in tax policy can affect the distribution of capital and labor supplies among sectors, even in the short run. However, the total supply of capital in our model in each time period is perfectly inelastic, since the available

[11] The relationship between the price of investment goods and the rental price of capital services is discussed in greater detail by Jorgenson (1989).

stock of capital is determined by past investments. An accumulation equation relates capital stock to investments in all past time periods and incorporates the backward-looking dynamics of capital formation into our model of intertemporal equilibrium.

Government and Foreign Trade

The two remaining final demand categories in our model are the government and the rest of the world sectors. We determine final demands for government consumption from the income-expenditure identity for the government sector.[12] The first step is to compute tax revenue by applying exogenous tax rates to all taxable transactions in the economy. We then add the capital income of government enterprises, which is determined endogenously, and nontaz receipts, determined exogenously, to tax receipts to obtain total government revenue.

The key assumption of our government submodel is that the budget deficit can be specified exogenously. We add the deficit to total revenue to obtain total government spending. To arrive at government purchases of goods and services, we subtract interest paid to domestic and foreign holders of government bonds together with government transfer payments to domestic and foreign recipients. We allocate the remainer among commodity groups according to fixed shares constructed from historical data. Finally, we determine the quantity of each commodity by dividing the value of government spending on that commodity by its price. Government consumption is not included in our representation of the preferences of the household sector.

Foreign trade has two quite different components-imports and exports. We assume that imports are imperfect substitutes for similar domestic commodities.[13] The goods actually purchased by households and firms reflect substitutions between domestic and imported products. The price

[12] Our treatment of government spending differs from the U.S. national accounts in that we have assigned government enterprises to the corresponding industry wherever possible. We include the remaining purchases by the government sector in final demands by governments.

[13] This approach was originated by Armington (1969). See Wilcoxen (1988) and Ho (1989) for further details on our implementation of this approach.

responsiveness of these purchases is estimated from historical data taken from the import and export columns of the use table, Figure 1, in our annual inter-industry transactions tables.

Exports are modeled by a set of explicit foreign demand equations, one for each commodity, that depend on exogenously given foreign income and the foreign price of U.S. exports. Foreign prices are computed from domestic prices by adjusting for subsidies and the exchange rate. The demand elasticities in these equations are estimated from historical data. We assume that U.S. firms are price-takers in foreign markets. The alternative approach of modeling imperfections in international markets would require firm-level data, not only for the U.S., but for its international competitors.

The key assumption of our submodel of the rest of the world sector is that the current account is exogenous and the exchange rate is endogenous. The current account surplus is equal to the value of exports less the value of imports, plus interest received on domestic holdings of foreign bonds, less private and government transfers abroad, and less interest on government bonds paid to foreigners.

CONCLUSION

Although the intertemporal general equilibrium approach has proved to be useful in modeling the impact of tax policies, much remains to be done to exploit the full potential of this approach. As an illustration, the model of consumer behavior employed by Jorgenson and Wilcoxen (1990b) successfully dispenses with the notion of a representative consumer. An important feature of this model is that systems of individual demand functions can be recovered from the system of aggregate demand functions. The consumer preferences underlying these individual demand systems can be used to generate measures of individual welfare that are useful in evaluating the distributional consequences of changes in tax policy, as described by Jorgenson, Slesnick, and Wilcoxen (1992).

We conclude that intertemporal general equilibrium modeling provides a very worthwhile addition to methodologies for modeling the economic impact of taxes. The neo-classical theory of economic growth is essential for understanding the dynamic mechanisms that underlie long run and intermediate run growth trends. The econometric implementation of this theory is critical for capitalizing on the drastic changes in energy prices and substantial alterations in tax policies of the past two decades. This wealth of historical experience, interpreted within an intertemporal framework, can provide valuable guidance in future tax policy formulation.

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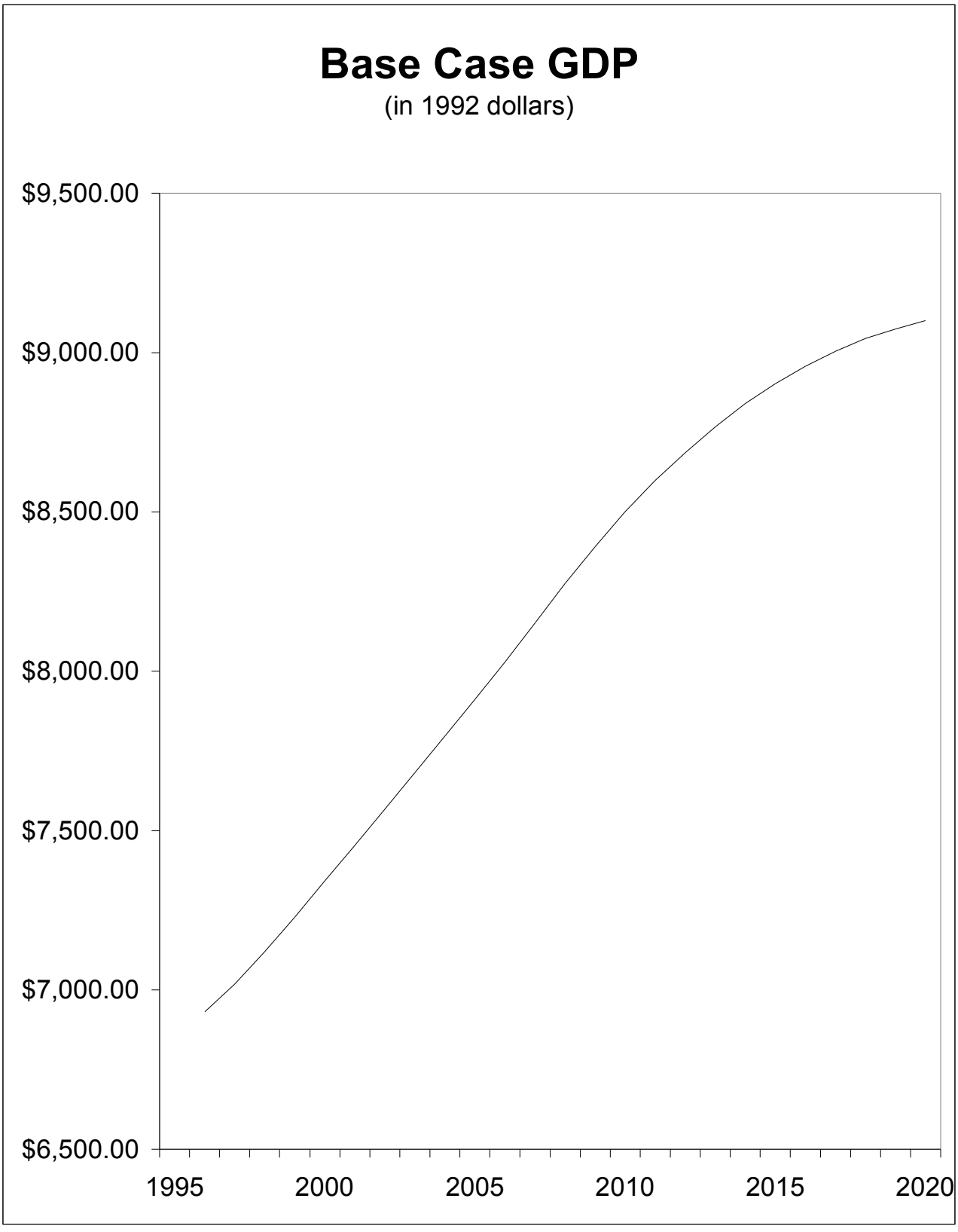
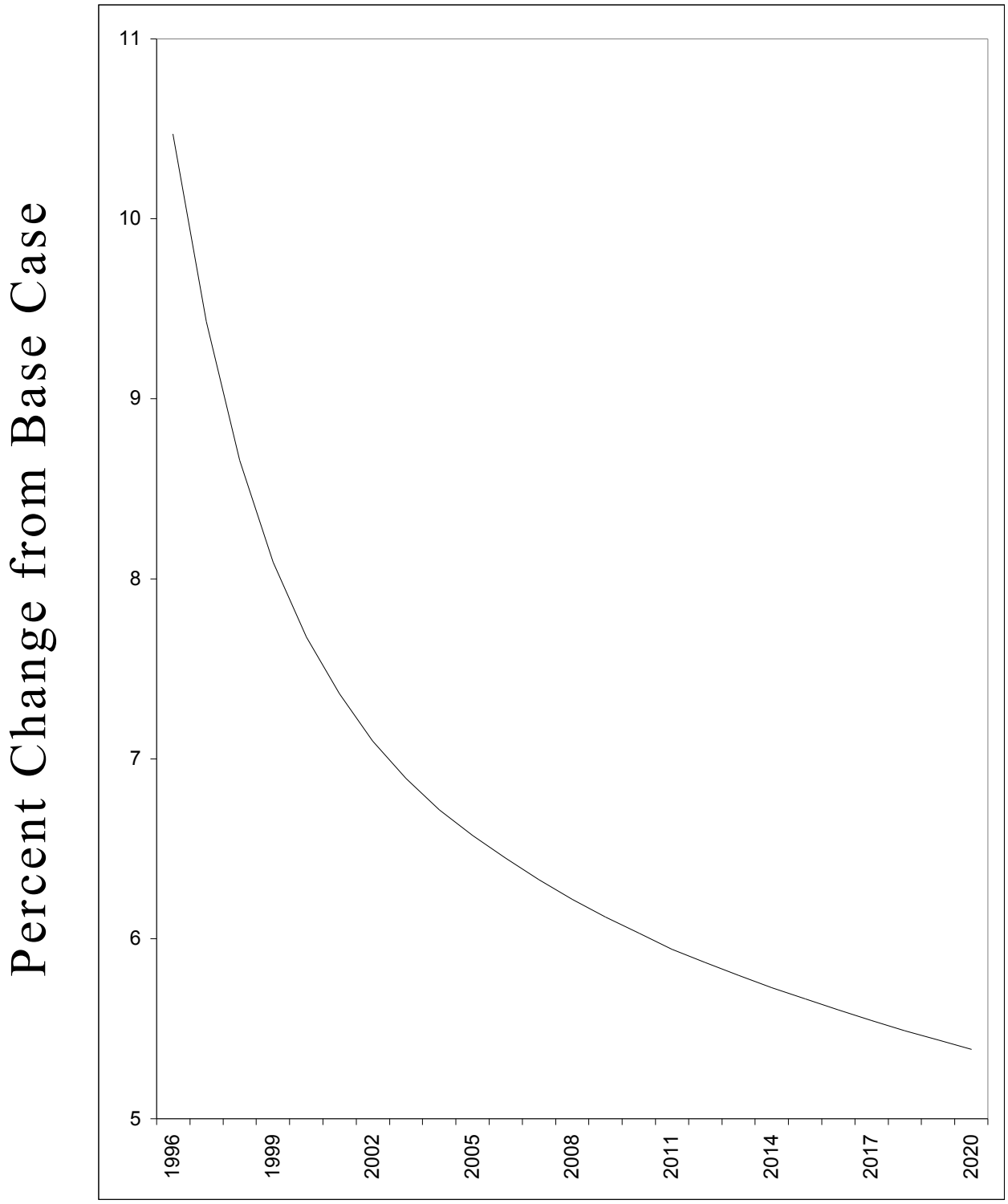

Base Case GDP
(in 1992 dollars)
$9,500.00
$9,000.00
$8,500.00
$8,000.00
$7,500.00
$7,000.00
$6,500.00
1995
2000
2005
2010
2015
2020

Base Case GDP

(in 1992 dollars)

1995	
1996	6,930.98
1997	7,019.01
1998	7,119.82
1999	7,228.06
2000	7,341.56
2001	7,453.23
2002	7,566.73
2003	7,681.22
2004	7,796.97
2005	7,912.96
2006	8,029.14
2007	8,152.47
2008	8,275.15
2009	8,391.09
2010	8,500.22
2011	8,598.68
2012	8,686.70
2013	8,767.13
2014	8,840.33
2015	8,901.93
2016	8,956.95
2017	9,003.90
2018	9,043.94
2019	9,074.73
2020	9,101.03

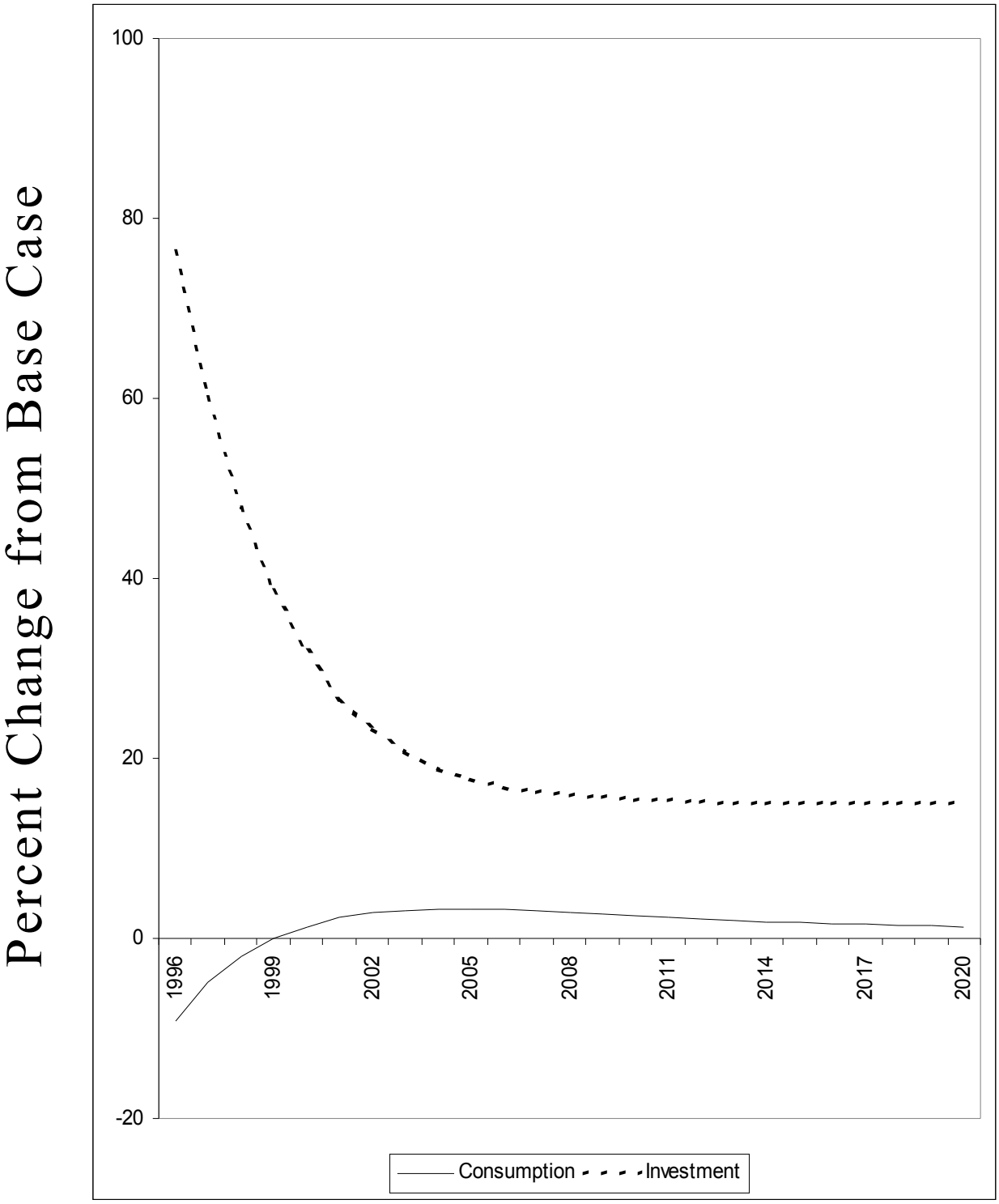
GDP


Percent Change from Base Case
11
10
9
8
7
6
5
1996
1999
2002
2005
2008
2011
2014
2017
2020

GDP

	GDP
1996	10.473
1997	9.428
1998	8.658
1999	8.093
2000	7.676
2001	7.363
2002	7.100
2003	6.890
2004	6.717
2005	6.573
2006	6.449
2007	6.329
2008	6.219
2009	6.119
2010	6.031
2011	5.943
2012	5.869
2013	5.797
2014	5.727
2015	5.664
2016	5.605
2017	5.545
2018	5.489
2019	5.437
2020	5.385

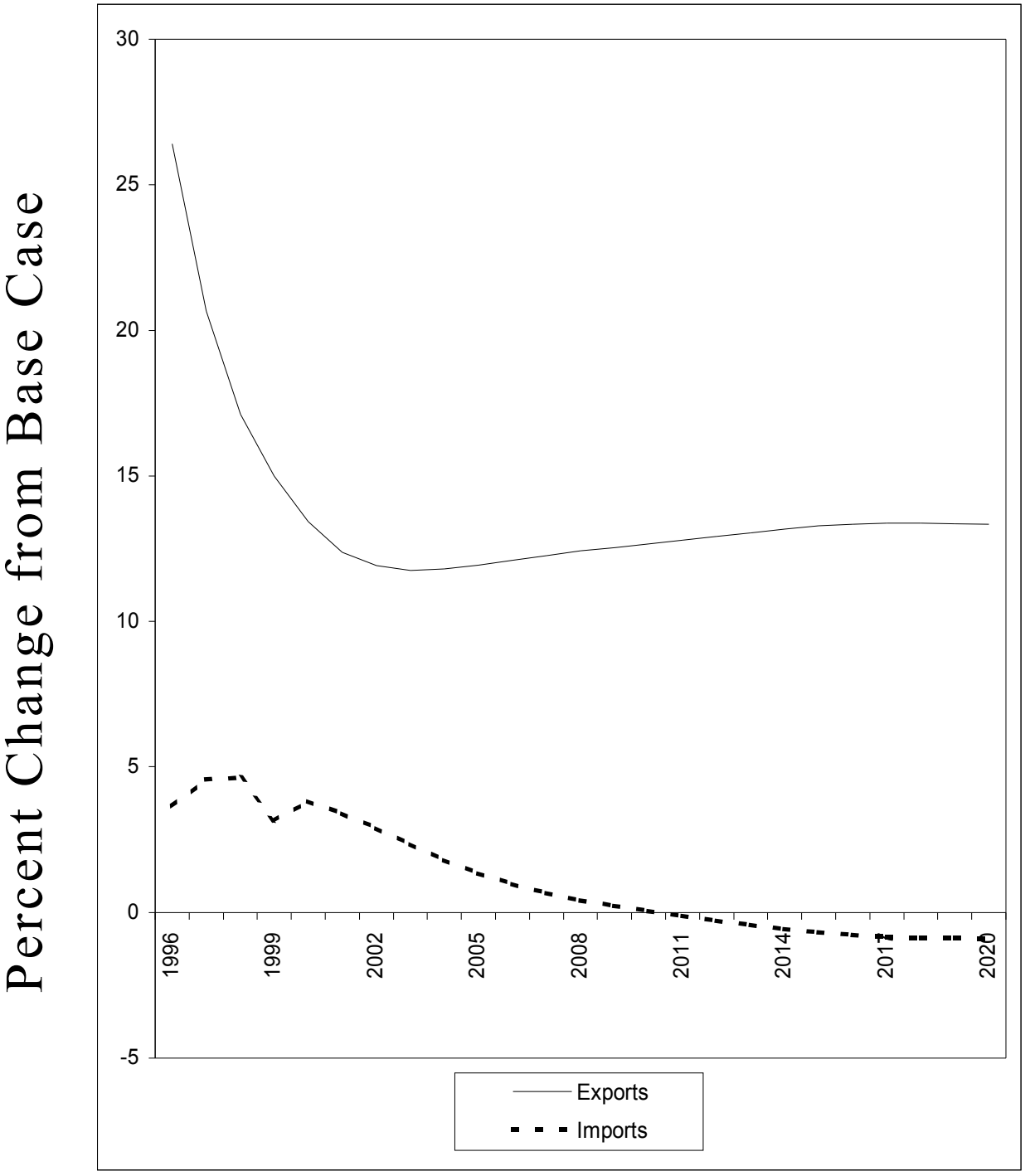
Consumption and Investment



Consumption and Investment

	Consumption	Investment
1996	- 9.124	76.448
1997	- 4.947	60.137
1998	- 2.005	47.916
1999	- 0.021	38.603
2000	1.281	31.888
2001	2.335	26.680
2002	2.821	23.250
2003	3.116	20.719
2004	3.283	18.807
2005	3.266	17.632
2006	3.187	16.798
2007	3.039	16.234
2008	2.857	15.843
2009	2.664	15.595
2010	2.485	15.395
2011	2.315	15.232
2012	2.167	15.110
2013	2.019	15.024
2014	1.880	14.960
2015	1.762	14.932
2016	1.655	14.929
2017	1.558	14.928
2018	1.472	14.954
2019	1.407	14.981
2020	1.341	15.008

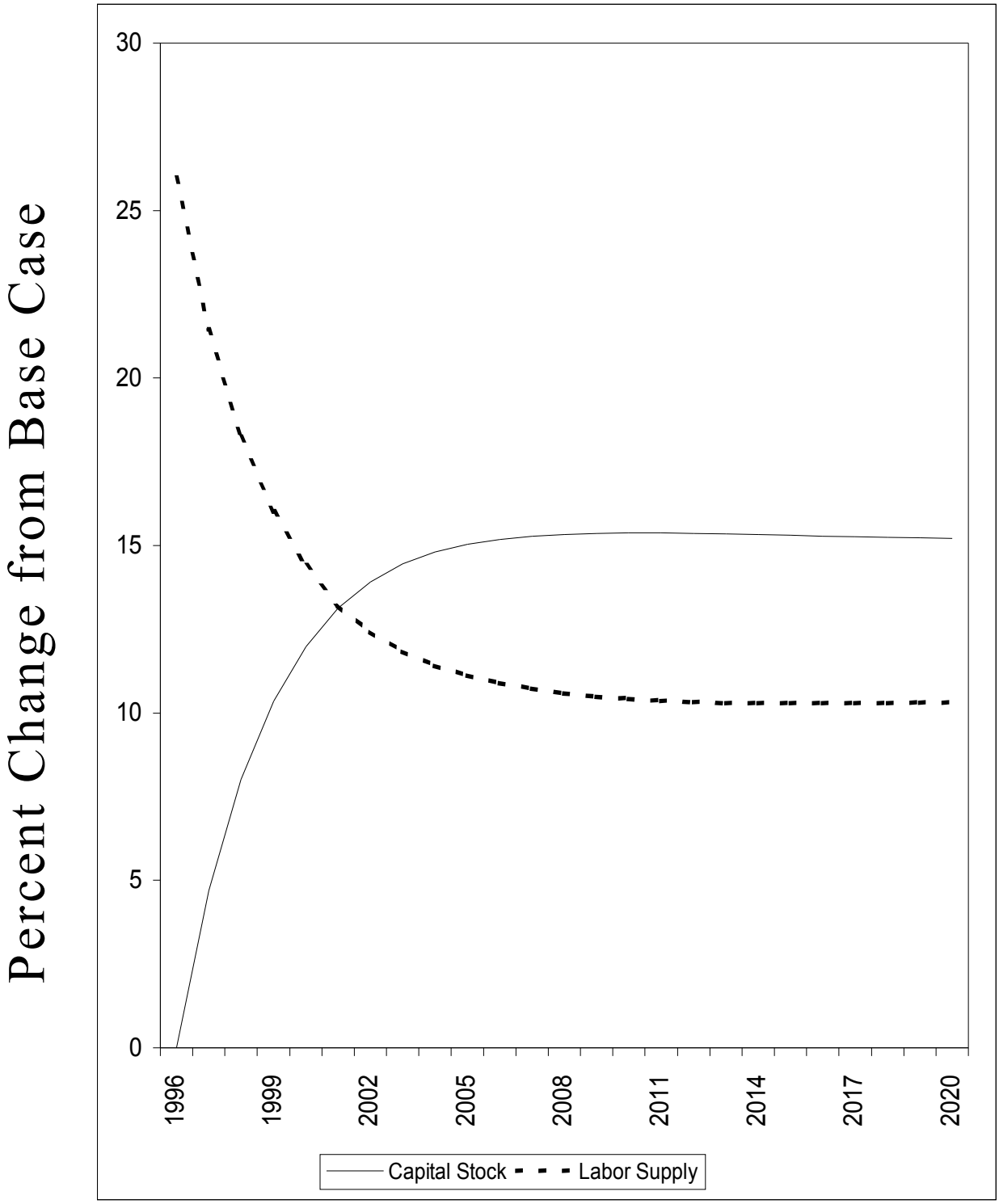
Imports and Exports



Imports and Exports

	Exports	Imports
1996	26.412	3.661
1997	20.669	4.573
1998	17.103	4.631
1999	14.990	4.154
2000	13.423	3.831
2001	12.377	3.403
2002	11.919	2.897
2003	11.760	2.351
2004	11.812	1.791
2005	11.941	1.349
2006	12.105	0.978
2007	12.270	0.669
2008	12.422	0.418
2009	12.539	0.230
2010	12.665	0.053
2011	12.786	- 0.115
2012	12.914	- 0.272
2013	13.050	- 0.427
2014	13.176	- 0.569
2015	13.275	- 0.685
2016	13.346	- 0.771
2017	13.380	- 0.835
2018	13.382	- 0.869
2019	13.358	- 0.886
2020	13.342	- 0.906

Capital Stock and Labor Supply

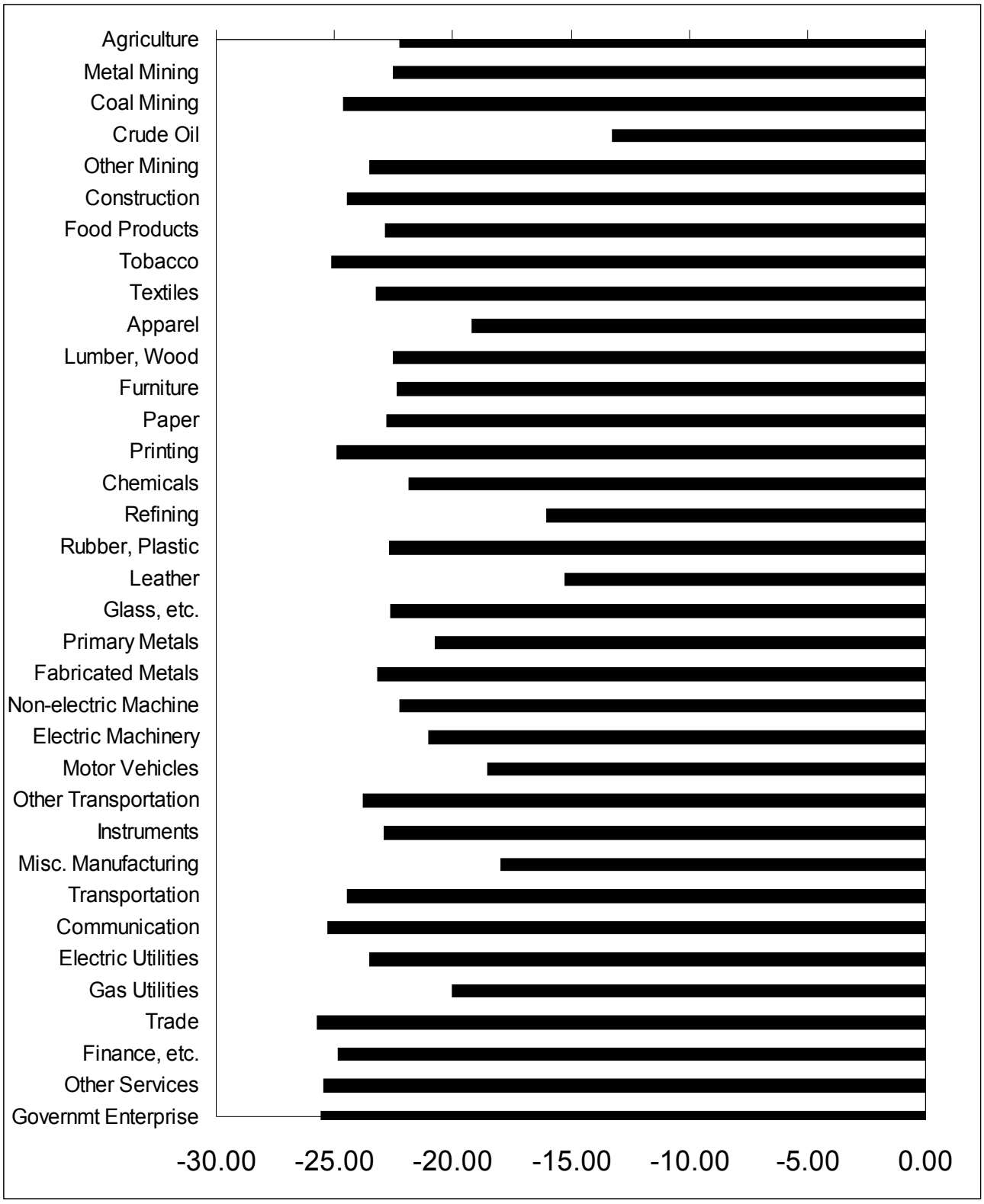


Capital Stock and Labor Supply

	Capital Stock	Labor Supply
1996	0.000	25.978
1997	4.689	21.446
1998	8.019	18.244
1999	10.355	16.002
2000	11.981	14.401
2001	13.129	13.217
2002	13.905	12.414
2003	14.440	11.830
2004	14.799	11.403
2005	15.027	11.110
2006	15.176	10.894
2007	15.269	10.719
2008	15.325	10.586
2009	15.355	10.487
2010	15.369	10.409
2011	15.371	10.355
2012	15.362	10.319
2013	15.347	10.295
2014	15.328	10.282
2015	15.306	10.281
2016	15.284	10.283
2017	15.263	10.286
2018	15.244	10.290
2019	15.227	10.296
2020	15.213	10.303

Prices 1996

(Percent Change)



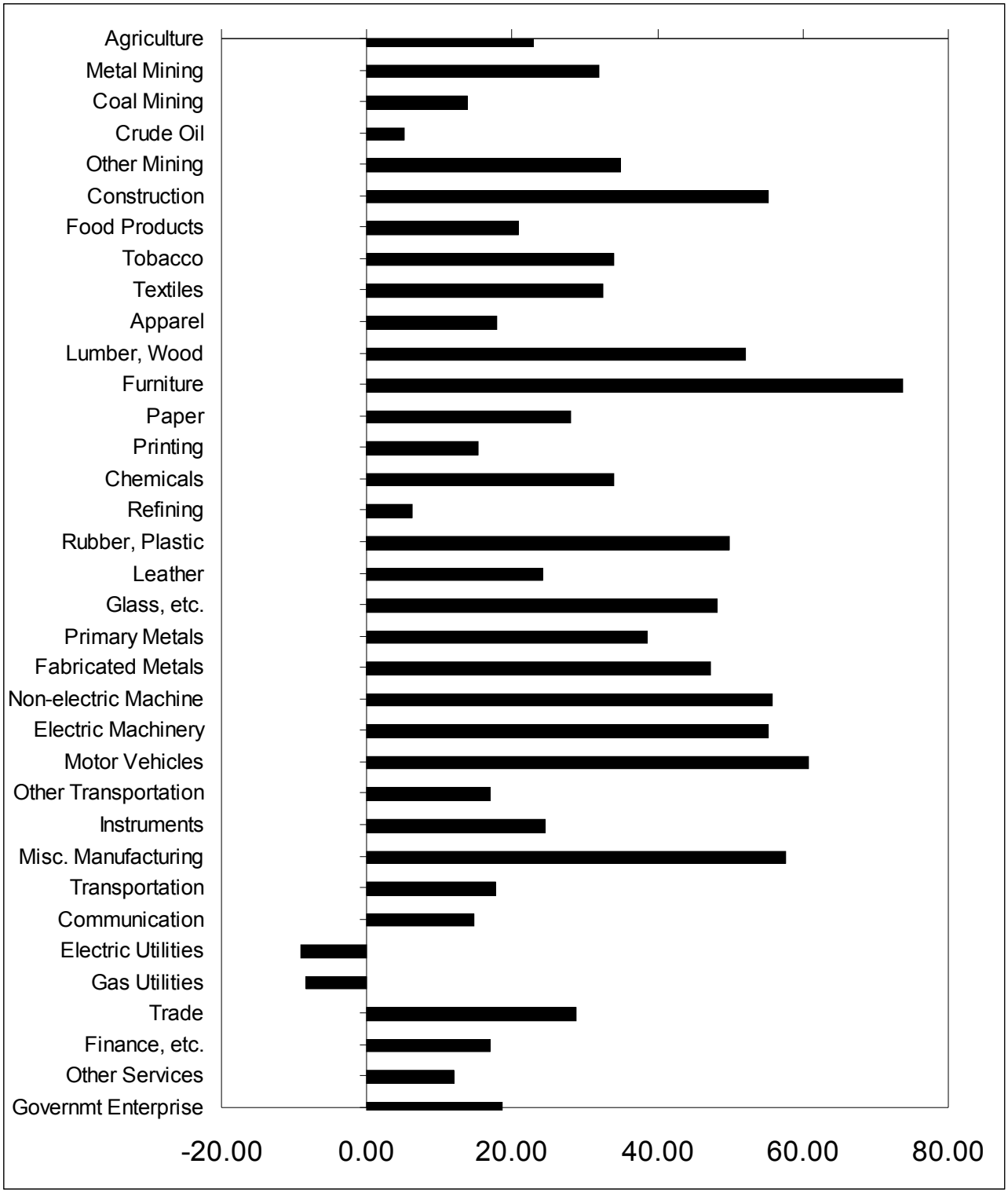
Prices 1996

(Percent Change)

	% Change in prices
Agriculture	-22.26
Metal Mining	-22.51
Coal Mining	-24.63
Crude Oil	-13.25
Other Mining	-23.50
Construction	-24.48
Food Products	-22.84
Tobacco	-25.14
Textiles	-23.21
Apparel	-19.19
Lumber, Wood	-22.51
Furniture	-22.36
Paper	-22.81
Printing	-24.91
Chemicals	-21.83
Refining	-16.05
Rubber, Plastic	-22.66
Leather	-15.25
Glass, Inc.	-22.63
Primary Metals	-20.72
Fabricated Metals	-23.20
Non-electric Machine	-22.26
Electric Machinery	-21.04
Motor Vehicles	-18.53
Other Transportation	-23.80
Instruments	-22.89
Miscellaneous Manufacturing	-17.95
Transportation	-24.45
Communication	-25.30
Electric Utilities	-23.51
Gas Utilities	-20.03
Trade	-25.74
Finance, etc.	-24.87
Other Services	-25.43
Government Enterprises	-25.57

Quantities 1996

(Percent Change)



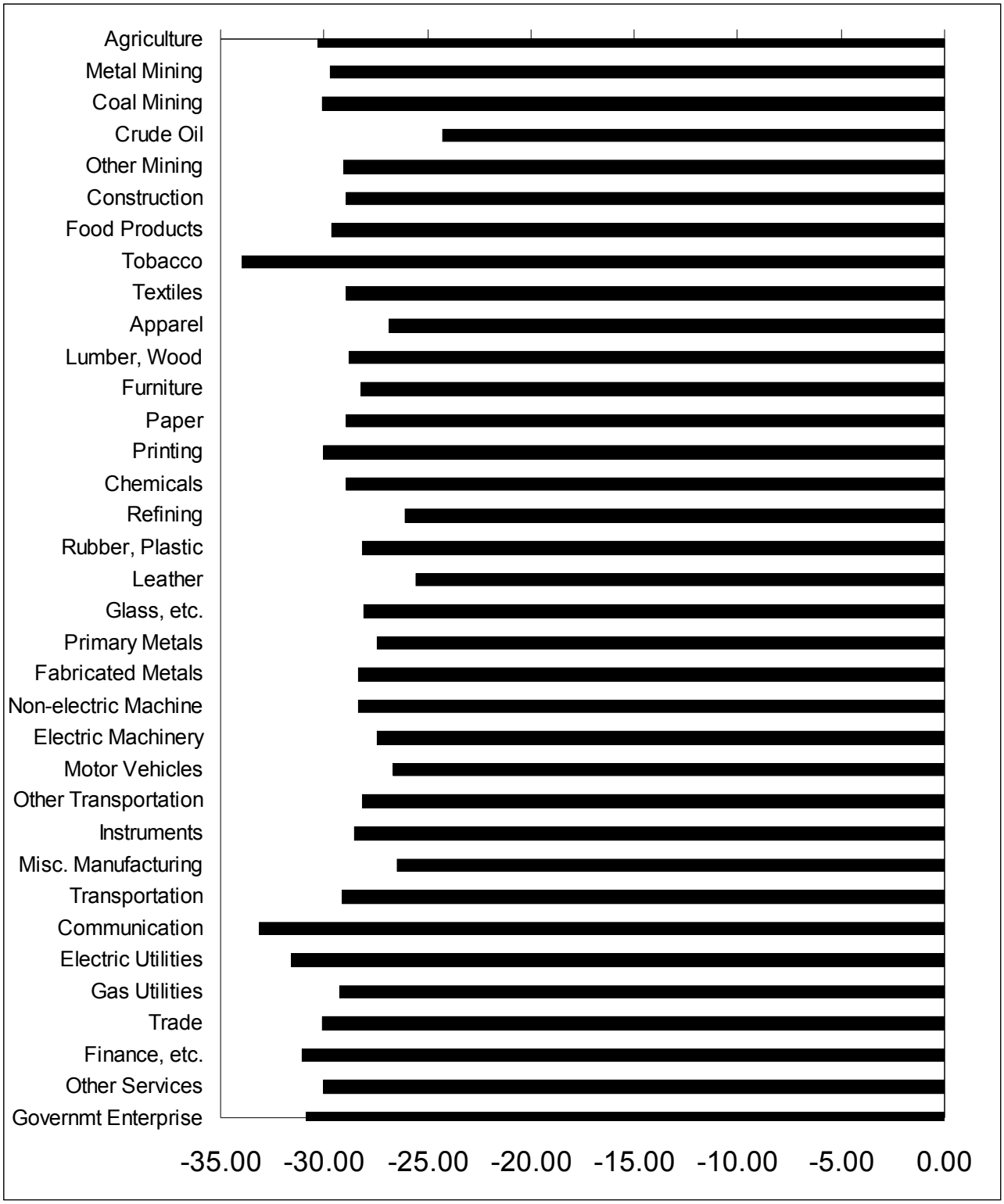
Quantities 1996

(Percent Change)

	% Change in prices
Agriculture	22.80
Metal Mining	31.96
Coal Mining	13.77
Crude Oil	5.10
Other Mining	34.99
Construction	55.28
Food Products	20.79
Tobacco	34.03
Textiles	32.58
Apparel	17.89
Lumber, Wood	52.14
Furniture	73.63
Paper	28.13
Printing	15.22
Chemicals	33.91
Refining	6.22
Rubber, Plastic	49.96
Leather	24.13
Glass, Inc.	48.25
Primary Metals	38.62
Fabricated Metals	47.20
Non-electric Machine	55.86
Electric Machinery	55.25
Motor Vehicles	60.82
Other Transportation	16.90
Instruments	24.51
Miscellaneous Manufacturing	57.57
Transportation	17.71
Communication	14.79
Electric Utilities	-9.05
Gas Utilities	-8.29
Trade	28.87
Finance, etc.	16.93
Other Services	12.04
Government Enterprises	18.56

Prices 2020

(Percent Change)



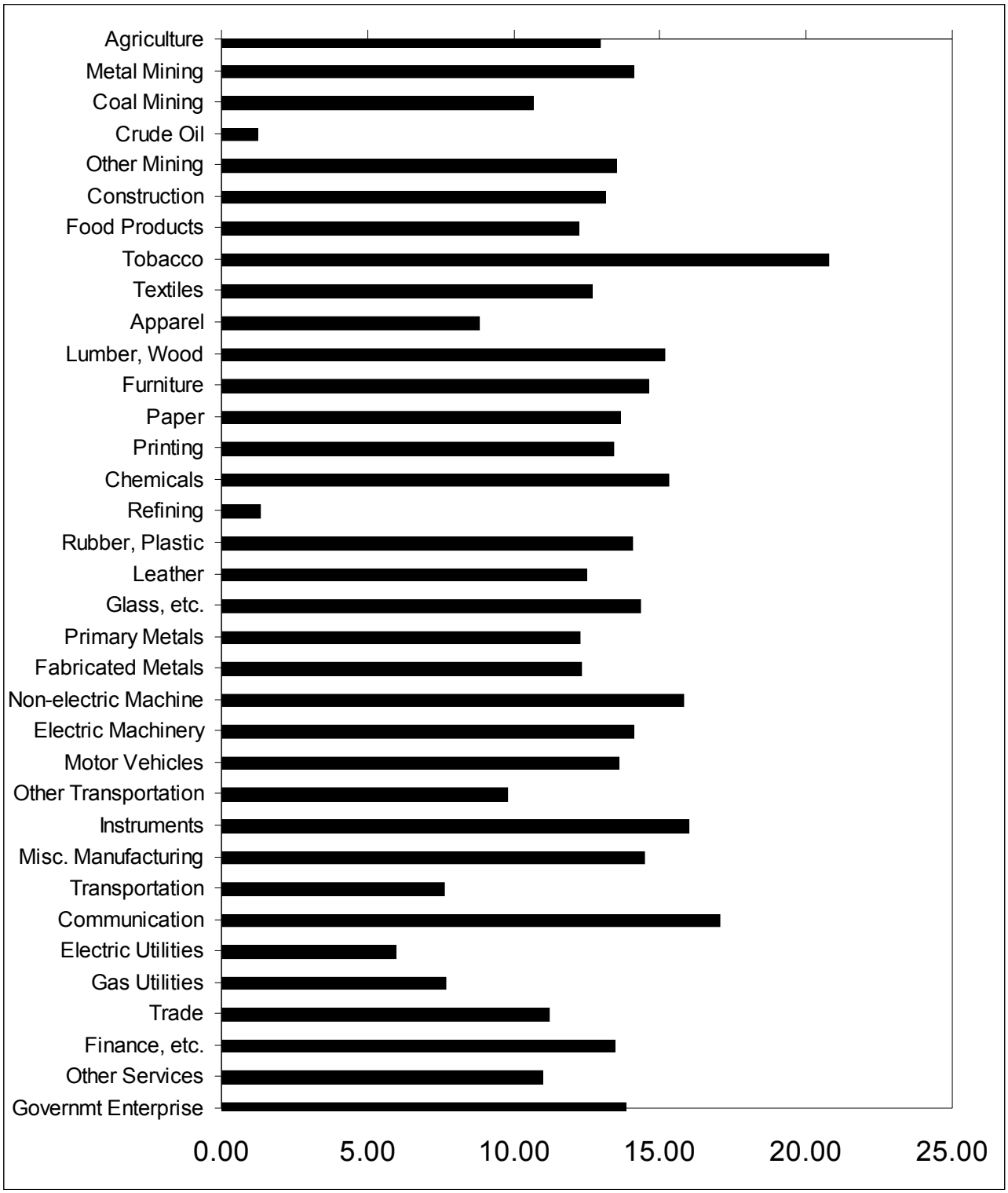
Prices 2020

(Percent Change)

	% Change in prices
Agriculture	-30.25
Metal Mining	-29.72
Coal Mining	-30.07
Crude Oil	-24.24
Other Mining	-29.02
Construction	-28.95
Food Products	-29.60
Tobacco	-33.97
Textiles	-28.89
Apparel	-26.82
Lumber, Wood	-28.76
Furniture	-28.19
Paper	-28.93
Printing	-30.00
Chemicals	-28.91
Refining	-26.10
Rubber, Plastic	-28.15
Leather	-25.54
Glass, Inc.	-28.08
Primary Metals	-27.44
Fabricated Metals	-28.36
Non-electric Machine	-28.34
Electric Machinery	-27.45
Motor Vehicles	-26.66
Other Transportation	-28.13
Instruments	-28.54
Miscellaneous Manufacturing	-26.44
Transportation	-29.12
Communication	-33.11
Electric Utilities	-31.54
Gas Utilities	-29.26
Trade	-30.08
Finance, etc.	-31.07
Other Services	-30.00
Government Enterprises	-30.84

Quantity 2020

(Percent Change)

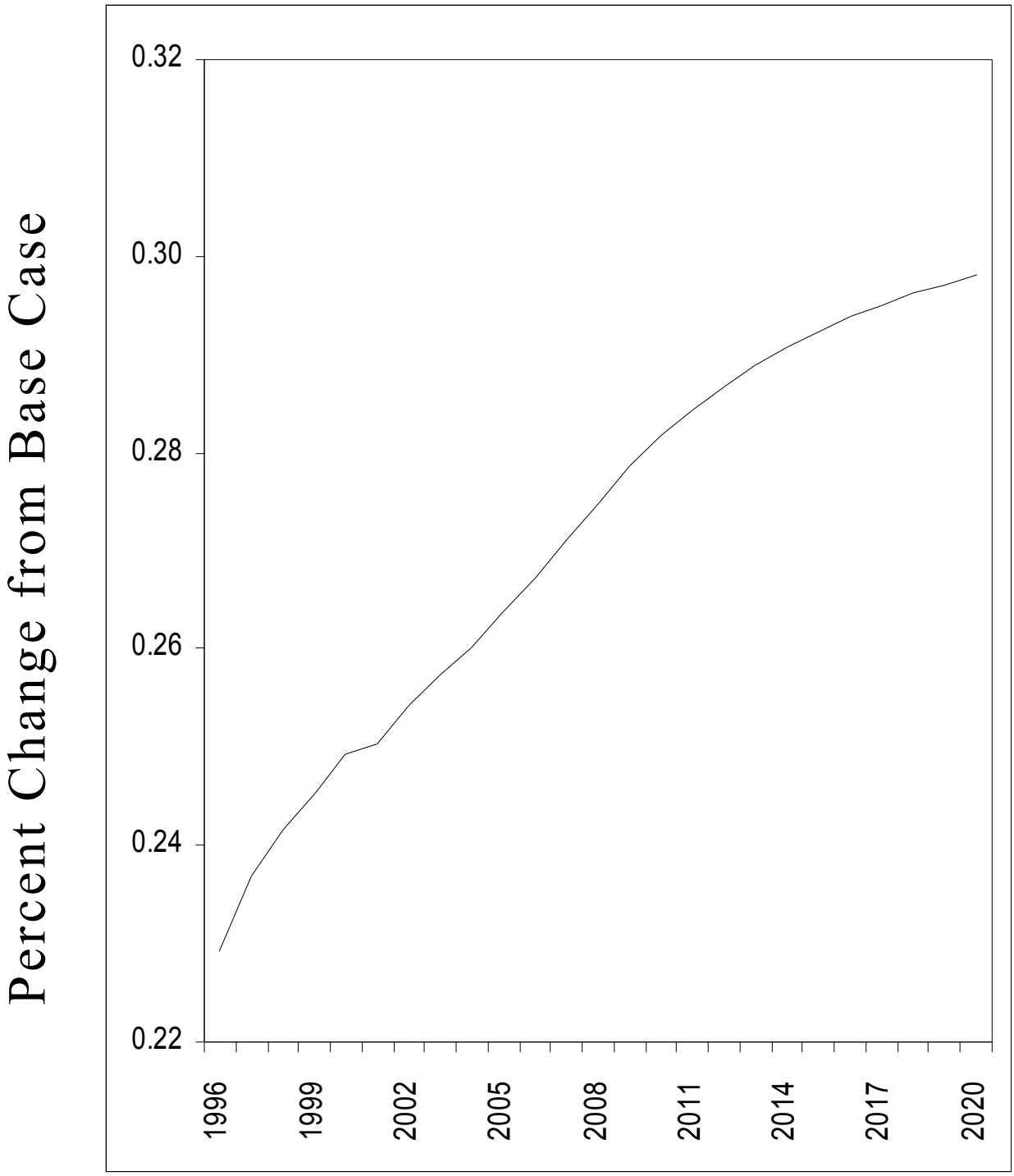


Quantities 1996

(Percent Change)

	% Change in prices
Agriculture	12.95
Metal Mining	14.10
Coal Mining	10.66
Crude Oil	1.25
Other Mining	13.53
Construction	13.14
Food Products	12.22
Tobacco	20.79
Textiles	12.67
Apparel	8.81
Lumber, Wood	15.17
Furniture	14.63
Paper	13.63
Printing	13.43
Chemicals	15.30
Refining	1.33
Rubber, Plastic	14.04
Leather	12.48
Glass, Inc.	14.36
Primary Metals	12.25
Fabricated Metals	12.31
Non-electric Machine	15.81
Electric Machinery	14.13
Motor Vehicles	13.61
Other Transportation	9.77
Instruments	15.98
Miscellaneous Manufacturing	14.47
Transportation	7.65
Communication	17.04
Electric Utilities	5.97
Gas Utilities	7.66
Trade	11.22
Finance, etc.	13.48
Other Services	10.98
Government Enterprises	13.81

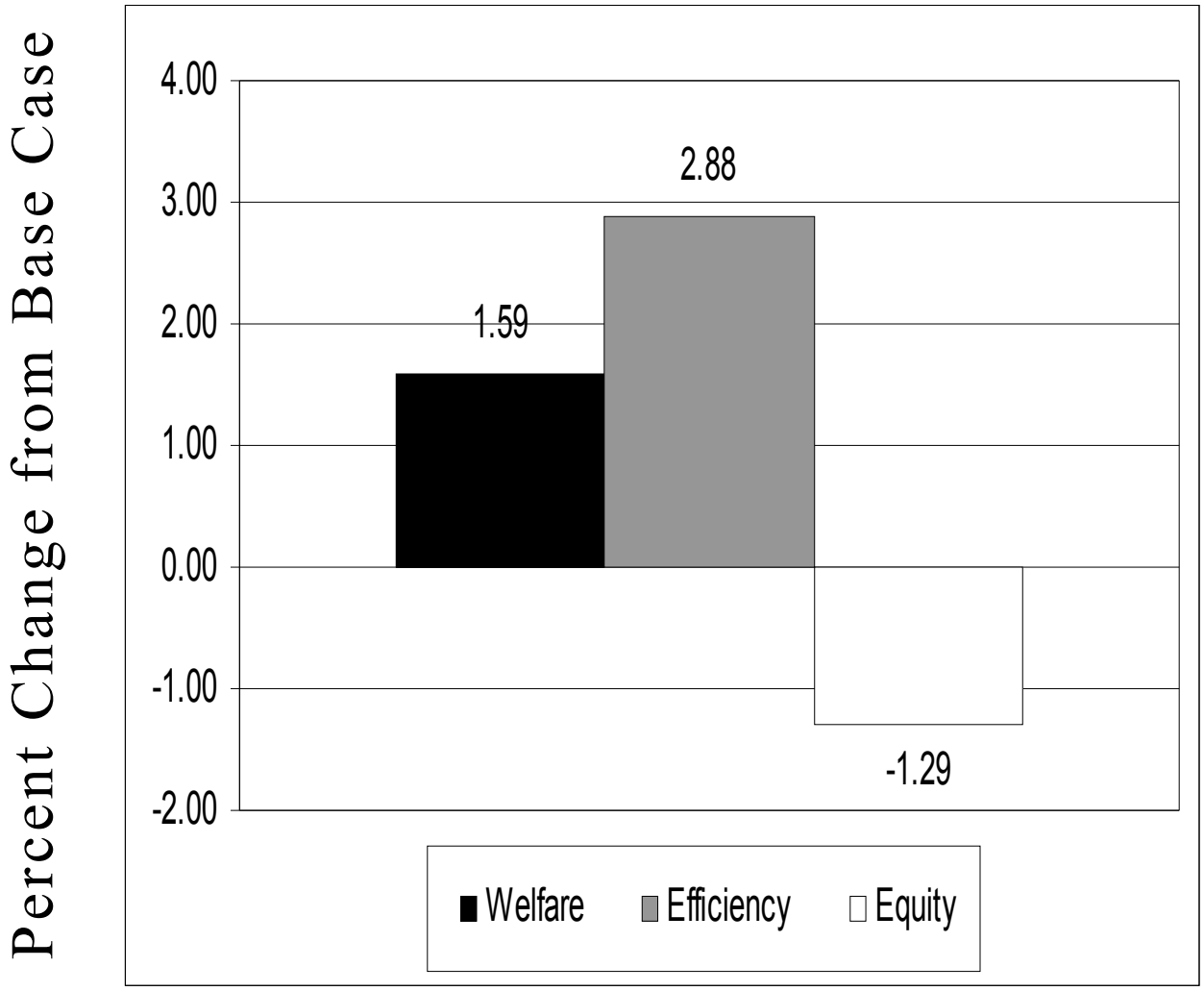
Consumption Tax Rate



Consumption Tax Rate

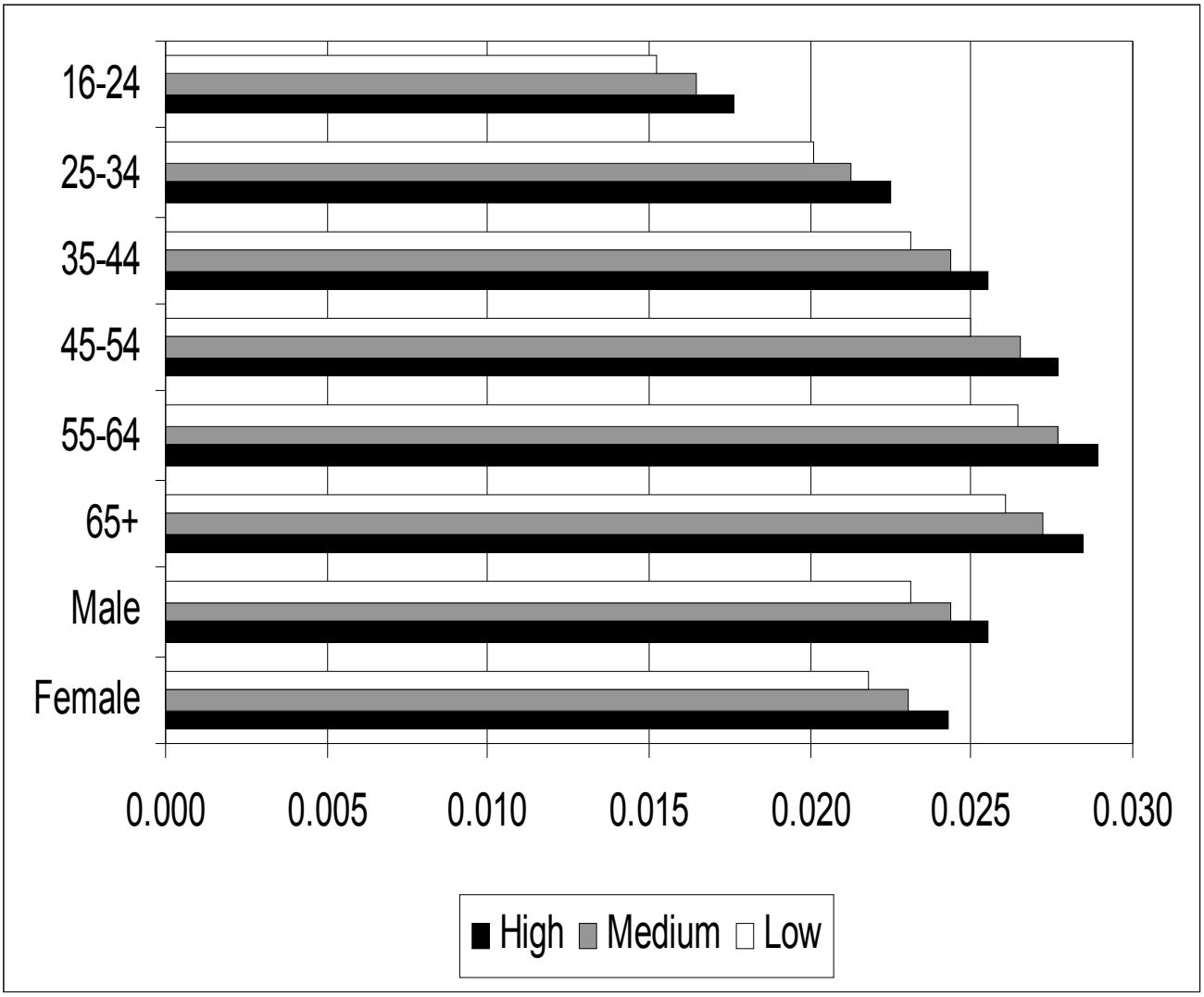
	Tax Rate in Percent
1996	0.229336
1997	0.237005
1998	0.0241586
1999	0.0245366
2000	0.0249416
2001	0.0250413
2002	0.0254211
2003	0.0257455
2004	0.0260068
2005	0.0263773
2006	0.0267303
2007	0.0271102
2008	0.0274917
2009	0.0278547
2010	0.0281766
2011	0.0284472
2012	0.0286785
1013	0.0288946
2014	0.0290822
2015	0.0292364
2016	0.0293784
2017	0.0295038
2018	0.0296183
2019	0.0297085
2020	0.0298009

Consumer Welfare



Household Welfare

Age and Sex of Head



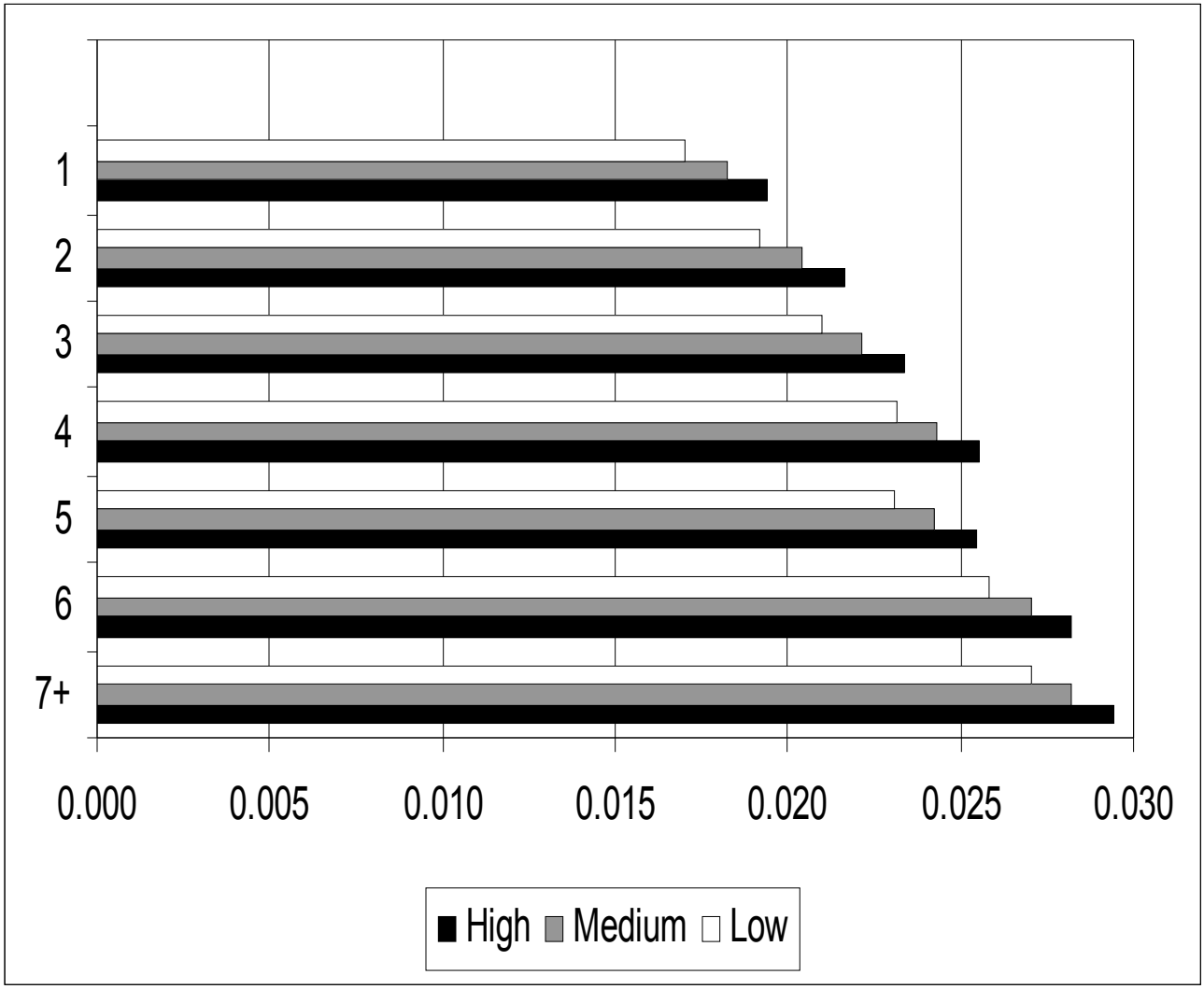
Household Welfare

Age and Sex of Head

	Low	Medium	High
16-24	0.015270	0.016465	0.017661
25-34	0.020098	0.021297	0.022499
35-44	0.023125	0.024328	0.025533
45-54	0.025000	0.026505	0.027712
55-64	0.026464	0.027671	0.028879
65+	0.026026	0.027232	0.028439
Male	0.023125	0.024328	0.025533
Female	0.021835	0.023037	0.024240

Household Welfare

Family Size



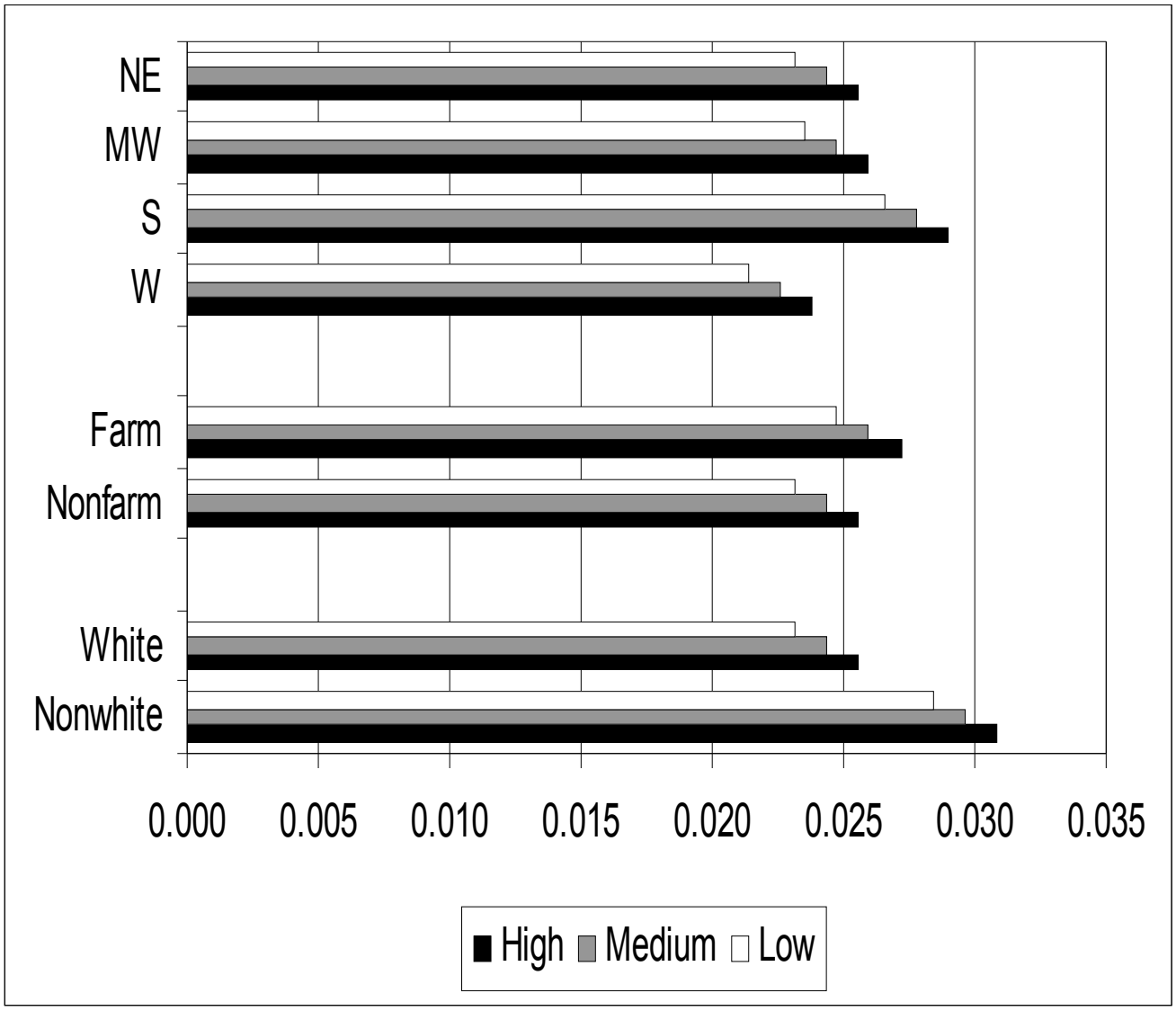
Household Welfare

Family Size

	Low	Medium	High
1	0.017019	0.018216	0.019414
2	0.019212	0.020411	0.021611
3	0.020972	0.022173	0.023375
4	0.023125	0.024328	0.025533
5	0.023063	0.024266	0.025470
6	0.025820	0.027026	0.028233
7+	0.027017	0.028224	0.029433

Household Welfare

Region, Farm vs Nonfarm, Race



Household Welfare

Region, Farm vs Nonfarm, Race

	Low	Medium	High
NE	0.023125	0.024328	0.025533
MW	0.023534	0.024737	0.025942
S	0.026572	0.027778	0.028986
W	0.021367	0.022568	0.023771
Farm	0.024767	0.025971	0.027177
Nonfarm	0.023125	0.024328	0.025533
White	0.023125	0.024328	0.025533
Nonwhite	0.028433	0.029642	0.030852