TAX ANALYSIS
AND
REVENUE FORECASTING

-- Issues and Techniques –

By

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Chapter 1
Functions of the Tax Policy Unit

Tax analysis and forecasting of revenues are of critical importance to governments in ensuring stability in tax and expenditure policies. To augment timely and effective analysis of the revenue aspects of the fiscal policy, governments have increasingly turned toward in-house tax policy units rather than relying on tax experts from outside.

These tax policy units have been increasingly called upon to analyze the impact of tax policies on the economy and to estimate the revenue implications of tax measures, with the ultimate objective of ensuring a healthy fiscal situation within the economy. Tax policy units also help ensure that tax systems are efficient, fair, and simple to understand and comply with. Such systems help to create an economic environment that is conducive to greater social justice.

The tax policy unit of any government has the following broad functions:

(a) Monitoring of Revenue Collection;
(b) Evaluation of the Economic, Structural and Revenue Aspects of the Tax Policy;
(c) Tax Expenditure Analysis;
(d) Evaluation of the Impact of Non-Tax Economic Policies;
(e) Forecasting of Future Tax Revenues.

1.1 Monitoring of Revenue Collections

To ensure a balanced budget and/or to curtail deficit financing, it is of the utmost importance for the Ministry of Finance to be able to effectively monitor not only the expenditure side but also the collections of tax revenues on a regular basis. Depending upon the level of sophistication of the monitoring system, it is possible to track major sources of revenue collection on a weekly or daily basis.

In order to perform this task, it is necessary to establish an effective information system within the government. A proper measurement of actual revenue collection vis a vis expected revenues is possible only if there is a well-developed database. This database should provide the main input for analysis of tax functions, including behavioral responses to new tax measures, revenue forecasting and tax expenditure analysis. Hence, the collection of data for the database and its computerization are pre-requisite conditions for the establishment of an efficient revenue collection and monitoring system.

1.2 Evaluation of the Economic, Structural and Revenue Aspects of the Tax Policy

A country's tax system reflects its evolutionary response to various social, economic, and political influences.[1] The form of a tax system, therefore, has wide economic, political, and social implications. In the process of policy formulation, each tax policy unit has to weigh tax policies in terms of the following basic criteria.[2]

[1] Richard A. Musgrave and Peggy B. Musgrave, Public Finance in Theory and Practice, (McGraw-Hill Inc., 1989), Chapter 12, pp. 216.

A. Economic Efficiency

First of all, any tax on goods and services increases the price of a good by adding a percentage of the price (ad valorem tax) or a fixed amount of money (specific or unit tax) to the original price. This creates a gap between the value that the consumer pays for the good (demand price) and the economic resource cost of production (supply price). If the tax is not designed to offset another market externality, it will create a distortion in the market that will affect the behavior of consumers and/or producers. Such a distortion will have a cost attached to it that the economy has to bear, known as the deadweight loss. If, however, we start with a tax distortion in one market (i.e., there are some constraints that prevent a first-best optimum), then adding yet another distortionary tax can be beneficial.[3]

Market distortions of any kind, as a result of a tax, create a loss of economic efficiency (e.g., a loss of consumer and producer surpluses). The size of this loss depends primarily on the price elasticities of demand and supply of the items whose markets are distorted, as well as on the rate of the tax imposed. The higher the price elasticity of demand/supply, the higher the inefficiency introduced into the market by the tax. Also, high tax rates lead to larger economic efficiency costs. A tax is said to be efficient if the deadweight, or efficiency loss, is small. These efficiency losses can be substantial. Empirical studies of efficiency loss for the US have found it to be in the range of 17 to 56 cents per dollar of tax revenue.[4]

Taxes, such as an income tax or a tax on goods and services with an inelastic demand/supply, tend to have a smaller impact on producer or consumer behavior and, therefore, cause less of a distortion in the economy. At present, the economic efficiency

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[2] See, e.g., Department of Finance Canada, Guidelines for Tax Reform in Canada, (October 1986).

[3] For a simple presentation, see Lipsey and Lancaster, Review of Economics and Statistics, v. 24, no. 1, (1956-57), pp. 11-32.

[4] There have been a number of empirical studies on this issue. See C.L. Ballard, J.B. Shoven and J. Whalley, "General Equilibrium Computations of the Marginal Welfare Costs of Taxes in the United States", American Economic Review, (March 1985).

of a tax is an important issue, although not the sole consideration, when designing an efficient tax system, reflecting a significant departure from the approach of the 1970s/80s, which was based primarily on the tenets of "Optimal Taxation."[5]

Efficiency criteria for any tax system require that the tax be neutral. That is, the tax should create neither major distortions in consumption and production behavior nor change private investment decisions by favoring one set of investments over the others.

B. Economic Growth

Every good tax system should foster economic growth in its country. This can be achieved primarily through the expansion of savings and the direction of investment into high return activities. An efficient tax system should also be a deterrent to the disincentive to work, which occurs in countries where there is a very high payroll tax.[6]

In order to stimulate higher economic growth, well-designed tax systems should encourage competitive growth across various sectors of the economy. Even more importantly, the distortion and/or opportunities created by a tax system should not be the cause for tax planning, but provide direction towards more productive endeavors through lowering the tax rates, eliminating tax on tax and widening the base.

C. Revenue Adequacy

Budget expenditures and revenue estimates are usually done within a specified framework of economic assumptions reflecting the level of the expected GNP growth rate, the rate of inflation, and other macroeconomic variables. Revenue estimates are undertaken with respect to these underlying macro variables. Besides the influence of

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[5] J. Slemrod, "Optimal Taxation and Optimal Tax Systems," J.Ec. Perspectives, (Winter 1990).
[6] In countries like Ukraine and Vietnam, the higher tax rate ranges between 52% and 72%.

macro variables, the challenge in making any revenue estimate lies in the ability to anticipate and incorporate the behavioral responses to changes in the tax laws.[7]

Generally, the total tax revenue of the government will invariably depend upon the size of the tax base, the levels of tax rates adopted within the tax system, administrative efficiency, and the compliance rate. The taxes introduced should be appropriate and sufficient to finance the expenditure needs of the government over time. In other words, revenues should rise with national income, and the entire tax system should evolve to enhance the revenue yield over time.

If the tax revenues are insufficient to meet expenditure needs, the government must resort to borrowing, printing money, selling assets or slowing down the implementation of development programs. All these actions generally hurt the economy, especially the poorer segment of society. For example, borrowing from the Central Bank or printing money could be inflationary, effectively devaluing the cash holdings of the poor at a disproportionately higher level than those of the rich. Therefore, the tax system should be buoyant; that is, tax revenues should increase at a rate equal to or greater than the growth of the GNP. To ensure this, the government should adopt tax policies that include growing sectors of the economy in the tax base.

D. Revenue Stability

Just as revenue adequacy is important to finance government needs, the stability of tax revenues over time is equally important in order to maintain the continuity of the fiscal policies of the government. If the tax revenue tends to fluctuate over time, it creates an air of uncertainty that adversely affects government programs. When revenues fall, expenditures must be curtailed. In the process of streamlining expenditures the first which go tend to be the development expenditures, as claims of recurrent expenditures precede development expenditures. The slowdown of development expenditures leads not only to lower economic growth rate over the medium and long term, but, over the

[7] As estimating behavioral change is a very information intensive, to go around this problem, such influence are

short run, new development programs are poorly implemented, resulting in delays, escalation of costs, and, ultimately, in total abandonment of projects.

In order to offset the impact of an unstable tax system brought about by constant changes in rates and in the rules of taxation, the private sector tends to procrastinate over long-term investment decisions and plans. When the tax system is structurally unstable, it becomes a source of risk and imposes another element of economic inefficiency on the country.

E. Simplicity

A tax system should be transparent, so that it is easy to administer and simple for the taxpayers to comprehend and comply with. Simplicity must apply to the administration of the law as well as its legal structure. A complex tax system may impose a disproportionately high level of compliance costs on taxpayers, as well as a high cost of tax administration on the government.

Complexity in tax administration and opaqueness in tax laws helps to induce corrupt behavior on the part of both taxpayers and tax officials. In such an environment, much of the efforts of the taxpayers and tax officials, which otherwise could have been used constructively for economic development, is channeled into circumventing the system.

F. Low Administration and Compliance Costs

The simpler and the more transparent a tax system, the lower its administration and compliance costs. As tax revenue is collected mainly to finance government needs, a high cost of tax collection reduces the net tax revenue available to the government. By the same token, a high compliance cost by taxpayers should reduce the resources available to the private sector for productive activities. Therefore, one of the criteria of

assumed to be fixed.

a good tax system is low administration and compliance costs. If these costs constitute a major portion of the tax revenue, the tax system needs to be restructured.

While undertaking a tax proposal, tax policy units employ various analytical tools to evaluate the system in terms of efficiency and distributional impacts, as well as potential revenue generation. Use of micro-simulation models is especially helpful, as it permits analysis of simultaneous interactions among different parameters -- such as tax bases, rate structures, and compliance rates -- and examines the impact on revenue brought about by changes in these parameters.

1.3 Tax Expenditure Analysis

The need to comprehend tax expenditure and its impacts has gained prominence, as countries recognize that without assessing tax expenditures they have little chance to control their budget policies and tax policies. In late 1960s, Germany and the United States started reporting tax expenditures, and starting in the late 1970s, other OECD countries began publishing tax expenditure reports. Some countries are legally obliged to produce tax expenditure reports, while others link them with the budget process, and countries such as Austria and Germany include them in a wider subsidy report.

The question that confuses most people is what is the total tax expenditure and how does it affect the budget and tax policy? In simple terms, the tax expenditure includes those provisions of the taxation law that effectively tax certain classes of taxpayers or particular types of activities differently from the chosen benchmark structure.[8] Hence, tax expenditure is a process of quantifying and evaluating the impact of tax policies brought about by exemptions and incentives so provided within the tax system.

To quantify tax expenditure, one needs to first establish the benchmark or norm of the tax system. The norm generally includes the tax base, rate structure, accounting

[8] This is the definition of Australian taxation law. OECD, "Tax Expenditures – Recent Experiences", Chapter 2, pp. 20; and Neil Bruce, Tax Expenditures and Government Policy, John Deutsch Institute for the Study of Economic Policy, (November 1988).

conventions, deductibility of payments, etc.[9] When a tax provision deviates from this norm, by definition, a tax expenditure is created. In other words, tax rules, which reflect a departure from those contained in the normative tax structure or are designed to help specific groups or favor certain activities, should be considered as tax expenditures. For example, tax relief provided to those industries established in depressed or remote areas or allowances provided to a family in a certain area/number/age are considered tax expenditures. It is government spending in the sense that instead of providing funds (e.g., grants, loan, subsidy) by the government through the budgetary process, the government provides relief (i.e., the amount so calculated is termed expenditure) through the tax system to these groups/activities. The revenue losses incurred to the government from these relief measures are essentially equivalent to spending programs and have very similar distributional effects on particular groups within the economy. This approach regards tax revenue codes not just as mere instruments for revenue mobilization, but also as spending mechanisms.

Tax expenditures are generally identified through an analysis of incentives or subsidies created by governments through various rules under the tax code. Tax expenditures may appear in different forms such as exemptions, allowances, credits, rate relief and tax deferrals.[10] However, what constitutes tax expenditure may differ from country to country. This is because tax expenditure is said to exist once the tax system deviates from the established norm, and norms vary from country to country. Generally speaking, besides the deviation from the established norm, tax spending is said to be present if: a) the tax relief benefits a particular person, group, sector, or activity; b) if it is a relief placed intentionally and, hence, can be removed later (e.g., removal of tariff exemptions once an industry has reached a certain stage of development; and c) the relief can be measured (i.e., revenue loss due to exemptions).

It is the work of the tax policy units to lay down the mechanisms and the process for estimating the amount spent by the government through tax expenditures. Quantitative estimations of tax expenditures applied to a particular tax require a thorough

[9] OECD, "Tax Expenditures - Recent Experiences", Part I, pp. 9.

understanding of the definition and the structure of the tax and the accounting conventions. Once defined, the legal structure of a tax represents the benchmark, which is to be used by the policy unit for measuring the revenue impacts of a proposed tax policy change. Any deviation from the benchmark constitutes a tax expenditure.

As tax expenditures can be quantified, generally speaking, there are three principal methods of calculating this government spending. The method that is commonly used by various countries is the *ex post* method, that is, the estimation of revenue foregone due to the enactment of a certain provision. The second method is *ex ante,* where revenue increases if the provision is removed. The third is the *outlay equivalent approach*, which estimates the same monetary benefits as the tax expenditure through direct spending. However, at times, due to the complexity of tax structure and laws, the amount of revenue loss brought about by a particular provision may not be clear.

In spite of some quantification problems in measuring the tax expenditure of a particular item, the concept of tax expenditure, as a source of information, is a powerful tool for policy analysts, government officials, and parliamentarians for initiating discussion of the repercussions of a certain policy. The presence of an item as a tax expenditure becomes a source of information upon which dialogues can be initiated as to the desirability or undesirability of this expenditure under the existing fiscal framework.

Since tax and expenditure policies are two pillars of any fiscal policy, tax expenditure provides further insight on budget spending and on the means to control the growth of the expenditure program. The aggregate quantification of tax expenditures provides insight into the direction/region/groups that have received these benefits that is not captured or highlighted in the normal budget spending codes. Once this information becomes available, the total spending program of a government is, then explicitly and implicitly, quantified. Any process of curtailing budgetary spending, without taking

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[10] OECD, " Tax Expenditures - Recent Experiences".

into consideration the tax expenditure component embedded in the fiscal policy, becomes grossly biased if steps are not undertaken to compress these tax expenditures.

Once the tax expenditure has been recognized as a spending through the existing tax system, the tax policy of the government then comes into focus. Since any tax system reflects two-way traffic of both revenue generation as well as spending, any attempt to reform or curtail the budget should encompass the tax expenditure as well. The question becomes which is a better method of spending: directly through the budgetary process or through the provision of tax expenditure. Furthermore, any attempt toward simplification of the tax system should take into account the need to remove these tax expenditures.[11] In the process of removing these tax expenditures, tax administration becomes less difficult.

As economies strive to bring about fiscal balance through efficient spending programs, tax expenditure reports have been used as a powerful tool during budgetary dialogues in those countries that have severe resource constraints to meet ever-increasing resource demands with too little emphasis on revenue generation. A dollar saved, in terms of curtailment of revenue foregone, is a dollar earned which can be used for productive investment in the economy.

1.4 Evaluation of the Impact of Non-Tax Economic Policies

There are certain non-tax economic policies that can have a significant impact on the economy. Revenue estimation models are based on fundamental premises about the social structure and economic conditions of the country under consideration and the rest of the world. One of the major tasks of the tax policy unit is to modify assumptions built into the models and to measure their impact on the tax regime and tax revenues. These assumptions can include specific changes in exogenous variables or the enactment of non-tax economic policies. For example, tax policy units are expected to estimate the impact of the removal of quantitative restrictions on imports, the effects of trade liberalization policies on import substitution and export promotion, the influence of international assistance on trade flows, and the outcome of interest rate policy changes in terms of business profits. These non-tax economic policies can have substantial effects on revenue collection.

1.5 Forecasting of Future Tax Revenues

Governments need funds to finance their budget expenditures. Taxes are the major source of government revenues. If expenditures exceed revenues, governments resort to deficit financing through borrowing or raising taxes. Either case can have negative consequences on the economy over time.

To maintain a balanced budget, governments can either curtail their expenditures and investments or increase revenues. Experience has shown that pruning of expenditures, especially if they are recurrent, is difficult to achieve, as in an increase in taxes. This section focuses on the latter issue.

There are several factors involved in the preparation of revenue forecasts of a tax system. It is useful to remember that all forecasts are done according to certain underlying methodologies and common assumptions. These assumptions are made for such economic variables as growth in the national income, the rate of inflation, interest rates and so forth, including the international environment. This framework relies on currently available information and on what is assumed at the time in the estimation process.

A. Evaluation of Tax Elasticity

For any tax system to be able to provide stable revenues to its government, it is desirable that the tax revenue can respond automatically to increases in the national income which result from economic growth. The pace of such an increase in revenue

[11] Tax expenditure analysis of the 1983 income tax showed 105 spending programs. Stanley S. Surrey and Paul R.

would depend on the revenue elasticity of the tax system. Evaluation of such a correlation between revenue and national income gives the tax policy unit a valuable insight into the overall tax system. This understanding assists the tax policy unit in planning for necessary tax changes confidently and in seeking the inclusion of the more buoyant sectors of the economy into the tax base.

B. Evaluation of Changes in Economic Conditions

Changes in economic conditions are expected to modify forecasting assumptions in various ways. For instance, changes in the foreign trade sector as a share of the total production in the economy affect the taxable capacity of a country. This is especially true in the case of a developing country, in which trade taxes constitute a significant proportion of tax revenues.

Similarly, the deregulation of certain sectors of the economy should automatically change the structure of the relevant markets for goods and services, and such changes will consequently affect the size of the tax bases. Devaluation of the domestic currency will also affect the quantities of imports and exports, which in turn will affect the trade tax revenues from import duties.

Changes in the economic conditions of major trading partners will also have a significant impact on the domestic economy and on tax revenues.

C. Evaluation of the Effect of Inflation and Price Changes

Movements in price levels have different effects on the tax structure and real revenue collection by the government. For instance, inflation has an ambiguous effect on business income tax revenues, by affecting differently the components of taxable income, such as depreciation allowances, accounts receivable and payable, and costs of goods sold. Furthermore, the impact of inflation on indirect tax revenues will

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McDaniel, Tax Expenditures, (Cambridge: Harvard University Press, 1985).

ultimately depend on whether the tax is imposed on a unit tax or ad valorem tax. Therefore, the tax policy units have to account for the impact of inflation on the tax bases, for the behavioral responses and for the expected changes in real revenue conditions.

D. Other Issues in Forecasting Revenues from Various Taxes

(a) Macroeconomic Environment

Revenue forecasts are based on variables and parameters consistent with the macroeconomic environment. Modeling of GDP growth often becomes essential, and it is usually done by econometric techniques. An alternative approach is to estimate an increase in GDP by the sum of the increase in factor incomes and a residual item, which can be categorized as the reduction in real costs, or an increase in factor productivity.[12]

(b) Changes in Different Tax Bases

The measurements of changes in tax bases are absolutely critical in assessing the overall impact on revenue collection as well as in determining revenue adequacy and economic efficiency. Tax bases respond to the relative magnitudes of the elasticities of demand and supply. Thus, in depth analysis of elasticities may become a prerequisite for understanding changes in the tax base brought about as a result of these elasticities and the tax revenue collection.

(c) Trade Flows

The taxable capacity of a country's economy, particularly of one in the developing world, is dependent on the size and the direction of foreign trade flows. Trade taxes are important to the tax authorities, considering their relatively low administrative costs and high levels of political acceptability. An accurate process of revenue forecasting should incorporate reasonable assumptions regarding trade policies of the country and the direction and magnitude of the international trade flows.

(d) Business Income

To develop a model for the forecasting of corporate income tax revenues, the concept of business income, as defined in national accounts, is the logical starting point. However, adjustments have to be made, depending upon the nature of the tax laws, in order to come up with a reliable tax base. For instance, the impacts of accelerated depreciation allowances, loss carry back or forward rules, inventory valuation methods (e.g., FIFO, LIFO) or the extent of repatriated foreign income, all have to be taken into account to form a reliable tax base.

(e) Domestic Transactions of Goods and Services

Considering the fact that revenues from indirect taxes depend on the consumption of goods and services, forecasting techniques focus on the nature of domestic transactions of such goods and services. Analytical frameworks used to simulate consumption behavior and assess potential revenue collections require the construction of tax bases by breaking down the various categories of expenditures incurred by different economic agents, such as households, firms and the government. Also, the forecasting techniques require the identification of transaction flows of commodities by intermediate levels of production of goods and services, because they are tax free under the destination principle of the VAT jurisdictions.

(f) Growth in Demand for Goods Subject to Excise Tax

Real increases in the demand for a certain commodity have strong implications for excise tax revenues. Tax policy units are able to assess the revenue, efficiency and incidence implications of a tax with the help of demand elasticities. These demand

[12] See, e.g., A.C. Harberger, "Reflections on Economic Growth in Asia and the Pacific", Journal of Asian

elasticities help to explain expected shifts in demand for the goods subject to tax. It is also important to assess the revenue impacts in the markets for complementary or substitute goods by using cross price elasticity. An increase in the demand for a taxable good will affect revenue collections not only from that good but also from other goods in the economy.

1.6 Summary

- Tax analysis and revenue forecasting are of critical importance for a government in ensuring adequacy and stability in tax and expenditures policies.

- The broad functions of tax policy units are:

  (a) Monitoring of Revenue Collection.

  (b) Evaluation of the Economic, Structural and Revenue Aspects of the Tax Policy. Tax policies have to be weighed against the following criteria: economic efficiency; economic growth; revenue adequacy; revenue stability; simplicity; and low administrative and compliance costs.

  (c) Tax Expenditure Analysis.

  (d) Evaluation of the Impact of Non-Tax Economic Policies.

  (e) Forecasting of Future Tax Revenues. The several steps involved in the preparation of revenue forecasts are: evaluation of tax elasticity, evaluation of changes in economic conditions, and evaluation of the effect of inflation and price changes.

Economics, (1996).

Chapter 2
Macro Foundations of Revenue Forecasting

A government generally presents its budget each year. The budget specifies the sources and uses of funds for the fiscal year. Taxes in most countries are the major source of government revenues. These taxes are levied on the earnings and on the consumption expenditures of various economic sectors within the economy. From a macro perspective, an understanding of tax bases and their relationship with other economic variables in the economy is useful in determining the extent to which tax revenues can be generated in a given economy at a particular time period.

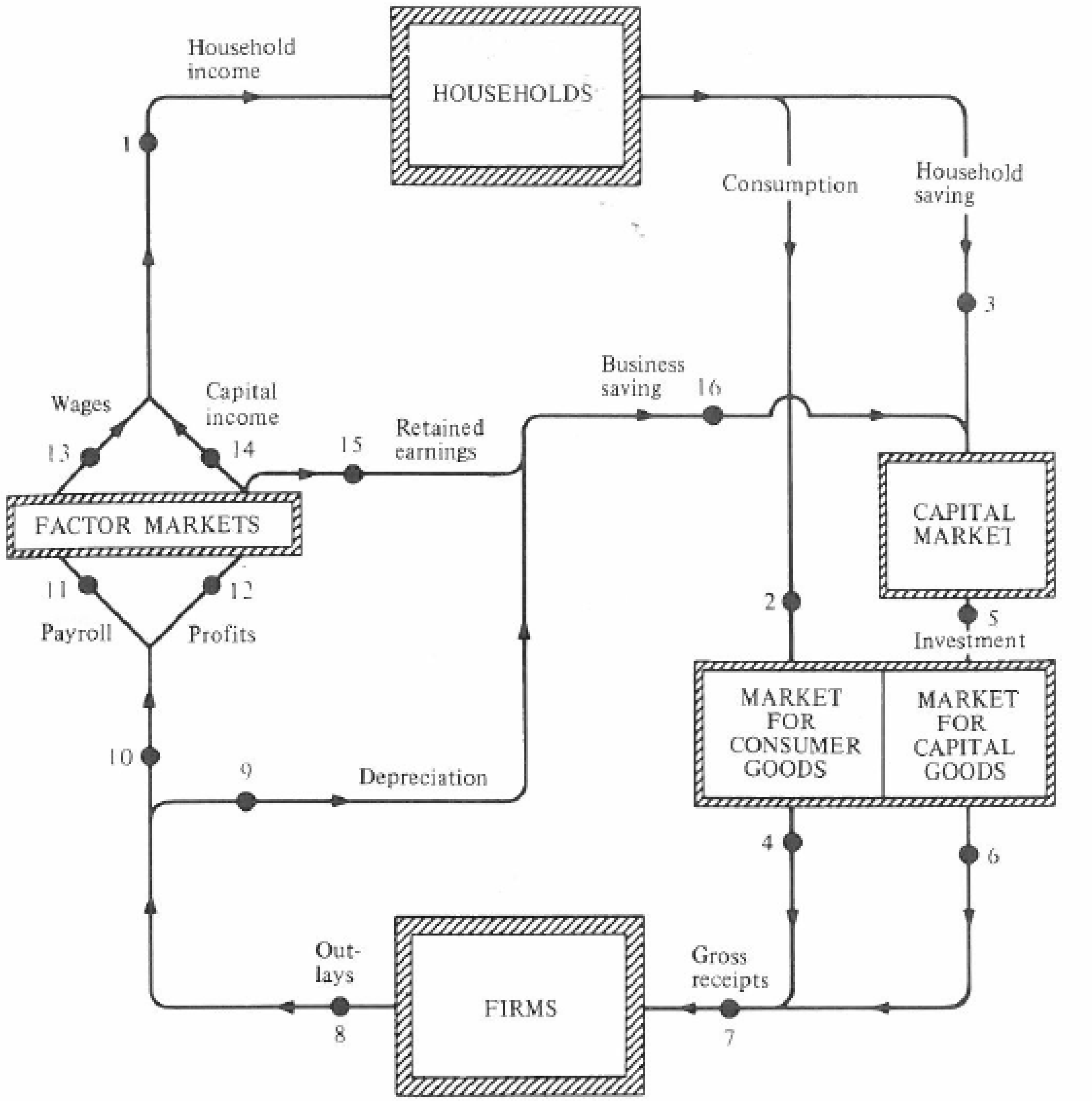
In this chapter, we first present a comprehensive picture of all possible tax points in an economy and then discuss the relationship between key economic variables, so that the government revenues can be forecast in a consistent manner.

2.1 Points of Tax Impact

A useful way to analyze and identify the impact points of different taxes is the circular flow of income and expenditure in the economy (Figure 2-1).

The analysis of the impact points of different taxes can start with the income received by households from the factor markets. Depending on the inter-temporal preferences of the households, income may be assigned for the consumption of goods and services or channeled as savings through financial institutions. From

Figure 2-1 Points of taxation in Circular Flow



the household expenditure side, (link 2), consumer expenditure taxes are levied as excises on such items as gasoline or cigarettes. Expenditures of households on consumer goods, at the same time, are represented as revenue flows for firms (link 4), which are generally subject to retail taxation, such as a sales tax or a consumption-type value added tax.

As income can be put aside as household savings (link 3), these savings are converted as resources to finance investment on capital goods through the capital market. Here again, investment expenditures become receipts for firms (link 6), and, added to the firms' receipts from the market for consumer goods, represent gross receipts for the firms. At this particular point of the circular flow structure (link 7), an old-fashioned turnover tax can be levied on the firm's gross receipts.

Firms allocate gross receipts to cover business outlays (link 8) and set aside some amount as a depreciation allowance (link 9). The remainder, net of depreciation (link 10), represents business income and is subject to a business turnover tax. At this point, an income-type of value added tax can be levied, as these resources become payments to factors of production, such as payroll for payment of labor (link 11) and profit and interest as cost of capital (link 12).

From the expenditure side, taxes can be imposed as payroll taxes (link 11) and on the distributions of dividends or interest payments as corporate income tax. These two represent payments in factor markets, but, from the income perspective, these payments become wages (link 13) and hence subject to personal income tax as well as taxes on dividends or rents. These are also points where social security taxes are levied (links 11 and 13). Payments such as wages, dividends, interest and rents become income for the households, completing the circular flow.

Retained earnings are channeled to capital markets as business savings to finance further investments in capital goods.

2.2 National Accounting

In a given time frame, an economy undertakes various production and service activities. To measure these total activities, a set of rules and techniques has been developed that is internally consistent. In simple terms, a national accounting system measures these activities, showing that the total amount of spending is equal to the total value of production -- which is equal to the total amount of income of an economy in a given period of time frame -- usually over a year. It must be noted that national accounting is not a statement of how an economy works, but rather a fundamental accounting identity[13] of standard national accounts. One of the measures used to quantify economic performance is national income, which is compiled from national accounts.

There are several methods for measuring economic activities within an economy. One can measure the prices of all goods and services produced and sold on the market, all factor inputs[14] -- (land, labor, capital) -- used to produce goods and services, or the value added in the production of goods and services. All three measures should yield the same result, via different approaches - production, expenditure, and income.

A. Production Approach

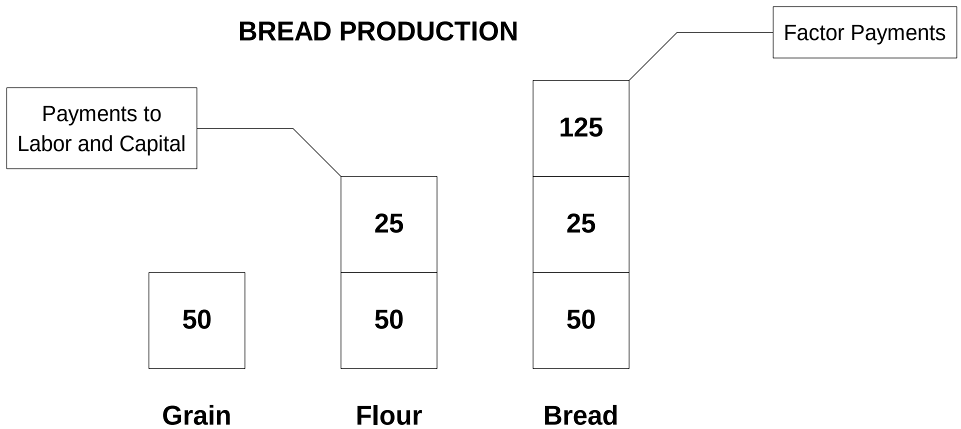
In simple terms, the Gross Domestic Product (GDP) measures the contribution to final national output of every firm in the economy. It would be easy if all one needed to do was to total the output (i.e., gross output) of all the firms in the economy and say that the total is the national income. However, this simple approach is incorrect, because there are firms that produce intermediate inputs and then go on to make the final output. If the output of intermediate firms is also counted, however, it would constitute double counting and would not, in the true sense, be the value of the final output. To avoid this double counting, only the value-added portion of the firms is counted and

[13] Identity is the outcome of an accounting system showing a relationship between different variables.

[14] Factor cost/income components are: wages, rent, interest, profits. Rent is payment for land; wages is payment for labor; interest and profit payment for capital.

summed up. The summation of all the added value of the production is called the gross domestic product.

Example 1: Suppose an economy produces only bread. What is the total GDP?



$$GDP \quad = \Sigma \quad \text{Factor of Production} = \Sigma \text{ Value Added} \qquad (2\text{-}1)$$

The total production of the final goods and services produced in this case is the value of the bread. That is, the GDP = 125 + 25 + 50 = 200.

Alternatively, GDP is obtained by adding up payments to factors of production or the value added at different stages of production:

$$GDP \quad = \text{VA farming} + \text{VA milling} + \text{VA baking}$$
$$GDP \quad = 50 + 25 + 125 = 200$$

Example 2: This illustrates that the GDP of the economy can be obtained by the summation of the value added by each sector of the economy. The GDP of Nepal in 1984 and 1994 is shown in Table 2.1. All figures are expressed in millions of rupees.

Table 2.1
GDP of Nepal (millions of rupees)

Sector	1984	1994
Agriculture	24,171	87,072
Mines	140	1,268
Power	2,511	19,559
Construction	196	1,923
Trade	3,583	23,560
Transport	1,837	9,735
Finance, Insurance, and Real Estate	2,764	20,673
Services	3,987	19,563
GDP at Factor Cost	**41,173**	**185,347**
Plus: Net indirect Taxes	425	5,593
Total GDP at Market Prices	**59,598**	**190,940**

GDP: measured in production terms is the value of all the final goods and services produced for the marketplace over a given period of time, usually a year. The term "domestic" refers to the goods and services produced within the geographical borders of the country concerned. The various terms in this definition are explained as follows.

Value of All: In the production approach, value is the measurement for all final products.

Final Goods: For GDP computation, only the value of final goods and services are taken into account. In order to avoid double counting, intermediate goods, in the process of being converted into final outputs, are excluded from the GDP computations. Furthermore, only new products are included in the estimation of GDP. Sales of used goods (other than sales margins) are excluded. Once again, this is done to avoid double counting.

In the Market Place: Goods and services that are subject to market transactions are included, while activities such as household work, (that are not transacted in the market) are not included in GDP.

Over a Period of Time: GDP measures goods and services produced within a certain time frame, which may be within a year or a quarter.

Within domestic borders: As the GDP reflects a territory approach, there is no regard to the nationality of the owner of the production factors within the country. Thus, the output of a production unit owned by a foreign national is included in GDP calculations, but not the output from a factory owned by a national of the country in another country.

B. Expenditure Approach

GDP under the expenditure approach is the summation of expenditures on final goods and services made by different groups in the economy. The total expenditures on goods and services can be broken down as follows:

GDP = Consumption + Government Expenditures
+ Investments + (Exports - Imports)

$$GDP = C + G + I + (X-M) \qquad (2\text{-}2)$$

where:

Private Consumption: Includes total spending by the households on durable goods (e.g., cars, machines, heaters), on non-durable goods (e.g., food, gas, clothes) and on services (e.g., education, health care). Spending on new houses is excluded, as it is considered part of the investment.

Government Expenditure: Includes total spending on goods and services incurred by all levels of government.

Investment: Includes total spending by businesses on plant, equipment, machinery, and inventories and spending by households on new housing. Total investment is considered in gross terms, which means basically that it includes the capital allocated by firms to replace worn-out capital. Thus, it includes both new capital and replacement for depreciated capital.

Net exports (Exports - Imports): Net exports form the last component of GDP. Exports are the amounts consumed by foreigners on the goods and services produced by a country. Imports include use of foreign goods and services, either consumed or used as inputs by domestic households or firms, and, hence, must be subtracted from the total production of goods and services within domestic borders.

C. Income Approach

The third method for calculating GDP is the income approach. From a business perspective, "value added" reflects the difference between revenue and expenditures. This difference also accounts for the income earned by different economic sectors involved in the production process, such as wages paid to workers, rents paid to landlords, interest payments to financial lenders or profits distributed to owners. Thus, the sum of various incomes should be equal to GDP, just as the sum of value added gives the value of total production, which is equal to GDP.

In the income approach, one should understand various concepts of national income used in the literature.

GDP may be broken down into different types of income and a variety of transfers within the economy. Thus,

$$\text{GDP} = \text{Wages} + \text{Interests} + \text{Rent} + \text{Profits} + \text{Depreciation}$$
$$+ \text{Indirect} \qquad \text{Taxes} - \text{Subsidies}$$

Gross National Product (GNP) = GDP + Net Factor Payments (i.e., payments received from abroad minus payments to foreigners) (2-3)

Net National Product (NNP) = GNP – Depreciation (2-4)

National Income (NI) = NNP – Indirect Taxes + Subsidies (2-5)

The above relationship can be illustrated in Table 2.2.

Table 2.2

Relationship between GDP and National Income

Gross Domestic Product	2,500
Plus : net factor payment	50
Equals: Gross National product	2,550
Less: Depreciation	100
Equals: Net National Product	2,450
Less: Indirect Taxes	500
Plus: Subsidies	50
Equals: National Income	2,000

2.3 An Example: From GDP to Personal Income

Consider the following data showing activities taking place in a country (Bahiti) over a period of one year. The last column in table 2.3 is for illustrative purposes only.

Table 2.3
Various Expenditures and Incomes in Bahiti
(millions of gongas)

Categories	Amount	Types of Taxes Applied
Household consumption spending	750	VAT
Business purchases of capital	120	
Government spending	250	VAT
Purchases of new homes	30	VAT
Additions to inventory stocks	60	
Government transfer payments	40	
Personal income tax payments	55	
Indirect business taxes	35	
Depreciation of capital stock	25	
Imports of goods and services	25	VAT, Customs
Exports of goods and services	10	
Factor payments from abroad	60	Income Tax
Factor payments to foreigners	45	Income Tax
Corporate income tax payments	75	
Wages and salaries	750	Income Tax
Rent	120	Income Tax
Interest income	115	Income Tax
Subsidies	165	
Profits	315	Income Tax

A. *GDP from the expenditure approach*

GDP = Consumption + Govt. Expenditure + Investments + (Exports - Imports)

GDP = 750 + 250 + 120 + 30 + 60 + (10 - 25) = 1,195

B. *GDP from the income approach*

GDP = Wages + Interest + Rent + Profits + Depreciation + Indirect taxes – Subsidies

GDP = 750 + 115 + 120 + 315 + 25 + 35 - 165 = 1,195

C. Gross National Product (GNP)

GNP calculations include the value of goods and services produced by all nationals of the country, regardless of whether the production unit is located within the country or outside.

GNP = GDP + (Net Payment from Abroad)
= GDP + Payments Received from Abroad – Payments to Foreigners
= 1,195 - 45 + 60 = 1,210

D. Net National Product (NNP)

NNP = GNP – Depreciation
= 1,210 - 25 = 1,185

E. National Income (NI)

NI = Wages + Profits + Interests + Rents + Net Payment from Abroad
= 750 + 315 + 115 + 120 - 45 + 60 = 1,315

F. Personal Income (PI)

Personal income is computed from national income after some adjustments are made, in order to reflect transfer flows between the government and individuals and between businesses and individuals. This is helpful in forecasting tax revenues from personal income taxes.

PI = NI - Retained Corporate Earnings - Social Security Payments
+ Transfer Payments + Non-Business Interest
(2-6)

G. Disposable Income (DPI)

Disposable personal income is the income that remains in the hands of households after payment of personal income taxes. This is the net income that the individual can either consume or save.

DPI = PI - Personal Income Taxes (2-7)

2.4 Savings and Investment

An important relationship in national accounting is the equivalence between savings and investment. This may be demonstrated in both open and closed economies.

In a non-tax closed economy, government expenditures are zero. Therefore,

GDP from Expenditure Approach = Consumption + Investment

From the basic definition of income, we know that:

Income = Savings + Consumption

Since the value of GDP from the expenditure approach should equal that from the income approach, we get:

Investment = Savings

In a taxed open economy, the total savings is broken down into three components: private savings by households and firms, government savings and savings from the rest of the world. Let us use the following set of notations:

C = Private Consumption

F = Government Transfer to Private Sector

G = Total Government Expenditures

X = Exports

M = Imports

N = Interest on Government Debt

T = Taxes

V = Factor Income and Transfer Payments from Abroad (net)

Y = GDP = Income

Total personal saving (S_p) is computed as follows:

$$S_p = \text{Income} - \text{Taxes} - \text{Consumption}$$
$$= (Y + V + F + N) - T - C \quad (2\text{-}8)$$

Government saving (S_g):

S_g = Taxes – Govt. Transfer to Private Sector – Interest on Government Debt – Government Expenditure

$$= T - F - N - G \quad (2\text{-}9)$$

Savings from the rest of the world (S_f):

$$S_f = -(X - M) - V \quad (2\text{-}10)$$

The total savings are:

$$S_p + S_g + S_f = (Y + V + F + N) - T - C + (T - F - N - G) - V - (X - M)$$
$$= Y - C - G - (X - M) = I$$

Therefore, the total savings equal the investment.

From the U.S. national accounts for 1990, the three savings components with statistical discrepancy (SD) expressed in billions of dollars are shown below:[15]

S_p = 851.3; S_g = -139.5; S_f = 82.8 and SD = 8.0

The sum of the total savings is $802.6 billion, which is equal to the gross private domestic investment.

The total savings may also be computed in a different manner:

Government deficit ($-S_g$) must be financed either by issuing money or bonds. Thus,

$$S_g = -(\Delta M + \Delta B) \qquad (2\text{-}11)$$

where M and B stand for money supply and bonds, respectively. The bonds issued by the government may be held by private domestic parties (B_p) or by foreigners (B_r). Therefore:

$$\Delta B = B_p + B_r \qquad (2\text{-}12)$$

[15] See R.E. Hall and J.B. Taylor, Macroeconomics, (New York: W.W. Norton & Company, 1993), pp. 53.

This implies that a government deficit is an increase in either the money supply or government bonds, or both.

From a private perspective, S_p should be equal to $\Delta M + \Delta B_p$ + Investment. That is:

$$S_p = \Delta M + \Delta B_p + I \qquad (2\text{-}13)$$

which means that the private sector may invest (in real assets, not financial assets), hold money or buy bonds.

If foreigners invest only in government bonds, foreign savings should equal the purchase of bonds by foreigners.

$$S_f = \Delta B_r \qquad (2\text{-}14)$$

Putting the three savings equations together:

$$S_g + S_f + S_p = -\Delta M - \Delta B + \Delta B_r + \Delta M + \Delta B_p + I = I$$

To summarize, there is a close relationship between private, public and foreign sector savings. When the government runs a deficit, the effect is an increase in the supply of money and/or bonds. Furthermore, the government deficit may also be partly financed by capital inflows from abroad through the accumulation of external debt.

International transactions fall into two categories, current and capital accounts. Current accounts consist of trade transactions of goods and services, net factor payments from abroad and transfer payments, such as international assistance. Capital account transactions consist of borrowing to and lending from foreign parties.

In equilibrium, the balances in current and capital accounts should be equal, although with different signs, and the total international transactions should be zero. That is:

Current Account Transaction + Capital Account Transaction = 0 (2-15)

Governments must finance trade deficits through borrowing from abroad. Conversely, when net exports turn out to be positive, it implies that a country is investing abroad in financial instruments, helping other countries to finance their trade deficits.

To illustrate the above assertion, the following example shown in Table 2.4 is provided.

Table 2.4

Current and Capital Account Transactions
(millions of dollars)
Balance of Current Account:

	Amount	Amount
Trade Balance (inclusive of services)		
Exports	180	
Imports	200	
Total		-20
Net Factor Payment		-19
Interest, government to foreign	-17	
Interest, private to foreign	-5	
Profit remittance	-2	
Transfer, foreign to private	5	
Current Account Balance		-39

Balance of Capital Account:

Categories	Amount	Amount
Direct Foreign Investment	2	
Net Loans: Foreign to government	10	
Net Loans: Foreign to private	27	
Capital Account Balance		39

In this example, as the economy's outflow in the current accounts exceeds its inflow by $39 million. This balance is financed through borrowing from abroad, as shown in the capital account. Thus, the current account transactions plus the capital account transactions must equal zero.

2.5 Summary

- Taxes are levied on the earnings and consumption expenditures within the economy by the various sectors.

- The expenditure of one becomes income for the other, and these become points for levying taxes. The circular flows of income and expenditures represent a useful way to analyze and identify the impact of different taxes on the economy.

- There are three different methods of calculating GDP – the production approach, the expenditure approach and the income approach. All yield the same results.

- GDP measured in production terms reflects the value of all final goods and services produced for the market place over a given period of time, usually a year. That is, GDP = ΣFactor of Production = Σ Value Added.

- GDP according to the expenditure approach is the measurement of all expenditures on final goods and services. GDP = Private consumption + Government expenditure + Private Investment + (Exports - Imports).

- GDP according to the income approach represents the difference between revenue and expenditures. This difference accounts for the income earned by different economic sectors involved in the production process, such as wages paid to workers, rents paid to landlords, interest payments to financial lenders and profits distributed to owners. Thus, GDP = Wages + Interests + Rent + Profits + Depreciation + Indirect Taxes - Subsidies.

- Gross National Product (GNP) = GDP + Payments Received from Abroad -

Payments to Foreigners.

- Net National Product (NNP) = GNP - Depreciation.

- National Income = Wages + Profits + Interests + Rents- Factor Payments to Foreigners + Factor Payments from Abroad.

- Personal Income = National Income - Retained Corporate Earnings - Social Security Payments + Transfer payments + Non Business Interest.

- Disposable Personal Income = Personal Income - Personal Income Taxes.

- An important identity in national accounting is the equivalence between savings and investment. That is, Savings = Investments.

Appendix
Nominal versus Real Prices

When measuring national income, it becomes difficult to compare results because of the rise and fall in prices between years. The way to circumvent this problem is to convert the value of all economic variables in nominal prices to real prices.

GDP is usually measured in current prices (i.e., in nominal terms). In the presence of inflation, GDP can be expressed in real value, or in units of equivalent purchasing power. Real GDP is obtained by deflating the nominal GDP values by a suitable price index.

Illustration: Assuming 1990 as the base year, constructing a real GDP series.

Year	GDP Nominal ($million)	Deflator (1990=100)	GDP Real ($million)
1990	10,000	100	10,000
1991	15,000	110	13,636
1992	27,000	120	22,500
1993	32,000	135	23,704
1994	40,000	160	25,000
1995	48,000	175	27,429
1996	57,000	190	30,000

The accumulated inflation between 1990 and 1996 is 90%.

Chapter 3
Tax Elasticity and Buoyancy

Every country in the process of formulating its budget undertakes revenue projections. When the revenues turn out to be smaller than the budget expenditures, countries end up with deficit financing. Since underdeveloped countries have few possibilities for prolonged external financing of budget deficits, without causing too much disruption in the macro economic environment, each country must decide how best to increase its internal tax revenues to meet its expenditure needs. One way that countries raise additional revenue is by making discretionary tax measure changes. The best outcome expected from such changes is that the tax system will automatically yield corresponding tax revenues as income or GDP grows, on a sustainable basis.

The response of tax revenues to changes in the GDP is measured by tax elasticity and tax buoyancy. These concepts help to explain the overall structure of a tax system and serve as valuable analytical tools for designing tax policy.

3.1 Tax buoyancy

Tax buoyancy measures the total response of tax revenues to changes in national income. Total response takes into account both increases in income and discretionary changes (i.e., tax rates and bases) made by tax authorities in the system. The responsiveness of tax revenues to discretionary changes in the tax rate and in the tax base in relation to the GDP is termed the buoyancy of the tax system.[16] Therefore**,** tax buoyancy is a measure of both the soundness of the tax bases and the effectiveness of

[16] See, e.g., Parthasarathi Shome, "On the Elasticity of Developing Country Tax Systems", Economic and Political Weekly, (August 20, 1988).

tax changes in terms of revenue collection. Tax elasticity, on the other hand, measures the pure response of tax revenues to changes in the national income. Tax elasticity reflects only the built-in responsiveness of tax revenue to movement in national income. The tax elasticity calculation excludes the impact of changes in tax rates and tax bases. It considers only the effects due to changes in income levels, whether or not changes were made in the tax structure during that time period.

Tax buoyancy can be expressed as follows:

$$E_{TY}^{b} = \frac{\Delta T^{b}}{\Delta Y} \bullet \frac{Y}{T^{b}} \qquad (3\text{-}1)$$

where:

E_{TY}^{b} = Buoyancy of tax revenue to income

T^{b} = Total tax revenue

ΔT^{b} = Change in total tax revenue

Y = Income

ΔY = Change in income

Buoyancy may be better expressed by breaking down the total tax system into individual taxes. Suppose that there are three individual taxes (e.g., sales tax, trade tax and income taxes) in the tax system.

The following relations should then hold:

$$T^{b} = T_{1}^{b} + T_{2}^{b} + T_{3}^{b}$$

$$\Delta T^{b} = \Delta T_{1}^{b} + \Delta T_{2}^{b} + \Delta T_{3}^{b}$$

where:

T_{1}^{b} = Revenue from tax 1 (sales tax),

T_{2}^{b} = Revenue from tax 2 (trade tax),

T_{3}^{b} = Revenue from tax 3 (income taxes).

Equation (3-1) can be written as:

$$E^{b}_{TY} = \frac{\Delta T_1^b + \Delta T_2^b + \Delta T_3^b}{\Delta Y} \bullet \frac{Y}{T^b}$$

$$= \frac{\Delta T_1^b}{\Delta Y} \bullet \frac{Y}{T^b} + \frac{\Delta T_2^b}{\Delta Y} \bullet \frac{Y}{T^b} + \frac{\Delta T_3^b}{\Delta Y} \bullet \frac{Y}{T^b}$$

$$= \frac{T_1^b}{T^b} \bullet [\frac{\Delta T_1^b}{\Delta Y} \bullet \frac{Y}{T_1^b}] + \frac{T_2^b}{T^b} \bullet [\frac{\Delta T_2^b}{\Delta Y} \bullet \frac{Y}{T_2^b}] + \frac{T_2^b}{T^b} \bullet [\frac{\Delta T_2^b}{\Delta Y} \bullet \frac{Y}{T_2^b}] \qquad (3\text{-}2)$$

$E^b_{T_1Y}, E^b_{T_2Y}, E^b_{T_3Y}$ stand for buoyancy of the tax revenues 1, 2, and 3 with respect to income, Equation (3-2) can then be written as:

$$E^b_{TY} = \frac{T_1^b}{T} \bullet E^b_{T_1Y} + \frac{T_2^b}{T} \bullet E^b_{T_2Y} + \frac{T_3^b}{T} \bullet E^b_{T_3Y} \qquad (3\text{-}3)$$

The above expression represents a weighted sum of buoyancy for the three taxes T_1, T_2, and T_3.

Buoyancy for a specific tax, say T_1 (sales tax), may be expressed as follows:

$$E^b_{T_1Y} = \left(\frac{\Delta T_1}{\Delta B_1} \bullet \frac{\Delta B_1}{\Delta Y}\right) \times \left(\frac{B_1}{T_1}\right) \times \left(\frac{Y}{B_1}\right)$$

$$= \left(\frac{\Delta T_1}{\Delta B_1} \bullet \frac{B_1}{T_1}\right) \times \left(\frac{\Delta B_1}{\Delta Y} \bullet \frac{Y}{B_1}\right) \qquad (3\text{-}4)$$

where B_1 stands for the base of tax 1. The first term, $\left(\frac{\Delta T_1}{\Delta B_1} \bullet \frac{B_1}{T_1}\right)$, represents the elasticity of the tax with respect to the tax base. It is a function of the legal structure and tax compliance and thus, it is a measure of the effectiveness of the tax policy. The second term, $\left(\frac{\Delta B_1}{\Delta Y} \bullet \frac{Y}{B_1}\right)$, represents the elasticity of the tax base with respect to income and it is a measure of the effect of economic growth on a particular sector of the economy. This is more an issue of a specific economic structure. Thus, equation (3-4) becomes:

$$E^b_{T_1Y} = E^b_{T_1B_1} \times E^b_{B_1Y} \qquad (3\text{-}5)$$

Using this expression, the total tax buoyancy may be written as:

$$E^b_{TY} = E^b_{T_1B_1} \times E^b_{B_1Y}\left(\tfrac{T_1^b}{T}\right) + E^b_{T_2B_2} \times E^b_{B_2Y}\left(\tfrac{T_2^b}{T}\right) + E^b_{T_3B_3} \times E^b_{B_3Y}\left(\tfrac{T_3^b}{T}\right) \qquad (3\text{-}6)$$

This expression also shows how each tax base responds to changes in income over time. In the process of economic growth, some tax bases may get reduced with changes in economic activity. For example, Malaysia used to levy heavy taxes on rubber and palm oil. As the country started exporting large quantities of these goods, the government reduced the tax burden in order to ensure that export-oriented industries did not lose their competitiveness in the international markets. Thus the tax base declined in this case.

Likewise, if one looks at personal income tax, one could argue that, under a progressive tax structure, revenue would automatically rise with the increase in income. However, if an increase in wages and salaries is restrained below inflation, the base may not grow by the same amount as the growth in national income. Income taxes as may have many exemptions and allowances, eroding the base even more.

With consumption taxes, various conflicting policies may further curtail the capacity of the base to increase. For example, with VAT, the presence of a multitude of exemptions (e.g., for unprocessed food, children's clothing and footwear) together with the existence of a high small business threshold greatly limits the revenue generation from this tax. With trade taxes, the presence of various slab rates, exemptions, and the change from *ad valorem* to specific rates further erodes potential tax revenue. The analysis of the composition and characteristics of the bases of these individual taxes helps policy makers to design better tax systems that are more responsive to income growth.

3.2 Tax Elasticity

Tax buoyancy is a useful concept for measuring the performance of both tax policy and tax administration over time. However, it is tax elasticity that is the relevant factor for forecasting purposes. The tax elasticity coefficient gives an indication to policy-makers of whether tax revenues will rise at the same pace as the national income.

Tax elasticity is the ratio of the percentage change in tax revenue to the percentage change in income or GDP, assuming that no discretionary changes have been made in the tax rate or tax base. It is defined as:

$$E_{TY} = \frac{\%\Delta T}{\%\Delta Y} \quad (3\text{-}7)$$

Where: E_{TY} = Elasticity of tax revenue to income or GDP,

ΔT = Change in tax revenue, and

ΔY = Change in income GDP

Since tax elasticity is a measure of the responsiveness of a given tax structure to changes in income, it is necessary to segregate the revenue effects of changes in the tax rates and tax bases from the calculation. An elastic tax system is a highly desirable system, as it provides the government with a sustained fiscal resource base for financing its outlays.

In contrast, an inelastic tax system forces governments to continuously make discretionary changes, either in the tax bases or in the tax rates or both, in order to be able to keep up with increasing public expenditures. This increase in public expenditures, if not contained, in an inelastic tax system environment further stretches the scarce resource envelope, leading to deficit financing, as well as augmenting the gestation periods of incomplete development projects and resulting in an overall slowdown in economic growth. A tax system that is subject to constant adjustments by policy-makers generates greater uncertainties and has adverse effects on long-term investments, as the private sector delays its investment decisions, due to uncertainties in the tax system.

Despite many limitations, the following measures have been used by various countries to keep their tax systems fairly elastic: gradual increase of the base, an inflation adjusted base, the limited use of differentiated rates, utilization of withholding and presumptive taxes, transparency and simplicity of the tax system, and minimization of lag duration of collection.

3.3 Examples

A comparison of buoyancy and elasticity coefficients gives the analyst a useful insight into the tax system for making further policy changes. This is illustrated by the following examples in different countries.

Case 1:	Bangladesh 1979-1984	
	Buoyancy	Elasticity
	0.99	0.71

If the national income in Bangladesh grew by 5% per annum during the period 1979-1984 and there had been no changes in the tax system, tax revenues should have increased at a rate of 3.5% (i.e., 71% of 5%) per year. When the effects of tax changes are included, the buoyancy index indicates that revenue collections should go up by 4.9% (i.e., 99% of 5%). In sum, the net effect of structural changes made in Bangladesh's tax system alone was 1.4% (= 4.9% - 3.5%). This means that the tax policy was effective in keeping revenue collections at par with increases in national income, given a low tax elasticity of 0.71.

Case 2:	Malaysia 1976-1982	
	Buoyancy	Elasticity
	1.23	0.50

In the case of Malaysia, considerable discretionary changes were made in the tax system. A tax buoyancy of 1.23, substantially larger than the tax elasticity, reflects the improvement in tax revenues after changes were made in the tax system. A closer scrutiny of the excise tax structure in Malaysia, for instance, gives an explanation of these results. It must be noted that tax elasticity of excises, if they are a unit or specific taxes, do not respond to increases in nominal prices, since they are imposed as fixed sums of money per unit of goods. As a result, the tax collections are not commensurate with income increases. Generally, a unit excise tax structure will result in an inelastic tax system. The relatively higher tax buoyancy is an indicator of efficient policy measures undertaken by the tax administration to overcome the problems of a rather inelastic tax structure. A high tax buoyancy may be the result of discretionary changes made in the excise tax structure either through the introduction of ad-valorem rates or through increasing the base by the elimination of exemptions and special treatments.

Case 3:	Philippines 1980-1985	
	Buoyancy	Elasticity
	0.80	0.50

The tax system in the Philippines in 1985 was not an efficient one. The discretionary changes undertaken by the policy makers to deal with the inelastic nature of the tax structures were not sufficient. Although the efforts yielded a higher tax buoyancy than tax elasticity, it was still very low. This suggests that the Philippine government should undertake several reforms to improve the elasticity of its tax system, which it did in fact.

Case 4:	Sri Lanka 1977-1985[17]	
	Buoyancy	Elasticity
Import Duties	1.456	0.901
Excises	0.657	0.168
Turnover Taxes	1.641	0.897
Personal Income Tax	1.115	1.194
Corporate Income Tax	1.046	0.909
Overall Tax Structure	0.915	0.740

The tax buoyancy of import duties and turnover taxes is greater than one, reflecting the impact of increases in tax rates. The fact that the excise tax elasticity is relatively low may be due to a small tax base or to the presence of numerous exemptions.

[17] P.B Jayasundera, "Buoyancy and Elasticity of Taxes" in Report of the Taxation Commission, 1990, printed on the Orders of the Government of Sri Lanka, (June 1991).

The tax buoyancy for personal income tax is greater than one, while the tax elasticity is even higher. The reason for a more than proportional increase in personal income tax revenue compared to the increase in national income may be explained by shifts of taxpayers into higher tax brackets. The fact that the tax buoyancy is smaller than the tax elasticity may be due to previous steps taken by the tax administration to adjust the personal income tax structure in order to avoid the bracket-creep impact of inflation.

The tax buoyancy and tax elasticity for the corporate income tax are close to each other, showing that effects of discretionary changes on tax collection were not significant. The overall tax elasticity of the system in Sri Lanka is rather low. Tax buoyancy is a useful tool for purposes of policy design, but the GDP based models reflect the existence of exemptions and tax holidays within the tax system.

Although tax buoyancy is a useful tool for the purposes of policy design, the income or GDP based revenue-forecasting models rely on tax elasticity for estimating future tax revenue collections based on the current tax system. This is because the forecast of aggregate revenues in the future are done within a given tax structure. On must bear in mind that the methodology does not take into account discretionary changes in the future.

3.4 Summary

- The response of tax revenues to changes in income or Gross Domestic Product is measured by tax elasticity and tax buoyancy.

- Tax buoyancy measures the total response of tax revenues to changes in national income. It measures both the soundness of the tax bases and the effectiveness of tax changes in terms of revenue collection.

- Tax elasticity, on the other hand, measures the undiluted response of tax revenues to changes in national income. Tax elasticity calculation excludes the impact of changes in tax rates and tax bases.

- Tax elasticity is the relevant factor for forecasting purposes.

Appendix
Computation of Buoyancy

Tax Buoyancy is expressed as:

$$E_{TY}^{b} = \frac{\Delta T^{b}}{\Delta Y} \bullet \frac{Y}{T^{b}}$$

where:

E_{TY}^{b} = Buoyancy of tax revenue to income

T^{b} = Total tax revenue

ΔT^{b} = % Change in tax revenue (total response)

Y = Income

ΔY = % Change in income

Example: All the values of GDP and income taxes are expressed in current dollars. Calculate the tax buoyancy.

Year	**1981**	**1982**
GDP	7,426	8,634
Income tax	599	710
GDP deflator	1.83	2.04

Steps:

1. Estimate income and tax in real terms;
2. Estimate % change of income and tax in real terms;
3. Apply the above formulae.

Step one:

Estimate GDP and income tax in real term.

$$real = \frac{nomial}{deflator} * 100$$

Year	1981	1982
GDP	7,426	8,634
Income tax	599	710
GDP deflator	1.83	2.04
Real GDP	4,057.92	4,232.35
Real Income Tax	327.32	348.04

Step two:

Estimate % change of income and tax in real terms:

$$\Delta\%Y = (\Delta Y)/Y = (Y_1 - Y_0)/Y_0$$

$$\Delta\%T = (\Delta T)/T = (T_1 - T_0)/T_0$$

where 0 refers to the base year, 1981 and 1 refers to 1982.

$$\Delta\%Y = \left(\frac{4232.35}{4057.92}\right) - 1 = 4.3\%$$

$$\Delta\%T = \left(\frac{348.04}{327.32}\right) - 1 = 6.33\%$$

Step three:

$$buoyancy = \frac{\%\Delta T}{\%\Delta Y} = \frac{6.33\%}{4.3\%} = 1.47$$

To estimate elasticity, one needs to segregate the effects of changes made in the base and tax rates. This method is more complex than the calculation of buoyancy. The calculation of tax elasticity will be explained in Chapter 4.

Chapter 4
GDP Based Estimating Models

This chapter will provide a method for forecasting aggregate tax revenue. Aggregate tax revenue forecasting plays a crucial role in the process of annual budget formulation. It provides policy makers and fiscal planners with first-hand insight and allows them to formulate policy options either to borrow or to use accumulated reserves to balance the budget in the short run as well as fiscal policy interventions to rectify financial anomalies over the medium term. To do this, one has to first estimate the elasticity with respect to the aggregate tax base and then forecast revenues for the future.

4.1 Dynamic versus Static Models

Generally, one would expect to find a close relationship between taxes and their bases in a revenue forecast.[18] For example, the amount of income tax should depend on the amount of taxable income and the tax rate. The magnitude of income tax liability shoul affect the incentive to work and the resulting wages and salaries received. If one is able to collect a large amount of information, sophisticated econometric models can be developed in order to illustrate the linkages (both direct and indirect) between a change in the tax structure and its effects on revenue. The indirect effect of income is harder to measure than the direct effect. Once the effects are known, the revenue implications can thus be calculated for the future. Such models as known as dynamic models.

Dynamic models are comprehensive by their nature. They also take into account the responses of tax bases when discretionary changes are introduced into the tax system.

These models consider the expected behavioral responses of economic sectors to the introduction of new taxes or to changes in the existing tax laws. Thus, tax bases are not assumed to be fixed when forecasting future revenue flows, as the bases are supposed to respond to the new tax regime. To be able to so capture such linkages, these sophisticated econometric models require a relatively large amount of solid information, which may not be possible in most countries.

Considering their information-intensive nature, these dynamic models are often not suitable for most countries that are trying to put a working model into place. Instead, the static forecasting models are used because of information constraints and lack of sophisticated computer skills. Static forecasting models are based upon predetermined paradigms for different types of tax. That is to say, unlike dynamic models static models do not provide feedback between taxes and bases, as the bases are considered to be predetermined.

4.2 Alternative Approaches

The GDP-based tax forecasting models follow the static approach. As a first step, the models require the construction of data series for tax revenues and their bases for each tax. As a general rule, all major revenue generating taxes,[19] if the share of tax is 5% or more of the total tax, should be desegregated as well as their bases onto which these taxes are levied. Once a time series of tax revenues has been compiled, the next step is to collect information on the tax bases from which these taxes were collected. It may not be possible to directly quantify the legal tax bases of all tax receipts but one can use proxies for such bases.

All these tax bases are assumed to be predetermined and are obtained from macroeconomic variables derived from national accounts and balance of payments aggregates. As explained earlier, these historical data series of tax revenues have

[18] International Monetary Fund, "Revenue Forecasting", IMF Institute Financial Policy Workshop: The case of Kenya, (Washington D.C.: IMF, 1981).
[19] See International Monetary Fund, Government Finance Statistics Yearbook.

embedded in them the effects of increases in national income or expenditures, as well as discretionary changes made in the tax system over time. For forecasting models, what is mainly required is to segregate the pure response of tax revenues to increases in income or expenditure (i.e., tax bases) from changes in revenue brought about by discretionary changes (e.g., legal or administrative).

The methodology that is to be followed is to construct ad-hoc tax bases series by separating the increases in revenues caused by increases in income from the increases due to discretionary changes. This can be done in two alternative ways, as described below.

A. The Constant Rate Structure Method

In this approach, the method is to apply the current year's rates to the previous year's tax bases and to construct the adjusted tax revenue series that would have been obtained, had the same tax structure been applied consistently over time. In order to do this, it is necessary to have a detailed tax-base series for all the individual taxes, which, at times, can be difficult to obtain in most developing countries.

As an example of the level of detailed information required in this particular methodology for revenue forecasting, consider the case of forecasting personal income taxes when the current system has different marginal tax rates for different levels of individual income. In this case, a tax base series with detailed information about the various income brackets is required in order to simulate the current period's marginal tax rate structure over previous years' income brackets and to obtain a clean adjusted series. Similar problems would arise in the case of multiple rates of consumption or excise taxes. However, this method can be used if the number of items is small, the range of tax rates is narrow, and the data can be compiled relatively easily (as in some excise tax cases).

B. Proportional Adjustment Method

This method is based on the construction of revenue series by adjusting for the effects of discretionary changes introduced in tax systems over time. Unlike the constant rate structure method, this approach requires only basic information about revenue collections for constructing the adjusted tax base series. The adjusted tax revenue will respond to changes in national income or expenditure only because the tax system is assumed to remain unchanged over the study period.

4.3 Details of the Proportional Adjustment Approach

Three steps are involved in constructing the adjusted revenue series under the proportional adjustment approach:

1) Compile actual revenue collections throughout the period.
   Tax revenues over n periods: T_1, T_2, ...T_{n-1}, T_n

2) Compile data series for discretionary changes.
   Revenues collected from discretionary changes:[20] D_1, D_2,..........D_{n-1}, D_n

3) Adjust actual tax revenue series using discretionary change coefficient.

Starting out from the current year's tax structure (T_n), the adjustment process removes the effects on revenue collection produced by discretionary changes introduced over time. For the n^{th} period, no adjustment is needed, since the tax collection includes discretionary changes. In other words, the tax revenue in the n^{th} period reflects the current tax structure.

[20] These figures can be collected from annul budget documents.

In order to reflect the current tax system, the adjustment for the year n-1 is as follows:

$$AT_{n-1} = T_{n-1} * [T_n / (T_n - D_n)] \qquad (4.1)$$

where AT_{n-1} denotes adjusted series for T_{n-1}. In other words, AT_{n-1} reflects the tax revenues for the year n-1, if the tax system were the same as the one in the year n.

Ideally, it would make sense to use an ex-post discretionary change for the D_n variable. However, it is possible to obtain this only if there are sophisticated information systems capable of quantifying the impacts of the policy changes.[21] Alternatively, the best ex-ante estimation made by the government should be used for the value of D_n.

The adjusted series for the year n-2 equals the actual tax revenue for year 2 times the cumulative adjusted coefficient:

$$AT_{n-2} = T_{n-2} * \underbrace{[T_n / (T_n - D_n)]}_{\text{Tax changes in current year}} * \underbrace{[T_{n-1} / (T_{n-1} - D_{n-1})]}_{\text{Tax changes introduced in previous year}} \qquad (4.2)$$

This would adjust the tax revenues from year n-2 to the current year's tax structure by taking into account the tax changes in the previous year and the current year. The expression may be expanded for subsequent years.

[21] If this were done, it would also incorporate the impact of the change in tax system on the tax base.

Factoring out discretionary changes, we may calculate the value of elasticities (E_{TY}) for the particular tax, say, income Y in year 2:

$$E_{TY} = \frac{AT_2 - AT_1}{Y_2 - Y_1} * \frac{Y_1}{AT_1} \qquad (4.3)$$

And the buoyancy (E^b) of the same tax in year 2 can be expressed as follows:

$$E^b = \frac{T_2 - T_1}{Y_2 - Y_1} * \frac{Y_1}{T_1} \qquad (4.4)$$

In other words, if unadjusted tax revenue is used to regress on the respective GDP, the result is buoyant. Instead, when an adjusted tax revenue stream is employed, the result is tax elasticity.

An Example:

Assume the following data series for tax revenues and discretionary changes for a given country during period 1 to 5:

T1 = 100	T2 = 140	T3 = 170	T4 = 250	T5 = 320
	D2 = 20	D3 = 0	D4 = 30	D5 = 0

Adjustments to the revenue series to account for discretionary changes are done by multiplying the following adjusted coefficients:

$$\frac{T_5}{T_5 - D_5} = \frac{320}{320 - 0} = 1 \qquad \frac{T_3}{T_3 - D_3} = \frac{170}{170 - 0} = 1$$

$$\frac{T_4}{T_4 - D_4} = \frac{250}{250 - 30} = 1.1364 \qquad \frac{T_2}{T_2 - D_2} = \frac{140}{140 - 20} = 1.1667$$

The results obtained above reveal the fact that for periods 2 and 4, discretionary changes made in the tax structure in these periods increased revenues by 16.67% and 13.64%, respectively.

From the general equation (4.2) for adjusted tax revenues, say, in year n-2, the following results are obtained:

$AT_5 = 320.$

$AT_4 = 250 * 1 = 250$, where $[AT_5 = 1]$.

$AT_3 = 170\ (1)\ (1.1364) = 193.2$, where $[AT_5 = 1]$, $[AT_4 = 1.1364]$.

$AT_2 = 140\ (1)\ (1.1364)\ (1) = 159.5$, where $[AT_5 = 1]$, $[AT_4 = 1.1364]$, $[AT_3 = 1]$.

$AT_1 = 100\ (1)\ (1.1364)\ (1)\ (1.1667) = 132.60$,

where $[AT_5 = 1]$, $[AT_4 = 1.1364]$, $[AT_3 = 1]$, $[AT_2 = 1.1667]$.

These calculations are made based on the assumption that both discretionary changes, D_2 and D_4, were made at the beginning of periods 2 and 4, so that values of T_2 and T_4 already includes the impacts of the respective discretionary changes.

Relationship between Tax Revenue and Tax Base

The next step for setting up the GDP based forecasting model is to establish an exact relationship between the adjusted tax data (AT) and the economic variables (i.e., proxy base). In order to do this, it is necessary to determine the correct base for each tax using the national accounts. The task is then to find out which component of the national account corresponds most closely to the base for a particular tax.

In the case of excise taxes, if the revenue from sale of tobacco is to be forecasted, the relevant relationship would be the tax levied on the sale of tobacco products:

$$AT_{TOBACCO} = f\ (\text{tobacco sales}) \qquad (4.5)$$

In the case of personal income tax (PIT), the relationship may be determined as follows:

$$AT_{PIT} = f\ (\text{wages and salaries, bonuses, interest, dividend, rents, profits from incorporated businesses}) \qquad (4.7)$$

In the case of a value-added tax, adjusted tax revenues are linked with total consumption expenditure on goods and services. This could be written as follows:

$$AT_{VAT} = f\ (\text{Consumption expenditures}) \qquad (4.7)$$

Even though items in national accounts may look quite similar to specific tax bases, there may not be a corresponding match. One should be careful in building up ad-hoc national accounts that closely mirror particular tax bases.

Functional Form

Once adjusted tax revenues are correlated with their corresponding national account component, a regression analysis is carried out to forecast future revenue collections.

The general form of the forecasting model[22] is expressed as:

$$AT_j = \alpha + \beta * Y_j \qquad (4.8)$$

[22] See appendix of the chapter for detailed steps and explanation.

where AT_j is the adjusted tax revenues in year j, Y_j is the tax base in year j, and α and β are coefficients to be estimated.

Alternatively, the same relationship may be expressed in log terms.

$$\text{Ln } AT_j = \gamma + \delta * \text{Ln } Y_j \qquad (4.9)$$

where $\delta = [\Delta AT_j / AT_j]/ [\Delta Y_j / Y_j] = [\%AT_j]/[\%Y_j]$. The advantage of using log form is that the coefficient of Y_j, δ, becomes the tax elasticity.

In the case of forecasting a particular tax revenue, AT_j takes the form of the adjusted series and the national account component which is used as the tax base proxy becomes the independent variable.

In addition, dummy variables are often introduced into the model to account for the other relevant explanatory variables in the model. In the case of VAT forecasting, the relevant equation to be estimated can look like the following:

$$AT_{VAT} = a + b * \text{Consumption} + g * D \qquad (4.10)$$

where D stands for other relevant variables affecting tax collections (e.g., a tax amnesty of the Iran-Iraq war affecting tourism in Cyprus).

Assume that the following equation is obtained from the model (4.8) described above:

$$AT_{VAT, 91} = 2.0 + (0.1) * (\text{Consumption})_{91}$$

$$= 10.0 \text{ million, if } (\text{Consumption})_{91} \text{ is 80 million.}$$

In tax revenue forecasting, error terms are important for policy issues. For example, supposing that the actual revenue collection from the VAT in 1991 is 9 million. The difference between the estimated revenues (10 million) and the actual collections (9 million) is regarded as the tax compliance gap. This gap has important implications both for tax administration and policy making.

Steps to Forecast Future Tax Revenues

If data are given for a time series of tax revenues for specific taxes and their corresponding tax bases in nominal terms, the following steps are necessary to forecast future tax revenues:

(1) Convert all categories of taxes from nominal to real terms;
(2) Obtain and convert all corresponding nominal discretionary changes to real;
(3) Calculate the adjusted coefficient and cumulative coefficient to reflect discretionary changes;
(4) Multiply real tax revenues with the cumulative coefficient of discretionary changes to get an adjusted tax series;
(5) Regress the respective adjusted tax revenues with the corresponding tax base to find the tax elasticity.
(6) Use the estimated elasticity to forecast the future revenue stream.

4.4 Summary

- GDP based estimating models may follow a dynamic or a static approach, depending on the amount and type of information available for a given economy. Dynamic models take into account feedback and the responses of tax bases when discretionary changes are introduced into the tax system. Considering the massive information required for the dynamic models, they are often not suitable for most countries that are trying to put a working model into place.

- Static forecasting models are built upon predetermined bases for different taxes. These tax bases have embedded into them the effects of the increases in national income, as well as the discretionary changes made in the tax system over time. The methodology constructs an ad-hoc tax bases series by separating the increases in revenues caused by gains in income from the increases due to discretionary changes.

- There are two alternative approaches for the static forecasting models. They are the constant rate structure method and the proportional adjustment method. The former method is not recommended, because of the difficulty in getting the same tax base over years.

- The proportional adjustment method is based on the construction of a revenue series by adjusting for the effects of discretionary changes introduced in the tax system over time. Three steps are involved in constructing the adjusted revenue series:

    1) Compile revenue collections throughout the period;
    2) Compile data series for discretionary changes; and
    3) Adjust actual tax revenue series using discretionary change coefficient.

- Once the adjusted tax revenues are estimated, one can establish a relationship between the adjusted tax data and the economic variables that closely mirror the tax bases and then run regressions to estimate the tax elasticity for the purposes of forecasting.

Appendix

Steps in Calculating Tax Elasticity

Example: Calculate the tax elasticity in Neco by using information provided in Table A 4.1

Table A4.1
GDP, Sales Tax Revenues and other Data in Neco
(thousands of rupees)

Year	GDP Deflator	Discretionary Changes	GDP	Sales Tax
1974	100	2.5	16571	190.5
1975	100.54	0	17394	161.9
1976	96.96	47.5	17280	222
1977	106.05	20	19732	273.1
1978	116.63	0	22215	356.8
1979	125.5	0	23351	401.2
1980	135.46	52	27307	537.7
1981	148.13	65.85	30988	597.4
1982	166.33	100	33761	709.3
1983	176.94	80	39390	770.7
1984	100	30	44441	845.8
1985	114.41	10	53215	985.9
1986	128.92	106	61140	1143.8
1987	144.15	45	73170	1300.5
1988	160.38	0	85830	1379.7
1989	177.56	30	99702	1650.1
1990	164.3	80.5	116128	2026.1
1991	231.77	100	144931	2841
1992	255.88	200	171474	3438
1993	274.86	418.2	199272	4693
1994	193.1	260	219175	6032
1995	314.66	300	248913	6431
1996	342	1383	280933	7126

Table A4.2
Variables Used to Compute Tax Elasticity

Sales tax

Year	GDP Deflator	Nominal GDP	Sales tax revenues	Ex post discretionary changes	Real GDP	Real Tax Revenues	Real Ex post discretionary changes	Coeff. Of Change	Cumm. Coeff. Of Changes	Sales Tax Adjusted	Log revenue unadjusted	Log revenue adjusted	Log GDP
A	B	C	D	E	F	G	H	I	J	K	L	M	N
1974	100.0	16571.0	190.5	2.5	16571.0	190.5	2.5	1.0	4.6	880.9	5.2	6.8	9.7
1976	100.5	17394.0	161.9	0.0	17300.6	161.0	0.0	1.0	4.6	744.6	5.1	6.6	9.8
1977	97.0	17280.0	222.0	47.5	17821.8	229.0	49.0	1.3	3.6	832.2	5.4	6.7	9.8
1978	106.1	19732.0	273.1	20.0	18606.3	257.5	18.9	1.1	3.4	867.4	5.6	6.8	9.8
1979	116.6	22215.0	356.8	0.0	19047.4	305.9	0.0	1.0	3.4	1030.5	5.7	6.9	9.9
1980	125.5	23351.0	401.2	0.0	18606.4	319.7	0.0	1.0	3.4	1076.8	5.8	7.0	9.8
1981	135.5	27307.0	537.7	52.0	20158.7	396.9	38.4	1.1	3.0	1207.8	6.0	7.1	9.9
1982	148.1	30988.0	597.4	65.9	20919.5	403.3	44.5	1.1	2.7	1091.8	6.0	7.0	9.9
1983	166.3	33761.0	709.3	100.0	20297.6	426.4	60.1	1.2	2.3	991.7	6.1	6.9	9.9
1984	176.9	39390.0	770.7	80.0	22261.8	435.6	45.2	1.1	2.1	907.8	6.1	6.8	10.0
1985	100.0	44441.0	845.8	30.0	44441.0	845.8	30.0	1.0	2.0	1700.3	6.7	7.4	10.7
1986	114.4	53215.0	985.9	10.0	46512.5	861.7	8.7	1.0	2.0	1714.7	6.8	7.4	10.7
1987	128.9	61140.0	1143.8	106.0	47424.8	887.2	82.2	1.1	1.8	1601.8	6.8	7.4	10.8
1988	144.2	73170.0	1300.5	45.0	50759.6	902.2	31.2	1.0	1.7	1572.5	6.8	7.4	10.8
1989	160.4	85830.0	1379.7	0.0	53516.6	860.3	0.0	1.0	1.7	1499.4	6.8	7.3	10.9
1990	177.6	99702.0	1650.1	30.0	56151.2	929.3	16.9	1.0	1.7	1590.3	6.8	7.4	10.9
1991	164.3	116128.0	2026.1	80.5	70680.5	1233.2	49.0	1.0	1.6	2026.5	7.1	7.6	11.2
1992	231.8	144931.0	2841.0	100.0	62532.3	1225.8	43.1	1.0	1.6	1943.4	7.1	7.6	11.0
1993	255.9	171474.0	3438.0	200.0	67013.4	1343.6	78.2	1.1	1.5	2006.3	7.2	7.6	11.1
1994	274.9	199272.0	4693.0	418.2	72499.5	1707.4	152.2	1.1	1.4	2322.4	7.4	7.8	11.2
1995	193.1	219175.0	6032.0	260.0	113503.4	3123.8	134.6	1.0	1.3	4065.7	8.0	8.3	11.6
1996	314.7	248913.0	6431.0	300.0	79105.4	2043.8	95.3	1.0	1.2	2536.0	7.6	7.8	11.3
1997	342.0	280933.0	7126.0	1383.0	82144.2	2083.6	404.4	1.2	1.0	2083.6	7.6	7.6	11.3

Step one: Convert all data from Nominal to Real Terms

- Convert nominal sales tax revenue (Column D of Table A4.2) to real sales tax revenue (Column G). This is an unadjusted revenue series and thus incorporates discretionary changes .The conversion formula is:

$$real = \frac{nominal}{deflator} * 100 .$$

- Convert nominal GDP (Column C) to real GDP (Column F) using the above formulae;

- Convert nominal discretionary changes (Column E) to real discretionary change (Column H).

Real sales tax revenue is:	Real Income GDP is:	Real Ex post discretionary
$real = \frac{columnD}{columnB} * 100$	$real = \frac{columnC}{columnB} * 100$	$real = \frac{columnE}{columnB} * 100$

where : Column D is nominal sales tax;
Column C is nominal income (GDP);
Column E is nominal discretionary changes;
Column B is deflator.

Step Two: Estimate Adjusted Sales Tax Revenues using Proportional Adjustment Method

- Following equation (4.2), adjusted series for year n-2 equals:

$$AT_{n-2} = T_{n-2} * [T_n / (T_n - D_n)] \quad * \quad [T_{n-1} / (T_{n-1} - D_{n-1})]$$

	Tax changes in current year	Tax changes introduced in previous year

This would adjust the tax revenues from year n-2 to the current year's tax structure by taking into account the tax changes in the previous year and in the current year. For example,

$$\text{Tax changes in current year} = \frac{revenue_5}{revenue_5 - discretionary_5}$$

where *revenue*$_5$ is tax revenue for year 5; *discretionary*$_5$ is discretionary tax revenue for year 5.

Hence, Column I of year 1994 = Real tax revenue of 1994/[(real tax revenue for 1994) – (real ex post discretionary tax of 1994) = 190.5/(190.5-2.5) = 1.013. For each consecutive year till 1997, the coefficient of change of the sales tax is calculated.

Tax changes introduced in the previous year are given by: (coefficient of change of T_{n-1}) * (cumulative coefficient of change of T_n). The series is then built up, as in the example:

1. Set the last year 1997 in column J as 1;
2. The cumulative coefficient of change in year 1996 (T_{n-1}) = (Coefficient of change 1997) * (cumulative coefficient of change in 1997).
3. Adjusted tax series in 1974 = (real tax revenue of 1974) * (cumulative coefficient of change) = 190.5 * 4.62388= 880.9. Using this method, the adjusted sales tax series is built up.

Step Three: Calculation of elasticity

One can use the regression equation (4.9) to determine the elasticity. The real numbers are converted in log form and then regressed.

In the above example, we get the following results:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.953618
R Square	0.909388
Adjusted R	0.905073
Standard E	0.132324
Observatio	23

elasticity sales tax

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	3.690276	3.690276	210.7565	2.02E-12
Residual	21	0.367703	0.01751		
Total	22	4.057979			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	0.521139	0.465805	1.118793	0.275863	-0.44756	1.489833	-0.44756	1.489833
X Variable	0.641065	0.044158	14.51745	2.02E-12	0.549233	0.732897	0.549233	0.732897

Hence, the elasticity of sales tax for the Neco country is 0.64. If the regression is done on the unadjusted sales tax revenue series, one would be calculating buoyancy. In our example, the buoyancy is 1.68.

To forecast future revenues, the following formula is used:

Forecasted tax revenue for 1999

= (Tax revenue of 1998) + (Δ in GDP from 1998 to 1999)*(elasticity).

Chapter 5
Statistical Analysis and Micro-Simulation Techniques for Revenue Forecasting

5.1 Introduction

Statistical analysis and micro-simulation models are used as analytical tools to estimate tax revenues and to evaluate the impact of public policy proposals on the various decision-making units in the economy. The unit of analysis in micro-simulation models will typically be an individual, a household or a firm. For macro-based models, aggregate data such as the total consumption or imports in the economy are used, and regression analysis or other analytical tools are applied.

Both macroeconomic forecasting and micro-simulation models contribute to policy formulation by providing quantitative data on the likely effects of policy proposals. Even though the methodologies provide the policy-makers with aggregate quantitative information, that may be quite similar, each is based on a different approach. The macro-economic model approaches the problem from the perspective of the entire country's economy, while the micro-simulation models focus on the actions or behavior of individual sectors affected by the relevant public policy. For example, the macro-economic model may observe the behavior of total consumption in the economy, while micro-simulation model will analyze the consumption decisions of individuals or households at a particular income level.

The main advantage of micro-simulation modeling lies in its capacity to estimate the distributional effect of a given policy proposal on particular sectors of the population, breaking them down by income, sex, age or number of children in the family under the personal income tax system. Since these models are capable of dealing with distributional impacts by identifying potential winners and losers in the society from a given policy proposal, they have proved to be powerful tools in the hands of analysts.

A problem with micro-simulation models, however, is the lack of availability of detailed data on an individual basis. The process of collecting data is often complex, since models require large representative samples from the total population. Data is sometimes collected through surveys for specific purposes. Analysts tend to use mostly administrative tax data or the censuses carried out by government agencies. Since such agencies are constrained by time and resources, the quality of the data is often poor. In addition, micro-simulation-based forecasting also requires well-designed models capable of producing detailed and good quality estimations of policy implications. Simulation models have benefited in recent years from computers capable of handling large data sets. It cannot, however, be over-emphasized that the quality of micro-simulation results is highly dependent on the quality of the data used by the model.

5.2 Data Sources

For micro-simulation analysis, the tax data may come in two different forms. One is the tax administrative data, which is essentially annual tax returns. The other is survey data. Surveys are often used as important sources of data, especially in those cases where data from tax returns are incomplete or inadequate, as may be the case in some developing countries.

Generally speaking, there are two types of surveys: general-purpose surveys and specific purpose surveys. In a general-purpose survey, one obtains data that is useful for several purposes. The best example of this type of survey is the population census taken every 10 years in America and every 5 years in Canada. Such a survey provides information not only about the total population but also about its division into categories – male/female, literate/illiterate, employed/jobless, old/young, poor/wealthy. The merits of this method are: (a) data are from every unit of the population; (b) the results obtained are likely to be more representative, accurate and reliable; and (c) the data can be used for other surveys. However, the problem with this method of data gathering is that it is time-consuming and very costly. Moreover, data collected from the census may not be detailed enough for tax analysis.

Sampling for specific purpose surveys becomes an important data source for analysis. By using sampling data, researchers are able to meet their information needs for data within reasonable time constraints and at reasonable cost. Even if we had the entire universe of data, we would only need one sample to conduct a analysis. Sampling is indeed the process of learning about the universe. On the basis of a sample study, one can predict and generalize the behavior of the entire population.

In sampling, each element of the data set has some probability, however small, to be selected as part of the sample. There are five types of sampling.

A. Simple Random Sampling

In simple random sampling, each observation in the data is assigned an equal probability of being selected in the sample. This probability will be equal to 1 divided by the total population in the data set for each element. Therefore, if the number of units in the sample is "n" and the population size is "N", the probability of a unit to be selected is that p = n/N.

For example, in a study of elderly people, 1,000 elements are selected from an elderly population of 200,000. The probability of selection for any given individual will be: p = 1,000/200,000 = .005.

B. Systematic Sampling

Systematic sampling is also known as quasi-random sampling method. This is because once the initial starting point is determined, the remainder of the items selected for the sample is predetermined by the sampling interval. This sampling is done in two steps: in the first part, the units are selected randomly from a list of the total population; thereafter, every unit is selected at equal intervals from the population list.

Suppose there are 98 tax return files. Under systematic sampling, the sample size would be 10. If the first tax return file selected were the third one, the sample would then consist of the following tax return files: 3, 13, 23, 33, 43,53,63,73,83,93.

C. Stratified Sampling

Before undertaking stratified sampling, the total population is subdivided into particular groups or strata, and each unit of the population is assigned to a unique stratum according to its specific nature. After the grouping is done, the sample is created using systematic sampling.

Stratified sampling can be carried out in such a manner that the same sampling fraction is used in each stratum. The purpose of stratification is to increase the efficiency of sampling by dividing a heterogeneous universe is such a way that (a) there is some degree of homogeneity; and (b) a somewhat marked difference is possible between strata. Generally not more than six strata are used. The number of items taken from each group may be in proportion to their relative weights. Given the fact this is a method with an equal probability of selection of items, it is also known as proportionate stratified sampling.

For example, the 100 total tax returns are divided into four strata. For various reasons, the weights of the strata are determined to be 10,20,30,40%, respectively, and a total of 30 samples are to be drawn for detail tax verification. The desired proportional sample can be obtained in the following manner:

From the first strata = 30 * 10% = 3
From the second strata = 30 * 20% = 6
From the third strata = 30 * 30% = 9
From the fourth strata = 30 * 40% = 12

This proportional stratification is simple and satisfactory if there is no great difference in dispersion from stratum to stratum.

Alternatively, sampling fractions can be set at different rates for each stratum. The use of different disproportionate stratified sampling leads to an unequal probability of selection. Disproportionate stratified sampling requires additional work on the part of the researcher, as the responses have to be weighted for the analysis. However, the payoff in terms of increased precision may justify the additional work. The use of proportionate stratification ensures the adequate representation of relatively small, but especially relevant groups, in the sample. In contrast, disproportionate stratification permits the analysis of particular members of a given stratum.

D. Cluster Sampling

Cluster sampling produces less precise, but more practical, results. Cluster samples are obtained even without having lists of the entire population. Furthermore, cluster samples allow for a substantial reduction in transportation costs when personal interviews have to be done for collecting data.

Similar to stratified sampling, cluster sampling follows a three-step procedure: first, it divides the survey population into groups; second, it selects some of the groups; and third, it chooses individual elements from each of the selected groups.

E. Multistage Sampling

This sampling technique is used when a complete list of the population is not available and there is no way to access the population directly, but it is still possible to assign members to groups. The multistage sampling technique follows a two-stage process.

In the first stage, population members are grouped in primary sampling units, which are similar to clusters. In the second stage, members of the population are randomly selected from each primary sampling unit. According to this sampling scheme, the probability of an observation being selected is determined by the cumulative probability of the selection stages. As a result, unequal probabilities in one stage can be compensated for in the succeeding stages to produce an equal probability of selection.

Example: Sampling students from schools

Assume that an analyst wants to draw a sample of all students enrolled in the public schools of a particular city. Even though a complete list of all the students may not be readily available, a full list of all public schools in that city is very likely to be available. Since every student in the population can be attached to one and only one of those schools, an acceptable sample of students can be selected using a two-stage strategy: first, by selecting a certain number of schools, and then by selecting the students from those schools. Assume that the following data is collected:

Number of students: 20,000
Number of schools: 40
Desired sample = 2,000 = 1/10 of total student population

Four different approaches are presented below. Each yields a sample of 2,000 students.

		Probability of Selection at Stage 1	Probability of Selection at Stage 2	Overall Probability of Selection
A	- Select all schools, - List all students, and select 1/10 students in school	1 / 1	1 / 10	1 / 10
B	- Select ½ the schools, - Select 1/5 of all students in school	1 / 2	1 / 5	1 / 10
C	- Select 1/5 schools, - Select ½ of all students in school	1 / 5	1 / 2	1 / 10
D	- Select 1/10 schools, - Collect information of all students	1 / 10	1 / 1	1 / 10

All of the four approaches listed above yield a sample size of 2,000. All of them give each student in the city an equal chance of selection (1/10). The difference is that as we go from top to bottom, the designs of the samples are increasingly less expensive. In each successive approach, data have to be collected from fewer schools, and fewer schools need to be visited. At the same time, the precision of the samples is likely to decline, as fewer schools are sampled and more students are sampled from each school.

The other type of sampling is based on the judgment of the researcher to achieve particular research objectives without relying on probabilistic methodologies. Under non-probability sampling, some elements of the population have zero probability of being selected.

5.3 Data Validation

Any micro-simulation model is likely to contain errors of estimation caused either by biases in the sampling process, poor quality of the input data or a straightforward failure of some of the components of the underlying model. Once the models are designed and the analysis is carried out, a validation system is needed to provide information on the likely margin of error. Every model should, therefore, include some form of data validation that is capable of producing minimum estimations of uncertainty in the outcome.
There are basically three validation techniques for obtaining information about the quality of micro-simulation outputs:

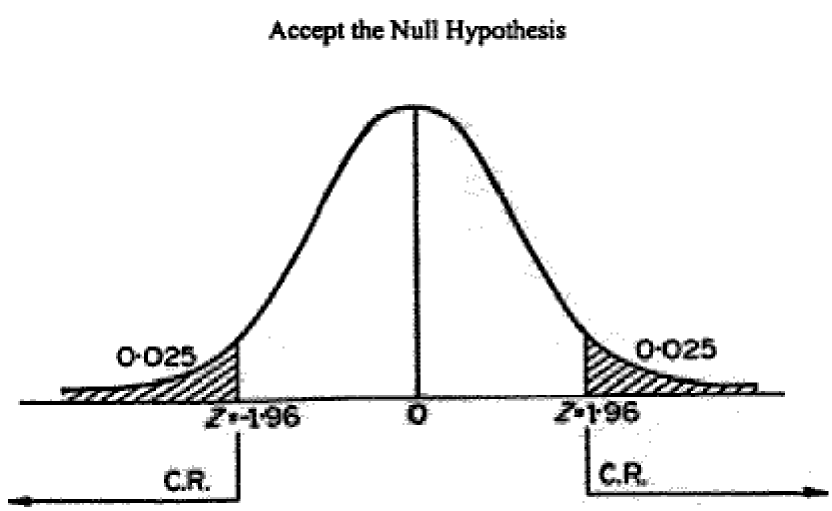
(a) External validity studies: Modeling output is compared with external sources to ensure objectivity.
(b) Sensitivity analysis: Models that are run under alternative input assumptions to study the effects of changes in the specific components of the model. These enable the analyst to assess the relative effect of changes in each component on the overall outcome.
(c) Computer techniques to measure the variance of model estimates.

Continuous model validation should be an integrated component of the micro-simulation process in order to ensure maximum reliability of the model output. Validation serves to overcome the natural limitations faced in micro-simulation modeling. One major limitation is the possible effects of policy changes on behaviors of units affected by the policy. These responses introduce certain elements of uncertainty that may bias the model outcomes.

During the last few decades, micro modeling has been going through a continuous process of development, given the increasing demand for better quantitative data from policy making units in different executive and legislative agencies. The introduction of behavioral responses to policy changes and dynamic data components are high on the micro-simulation research agenda.

5.4 Statistical Analysis

Very often one is called upon to make a decision for a population on the basis of sample information. In attempting to make this decision, it is useful to make assumptions about the population in question. In many instances, one formulates a statistical hypothesis that a certain general statement about the probability distribution of the population is true. This is known as



the null hypothesis. It asserts that there is no true difference between the sample and the population in the particular matter under consideration. This hypothesis is put to the test before it is accepted or rejected under a certain level of significance. In practice, a level of significance of 0.05 is customary. What this 5% level of significance means is that there are about 5 chances out of 100 that one would reject the hypothesis after it has been accepted. In order words, one is 95 % confident that the decision that one has made is the right one. The total shaded area 0.05 is the level of significance of the test. It represents the rejection of the hypothesis.

Normally, the statistical value of the correlation coefficient R^2 , if greater than 90 %, is considered to be reasonably fit. For cross section data, R^2 tends to be much lower. As a rule of thumb, a t-statistic of 1.96 or greater is statistically significant at a 5% level of significance.

In Chapter 3, the concept of elasticity and buoyancy were introduced, along with techniques to measure the responses of tax revenues to changes in GDP. These revenue responses measured by tax elasticity and buoyancy offer excellent insights into the overall tax structure. The method of estimating elasticity has been more well developed in Chapter 4 and buoyancy in Chapter 3. In this section, we expand the regression analysis and elaborate these techniques further to analyze the impact of a major tax reform on revenue collections.

To recapitulate, a simple regression between income (Y_j) and tax revenues (AT_j) is expressed below:

$$AT_j = \alpha + \beta * Y_j \qquad (5\text{-}1)$$

This regression analysis can be extended to discover whether if tax reform has any impact on revenue collection. Equation (5-1) is not appropriate to capture the effects of tax reform since it assumes that the coefficient (β) is constant, regardless of tax reform. In order to capture whether tax reform has an impact on tax revenues, one may add a dummy variable in the equation. This dummy variable is represented by the value of "0" for the years in the pre reform period and a value of "1" for the years of post reform. The equation is shown as follows:

$$Ln\ AT_j = \alpha + \beta *Ln\ (Y_j) + c * (Dummy) + d * (Ln\ Y_j * Dummy) \qquad (5\text{-}2)$$

The elasticities of pre reform and post reform are β and (β +d), respectively, if they are both statistically significant.

Example

Table A5.1 provides data on annual sales tax revenues and discretionary changes over the period from 1974 to 1997 for a country. Nominal GDP and GDP deflators are also provided. The country implemented sales tax reform in 1989. What is the income elasticity of the sales taxes?

A. <u>Calculation of Income Elasticity without Consideration of Tax Reform</u>

- Convert all categories of taxes from nominal to real terms (Column D of Table A5.1) to real sales tax revenue (Column G);
- Obtain and convert all corresponding nominal discretionary changes (Column E) to real (Column H);
- Calculate the adjusted coefficient and cumulative coefficient to reflect discretionary changes (Column I and J);
- Multiply real tax revenues by the cumulative coefficient of discretionary changes to get an adjusted tax series (Column K);
- Regress respective adjusted tax revenues with the corresponding tax base in log form using equation (5-1) to get tax elasticity and buoyancy.

The elasticity of the sales tax with respect to income is 0.64, and buoyancy is 1.68.

B. Calculation of Tax Elasticity with Consideration of Tax Reform

- In order to capture the impact of sales tax reform, one can introduce a dummy variable into the equation, as specified in equation (5-2). This dummy variable is represented by the value of "0" for the years preceding 1989, as shown in "Column O" of Table A5.2 for the pre reform period and a value of "1" for the years from the year 1989 for the post-reform period. Column P gives the interactive dummy variable that is Log GDP (Column N) * Dummy variable (Column O).

The results of the regression are:

$$\text{Ln } AT_j = 0.9729 + \underset{(8.835)}{0.60558} * \text{Ln } Y_j - \underset{(-3.523)}{7.02571} * \text{Dummy} + \underset{(3.483)}{0.629687} * \text{Ln } Y_j * \text{Dummy}$$

$$R^2 = 0.94$$

Parentheses indicate the t-statistic of the coefficients. These coefficients are all statistically significant at the 1% level. Therefore, the elasticity for sales tax pre-reform should 0.61, while the elasticity for post reform is 1.24 (=0.60558 + 0.629687).

Table A5.1:

Sales Tax Elasticity and Buoyancy Without Consideration of Tax Reform

Sales tax

Year	GDP Deflator	Nominal GDP	Sales tax revenues	Ex post discretionary changes	Real GDP	Real Tax Revenues	Real Ex post discretionary changes	Coeff. Of Change	Cumm. Coeff. Of Changes	Sales Tax Adjusted	Log revenue unadjusted	Log revenue adjusted	Log GDP
A	B	C	D	E	F	G	H	I	J	K	L	M	N
1974	100.0	16571.0	190.5	2.5	16571.0	190.5	2.5	1.0	4.6	880.9	5.2	6.8	9.7
1976	100.5	17394.0	161.9	0.0	17300.6	161.0	0.0	1.0	4.6	744.6	5.1	6.6	9.8
1977	97.0	17280.0	222.0	47.5	17821.8	229.0	49.0	1.3	3.6	832.2	5.4	6.7	9.8
1978	106.1	19732.0	273.1	20.0	18606.3	257.5	18.9	1.1	3.4	867.4	5.6	6.8	9.8
1979	116.6	22215.0	356.8	0.0	19047.4	305.9	0.0	1.0	3.4	1030.5	5.7	6.9	9.9
1980	125.5	23351.0	401.2	0.0	18606.4	319.7	0.0	1.0	3.4	1076.8	5.8	7.0	9.8
1981	135.5	27307.0	537.7	52.0	20158.7	396.9	38.4	1.1	3.0	1207.8	6.0	7.1	9.9
1982	148.1	30988.0	597.4	65.9	20919.5	403.3	44.5	1.1	2.7	1091.8	6.0	7.0	9.9
1983	166.3	33761.0	709.3	100.0	20297.6	426.4	60.1	1.2	2.3	991.7	6.1	6.9	9.9
1984	176.9	39390.0	770.7	80.0	22261.8	435.6	45.2	1.1	2.1	907.8	6.1	6.8	10.0
1985	100.0	44441.0	845.8	30.0	44441.0	845.8	30.0	1.0	2.0	1700.3	6.7	7.4	10.7
1986	114.4	53215.0	985.9	10.0	46512.5	861.7	8.7	1.0	2.0	1714.7	6.8	7.4	10.7
1987	128.9	61140.0	1143.8	106.0	47424.8	887.2	82.2	1.1	1.8	1601.8	6.8	7.4	10.8
1988	144.2	73170.0	1300.5	45.0	50759.6	902.2	31.2	1.0	1.7	1572.5	6.8	7.4	10.8
1989	160.4	85830.0	1379.7	0.0	53516.6	860.3	0.0	1.0	1.7	1499.4	6.8	7.3	10.9
1990	177.6	99702.0	1650.1	30.0	56151.2	929.3	16.9	1.0	1.7	1590.3	6.8	7.4	10.9
1991	164.3	116128.0	2026.1	80.5	70680.5	1233.2	49.0	1.0	1.6	2026.5	7.1	7.6	11.2
1992	231.8	144931.0	2841.0	100.0	62532.3	1225.8	43.1	1.0	1.6	1943.4	7.1	7.6	11.0
1993	255.9	171474.0	3438.0	200.0	67013.4	1343.6	78.2	1.1	1.5	2006.3	7.2	7.6	11.1
1994	274.9	199272.0	4693.0	418.2	72499.5	1707.4	152.2	1.1	1.4	2322.4	7.4	7.8	11.2
1995	193.1	219175.0	6032.0	260.0	113503.4	3123.8	134.6	1.0	1.3	4065.7	8.0	8.3	11.6
1996	314.7	248913.0	6431.0	300.0	79105.4	2043.8	95.3	1.0	1.2	2536.0	7.6	7.8	11.3
1997	342.0	280933.0	7126.0	1383.0	82144.2	2083.6	404.4	1.2	1.0	2083.6	7.6	7.6	11.3

Table A5.2:

Calculation of Tax Elasticity with consideration of Tax Reform

Year		Real Tax Revenues	Real Ex post discretionary changes	Coeff. Of Change	Cumm. Coeff. Of Changes	Sales Tax Adjusted	Log revenue unadjusted	Log revenue adjusted	Log GDP	Dummy	Dummy Interactive
A		G	H	I	J	K	L	M	N	0	P
	1974	190.5	2.5	1.013	4.62389	880.9	5.250	6.781	9.715	0.000	0.000
	1976	161.0	0.0	1.000	4.62389	744.6	5.082	6.613	9.758	0.000	0.000
	1977	229.0	49.0	1.272	3.63454	832.2	5.434	6.724	9.788	0.000	0.000
	1978	257.5	18.9	1.079	3.36837	867.4	5.551	6.766	9.831	0.000	0.000
	1979	305.9	0.0	1.000	3.36837	1030.5	5.723	6.938	9.855	0.000	0.000
	1980	319.7	0.0	1.000	3.36837	1076.8	5.767	6.982	9.831	0.000	0.000
	1981	396.9	38.4	1.107	3.04262	1207.8	5.984	7.097	9.911	0.000	0.000
	1982	403.3	44.5	1.124	2.70724	1091.8	6.000	6.996	9.948	0.000	0.000
	1983	426.4	60.1	1.164	2.32556	991.7	6.055	6.899	9.918	0.000	0.000
	1984	435.6	45.2	1.116	2.08417	907.8	6.077	6.811	10.011	0.000	0.000
	1985	845.8	30.0	1.037	2.01024	1700.3	6.740	7.439	10.702	0.000	0.000
	1986	861.7	8.7	1.010	1.98985	1714.7	6.759	7.447	10.747	0.000	0.000
	1987	887.2	82.2	1.102	1.80545	1601.8	6.788	7.379	10.767	0.000	0.000
	1988	902.2	31.2	1.036	1.74297	1572.5	6.805	7.360	10.835	0.000	0.000
	1989	860.3	0.0	1.000	1.74297	1499.4	6.757	7.313	10.888	1.000	10.888
	1990	929.3	16.9	1.019	1.71129	1590.3	6.834	7.372	10.936	1.000	10.936
	1991	1233.2	49.0	1.041	1.64329	2026.5	7.117	7.614	11.166	1.000	11.166
	1992	1225.8	43.1	1.036	1.58545	1943.4	7.111	7.572	11.043	1.000	11.043
	1993	1343.6	78.2	1.062	1.49322	2006.3	7.203	7.604	11.113	1.000	11.113
	1994	1707.4	152.2	1.098	1.36016	2322.4	7.443	7.750	11.191	1.000	11.191
	1995	3123.8	134.6	1.045	1.30153	4065.7	8.047	8.310	11.640	1.000	11.640
	1996	2043.8	95.3	1.049	1.24081	2536.0	7.623	7.838	11.279	1.000	11.279
	1997	2083.6	404.4	1.241	1.00000	2083.6	7.642	7.642	11.316	1.000	11.316

Chapter 6
Personal Income Tax Models

6.1 Introduction

Revenue forecasting of personal income tax can be accomplished with the help of microsimulation models.[23] What is of importance and relevance is that, besides the forecast of revenues, these models have the capability to show the effects of both fine and broader policy changes on specific groups or the total population. These models provide a winner/loser analysis and tools to assess who benefits from a given policy change. For example, is it the low income, modest income, or high-income families who benefit from such policy changes? What are the potential impacts of the changes in the tax structures on diverse groups such as the elderly, two parent families with children or single-parent families with children? These models thus provide useful handles for assessing the efficacy of policy proposals in achieving the stated policy objectives.

Microsimulation models help to provide estimates of the fiscal and distributional impact of the changes involved under various scenarios. The sophistication of these models depends upon the quality of data, validation, and the level of information sought, and the effects of policy changes on specific groups or on the larger population.

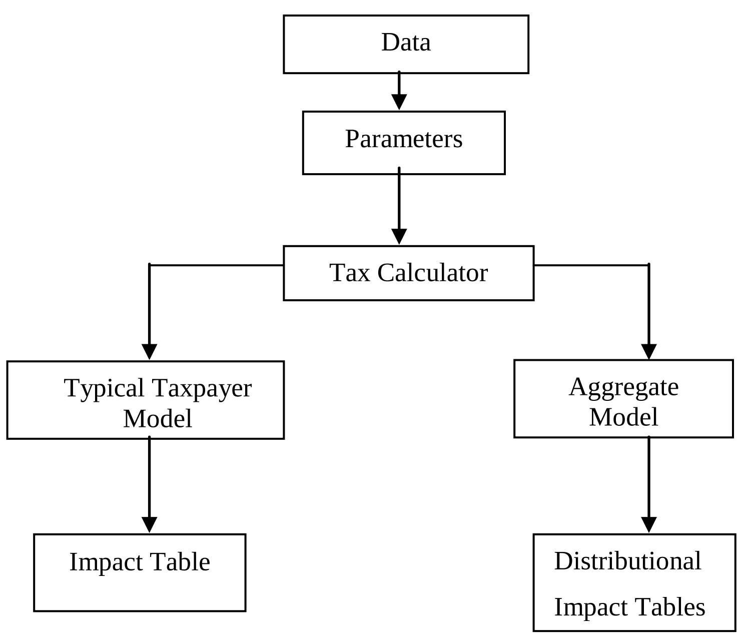
[23] There are alternative forecasting models based on macroeconomics. See, e.g., Department of Finance Canada, Fiscal Policy Division, "Personal Income Tax Forecasting Model", (May 1992). These models use econometric techniques on time series data to produce a forecast of economic and tax variables. These are then used in the projection of budgetary estimates. Many countries routinely use the two techniques in conjunction to provide a more reliable (and internally consistent) estimate of tax policy measures. By these macro to micro links, one can assure that estimates produced by macro models within the ministry are consistent with the microsimulation estimates of various tax policy initiatives. A. Gupta and V. Kupur, "Microsimulation Modeling Experience at the Canadian Department of Finance", in Microsimulation in Public Policy, edited by Ann Harding , (North-Holland Press, 1996). See also W. B. Trautman, "A Microsimulation Model of the Slovak Individual Income Tax", paper prepared for the Slovak Ministry of Finance by the U.S. Treasury Department's Office of Technical Assistance (March 1999). See also W.B. Trautman," A Microsimulation Model of the Slovak Individual Income Tax" paper prepared for Slovak Ministry of Finance by the U.S. Treasury Department's Office of Technical Assistance, (March 1999).

A salient feature of a microsimulation model is its capacity to assess the effects of a variety of policy options. Examples include changes in the definition of income, modifications in the size and scope of deductibles, revenue effects due to modifications in the tax rate structure, and the effect of population growth or changes in income.

The information provided by the microsimulation models help the executive and legislative branches to make choices among alternative policies by allowing for various policy analysis simulations, as well as assisting the budget department in forecasting revenue changes from such policy changes.

Figure 6.1 presents the process of building a microsimulation model. The data is based essentially on individual or family based annual income tax returns, supplemented by surveys to cover non-filers. The growth factors for projection into the future are also necessary. This data, together with tax parameters obtained from the existing tax laws and regulations, provides information necessary for the computation of individual tax liability. There are two types of models one can consider: Typical Taxpayer Models and Aggregate Models.

Figure 6.1
A Microsimulaton Model



Typical taxpayer models simulate the impact of proposed policy changes on the tax liability of an individual. Aggregate models, on the other hand, simulate the distributional impact of tax liability on various categories as well as the fiscal impact on tax revenues for the nation as a whole. Before we describe the two models in detail, we will briefly explain the process of data creation.

6.2 Development of the Database

Microsimulation models can be useful to illustrate tax policy to taxpayers through specific examples and to produce estimates of the effects of proposed changes in government programs by obtaining inputs from micro level databases of individual records. Based upon the description of the individual in the database, the effects of current and proposed programs on individuals is observed.

Basic Database

The basic data required for microsimulation modeling is usually obtained from annual personal income tax returns. These data are supplemented by survey data, such as general population surveys, household income-expenditure surveys and labor markets survey.[24] These surveys capture additional information for the database, as well as from non-filing individuals.

A stratified sample of the database is used as the input for microsimulation models. Typically, the stratification follows the following criteria: first, source of income -- whether salaried employment, investment, farming, fishing, professional, or business; second, place

[24] Though surveys generally suffer from a number of limitations, including systematic under-reporting, the estimates are useful for specific tax policy analysis.

of residence -- urban, rural, states, provinces, and foreign residence; and third, tax status -- income range and taxability. The stratification process can also differentiate taxfilers with special circumstances, such as those with relatively large incomes, or large deductions, or those with non-resident status. The size of the sample ranges from 1% to 5% of the total filing population, depending upon the size of the population and resources available to collect the data.

Data Aging

Given the nature of revenue forecasting, most input data comes from the past, while estimates are needed for several years into the future. In most cases, the latest available historical data lags considerably behind the time period into which the forecast has to be made. For this reason, revenue forecasting requires the "aging" of the latest available data to future time periods before conducting policy simulations. This process of "data aging" is completed with the help of statistical tools such as time series regression.

The process of "data aging" is done in two stages:

(a) The base data is adjusted for future periods by taking into consideration the population growth projections. Once the data is broken down into its basic components relating to sex, occupation, and age, regression techniques are used to project the aggregate number of filers based on the time series of population projections.

(b) In addition to population projection, adjustment is done to reflect income growth throughout the period. Again, regression techniques project base data into future years, taking into consideration the time series of income components. The remaining items detailed in tax returns, such as deductions, taxable income and taxes owed, are computed by the tax models.

Data Validation

In order to maximize the reliability of the model, data validation should be done at different stages of the microsimulation process. One way to validate data is to continuously crosscheck against external data sources both before and after data aging. A new database resulting from the aging process can be checked against external data obtained from alternative data sources, such as administrative data, program data, independent surveys or external simulation models.

Longitudinal data

The above data refers to data for a specific year. However, when tax codes provide "carry-back or carry-forward" mechanisms in a tax system, data pertaining to several years are necessary to properly assess individual tax liability and to forecast government tax revenues. In this case, the models consider moving data blocks pertaining to several years to forecast revenue collections. The development of longitudinal data and simulation models becomes useful and important. These models are not discussed in this chapter because of their complexity. However, the multi-year effect is the most relevant and important for of models used in forecasting corporate income tax revenues. These will be discussed in detail in Chapter 7.

6.3 A Typical Taxpayer Model

A typical taxpayer model calculates the tax liability of a typical individual (or family), be it a young student, an elderly person, a couple with children, a single person or a disabled person. The underlying idea is to understand the application of tax law on individuals under the existing tax regime and to compare it with the tax liability of the same individual under a proposed tax policy change.

A simplified tax return module consists of three components:[25]

(a) personal income tax parameters (tax code regulations);
(a) taxpayer personal history; and
(c) tax calculator.

Under the personal income tax parameters (tax code regulations), detailed information on rates, credits, exemptions, tax benefits, and inclusion rates are specified. The personal income tax parameters can be looked upon as a tax check list on which the tax calculator (Table 6.3) picks up the specified rates/credits/deductions and matches it against the information provided under the personal history of the individual to assess the total tax liability.

It is important to understand the difference between tax credits and deductions. For a progressive tax system, a deduction will result in a tax reduction based upon the marginal tax rate of the taxpayer. This results in a higher tax reduction for a high income taxpayer vis-à-vis a lower income taxpayer for the same amount of deduction. Tax credits, on the other hand, provide the same relief regardless of the income of the individual. It is for this reason that many countries are switching to a credit system from a deduction system.[26]

A typical taxpayer personal history can consist of the following information: age, number of children in various age categories, marital status, area and region of residence, and other personal information. Also available is income and deduction information, such as income from different sources and charitable donations. All this information is then used to calculate necessary credits, deductions, and taxable amounts in order to determine the total tax liability.

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[25] The level of information provided under these three components determines the degree of analysis that can be undertaken.

[26] In Canada, most of the tax deductions were converted into a 17% tax credit under the country's 1987 personal income tax system.

The tax calculator takes individual taxpayers returns and applies the tax code, yielding an assessment of the total tax payable. Taxable income is calculated based on the Haig-Simons definition of income (i.e., Income = Consumption + Net Wealth). Taxable income is obtained by subtracting personal deductions from total income from different sources. Tax liability is calculated by applying taxable income to the marginal tax rate schedule, which is typically a progressive tax structure. Finally, tax due is calculated by subtracting basic credits from total tax liability. As mentioned above, in a typical tax system, credits lower the tax payable unit by unit (e.g., dollar by dollar), while deductions reduce it by an amount equivalent to each taxpayer's marginal tax rate.

Table 6.1 details tax parameters for a progressive rate structure and tax credits allowed in a particular income tax code. Table 6.2 details taxpayer personal information. The values in the parameter table are linked to the tax return model in order to yield tax liabilities. Although instructions and parameters shown in the tables may look rather basic, tax codes may have complex rules for the calculation of income, deductions and credits.

Table 6.1

Personal Income Tax Parameters

	Parameters	Value
1	% Tax Credit Applied on Pers. Amount	17%
2	Basic Personal	6,169
3	Married or Equiv.	5,141
4	Allow. Income	514
5	Age Credit to 65 and Over	3,327
6	Pension Income Deduction	1,000
7	Child Tax Benefit	
8	- Amount per Child	1,020
9	- Supplement for Children < 7	203
10	Tax Table:	0
11	0-30,000	17%
12	30,000-60,000	26%
13	60,000+	29%
14	Federal Surtax:	3%
15	Capital Gains Exemption:	100,000
16	Capital Gains Inclusion Rate	75%
17	Dividend Gross-up Rate	1.25
18	Dividend Tax Credit	13.33%

Table 6.2

Taxpayer Personal Information

19	Age	35
20	Children under seven	2
21	Children 7-18 years	3
22	Married	yes

A typical tax return model computing the taxpayer's total income and tax liability is shown in Table 6.3. The taxpayer's gross income is $151,250, and the total federal tax payable is $10,040.

Table 6.3 Flow of Income Tax Calculations

			Amounts	
23	Wages and salaries		75,000	
24	Capital gains	100,000	75,000	24*16
25	Dividends	1,000	1,250	25*17
26	~~**Total Income**~~		151,250	23+24+25
27	Deductions: retired pension plans		1,500	
28	~~Net income~~		149,750	26-27
29	Deductions from net income: capital gains		75,000	24
30	Taxable income		74,750	28-29
31	~~**Tax on taxable income**~~		**17,178**	see footnote
32	Non-refundable credits:			
33	Basic Personal		6,169	2
34	Married		5,141	3
35	Age		0	5
36	Total deduction equivalent		11,310	33+34+35
37	~~Total non refundable credits~~		1,923	36*1
38	~~Basic Federal tax~~		15,255	31-37
39	Federal surtax		458	38*14
40	Federal tax before refundable credits		15,712	39+38
41	Child Benefits:			
42	Basic for child		5,100	8*5 children
43	supplement for <7		406	9*2 children
44	Total benefits		5,506	42+43
45	Dividend tax credits		167	25*18
46	~~***TOTAL FEDERAL TAX PAYABLE:***~~		**10,040**	40-44-45

~~**tax on taxable income=74750*17%+(74750-30000)*(26%-17%)+(74750-60000)*(29%-26%)**~~

Table 6.4 The Impact of a 25% Flat Tax on Tax Revenues

			Amounts	Option	**impact**
23	Wages and salaries		75,000	75,000	
24	Capital gains	100,000	75,000	75,000	
25	Dividends	1,000	1,250	1,250	
26	~~**Total Income**~~		151,250	151,250	
27	Deductions: retired pension plans		1,500	1,500	
28	~~Net income~~		149,750	149,750	
29	Deductions from net income: capital gains		75,000	75,000	
30	Taxable income		74,750	74,750	
31	~~**Tax on taxable income**~~		**17,178**	**18,688**	**1,510**
32	Non-refundable credits:				
33	Basic Personal		6,169	6,169	
34	Married		5,141	5,141	
35	Age		0	0	
36	Total deduction equivalent		11,310	11,310	
37	~~Total non refundable credits~~		1,923	1,923	
38	~~Basic Federal tax~~		15,255	16,765	**1,510**
39	Federal surtax		458	503	
40	Federal tax before refundable credits		15,712	17,268	**1,555**
41	Child Benefits:				
42	Basic for child		5,100	5,100	
43	supplement for <7		406	406	
44	Total benefits		5,506	5,506	
45	Dividend tax credits		167	167	
46	~~***TOTAL FEDERAL TAX PAYABLE:***~~		**10,040**	**11,595**	**1,555**

Having developed the typical taxpayer model, one can simulate the impact on the tax liability of the proposed policy changes in the tax system, such as changes in the definition of income, modifications in the size and scope of deductibles, tax structure, etc.

In the following example, a flat tax rate scenario is simulated. For simplicity, the only parameters that are changed relate to the tax rate schedule. To evaluate this policy change to a flat rate tax system, we simulate tax liability under the proposed tax system. The base case has been defined as the outcome of the current tax system and the optional case as the outcome from policy changes being contemplated. Table 6.4 shows that, under the optional case of a flat tax of 25%, without any changes in the tax code, the individual pay $1,555 more than under the existing tax laws. This is shown under the impact column.

Using this typical taxpayer model, various scenarios can be simulated for different income levels in order to obtain a comparison of distributional impacts from the current and the proposed tax policy structure. As can be seen from Table 6.5, a single flat rate tax seems to benefit the higher income group which is married with no children. The lower income taxpayers are negatively effected, as they end up paying higher average tax rates. The average tax rate for the $50,000 total income bracket goes from 15.56% to 18.23% (or 15.86 %, if one is contemplating a flat rate tax of 25 % or 22 %). If the flat rate tax is 22%, the low income bracket (up to $ 50,000) loses, while the higher-income bracket ($ 50,000 and over) gains. Furthermore, if it is a flat rate tax of 25 %, those with incomes above $ 90,000 gain, while those with total incomes of less than $90,000 lose. In the above simulations, a flat rate tax does not benefit low income filers. Changes to other parts of the tax system are necessary along with this single rate. It is outputs such as these produced by simple typical taxpayer models that help the policy makers fine-tune their policy options as well as the direction of their changes. These results may also help to decide whether or not a policy initiative falls

Table 6.5

Impact of a 25 % and 22 % Flat Tax on Various Income Groups

TAXFILER TYPE: MARRIED

	Base case		Option Case Rate at 25%		Option Case Rate at 22%	
Total Income	Federal Tax Payable	Average Tax Rate	Federal Tax Payable	Average Tax Rate	Federal Tax Payable	Average Tax Rate
10,000	-2,781	-27.81%	-2,781	-27.81%	-2,781	-27.81%
20,000	-803	-4.02%	-108	-0.54%	-369	-1.84%
30,000	1,448	4.83%	2,967	9.89%	2,397	7.99%
40,000	4,602	11.51%	6,042	15.11%	5,163	12.91%
50,000	7,780	15.56%	9,117	18.23%	7,929	15.86%
60,000	10,958	18.26%	12,192	20.32%	10,695	17.83%
70,000	14,052	20.07%	14,882	21.26%	13,076	18.68%
75,000	15,546	20.73%	16,169	21.56%	14208.8654	18.95%
80,000	17,039	21.30%	17,457	21.82%	15341.8654	19.18%
90,000	20,026	22.25%	20,032	22.26%	17607.8654	19.56%
100,000	23,013	23.01%	22,607	22.61%	19,874	19.87%

within a particular objective of the government.

6.4 An Aggregate Tax Model

As mentioned before, aggregate models are based on annual tax returns. The model reads individual sets of data obtained from the microsimulation database and performs individual tax calculations based on laws and regulations. As the database is formed by a stratified sample, each observation carries a weight representing the number of tax filers represented by that observation. Calculations of the model have to be adjusted by this weight in order to obtain aggregate revenue estimates. We now describe components of an aggregate model.

Basic Database

The data consists of five distinct components:

(a) historical database of individual tax returns;
(b) weighted historical data of individual tax returns;
(c) growth factors;
(d) historical data base of individual tax returns incorporating respective growth rates; and
(e) weighted historical database of individual tax returns incorporating respective growth rates.

The first component of this database is the compilation of the historical database of individual tax returns. Table 6.6 displays the aggregate database of individual tax returns of Mayo Town. In Mayo Town, there are 8,399 taxpayers. The first record indicates that there are 1,197 taxpayers (male, married) age 66, each with a pension income of $11,895 and each donating $334. The total wage represented in the above data is $1,401,431,943 (=$8,399*166,857).

Table 6.6
Aggregate Database of Individual Tax Returns in Mayo Town

Identifier	Weight	Age	Sex	Martial Status	Children ≤ 6	Children 7-18	Wages ($)	Pension income ($)	Investment income ($)	Self. Emp. Income ($)	Total Income ($)	Donations ($)
1	1,197	66	1	2	0	1	0	11,985	0	839	12,824	334
2	231	15	1	1	0	0	0	0	128	45	173	330
3	729	28	1	1	1	0	75,614	0	0	2,837	78,451	453
4	389	93	1	1	0	0	0	11,800	0	7,977	19,777	696
5	1,444	68	2	1	0	1	0	11,998	0	3,982	15,980	976
6	521	40	1	2	1	1	63,398	0	128	3,298	66,824	494
7	835	69	2	2	0	1	0	570	120	7,081	7,771	913
8	1,151	81	2	1	0	0	0	991	299	1,079	2,369	0
9	1,051	28	1	2	3	1	10,351	0	0	1,319	11,670	832
10	851	21	2	2	2	0	17,494	0	2,564	4,008	24,066	945
Total	8,399						166,857	37,344	3,239	32,465	239,905	5,973

The second component of this module is the weighted historical database. The weighted historical base is the extrapolation of individual tax return information aggregated to present the total for that sample record, as illustrated in Table 6.7.

Table 6.7
Weighted Database of Mayo Town

Identifier	Number of files	Weighted children under 6	Weighted Children 7-18	Weighted wages ($)	Weighted pension ($)	Weighted investment ($)	Weighted self emp. Income ($)	Weighted total income ($)	Weighted donations ($)
1	1,197	0	1,197	0	14,346,045	0	1,004,283	15,350,328	399,798
2	231	0	0	0	0	29,568	10,395	39,963	76,230
3	729	729	0	55,122,606	0	0	2,068,173	57,190,779	330,237
4	389	0	0	0	4,590,200	0	3,103,053	7,693,253	270,744
5	1,444	0	1,444	0	17,325,112	0	5,750,008	23,075,120	1,409,344
6	521	521	521	33,030,358	0	66,688	1,718,258	34,815,304	257,374
7	835	0	835	0	475,950	100,200	5,912,635	6,488,785	762,355
8	1,151	0	0	0	1,140,641	344,149	1,241,929	2,726,719	0
9	1,051	3,153	1,051	10,878,901	0	0	1,386,269	12,265,170	874,432
10	851	1,702	0	14,887,394	0	2,181,964	3,410,808	20,480,166	804,195

The third component of this module is the growth rate structure. These factors grow the appropriate information to the projected year. It must be noted that the database is historical and hence does not represent the current status. These growth factors are necessary to grow the database to represent the current position and to a desired future year. Table 6.8 presents a sample of the growth factors that are used to grow the data to the current or future year.

Table 6.8
Growth Factors in Mayo Town

Population	2%
Wage	3%
Investment	5%
Consumer Price Index	4%

The fourth component uses the above growth rates with appropriate information to help represent the historical database to the current position. For example, using the population growth rate, we can transform the population base data to represent a future year. Similarly, the wage income for a future year is obtained by multiplying the existing wage by the wage growth factor. Table 6.9 shows the grown database.

Table 6.9
Projected Data in Mayo Town

Iden-tifier	Weight	Wages ($)	Pension Income ($)	Investment Income ($)	Self. Emp. Income ($)	Total Income ($)	Donations ($)
1	1,221	0	12,584	0	864	13,448	347
2	236	0	0	134	46	181	343
3	744	77,882	0	0	2,922	80,805	471
4	397	0	12,390	0	8,216	20,606	724
5	1,473	0	12,598	0	4,101	16,699	1,015
6	531	65,300	0	134	3,397	68831	514
7	852	0	599	126	7,293	8,018	950
8	1,174	0	1,041	314	1,111	2,466	0
9	1,072	10,662	0	0	1,359	12,020	865
10	868	18,019	0	2,692	4,128	24,839	983

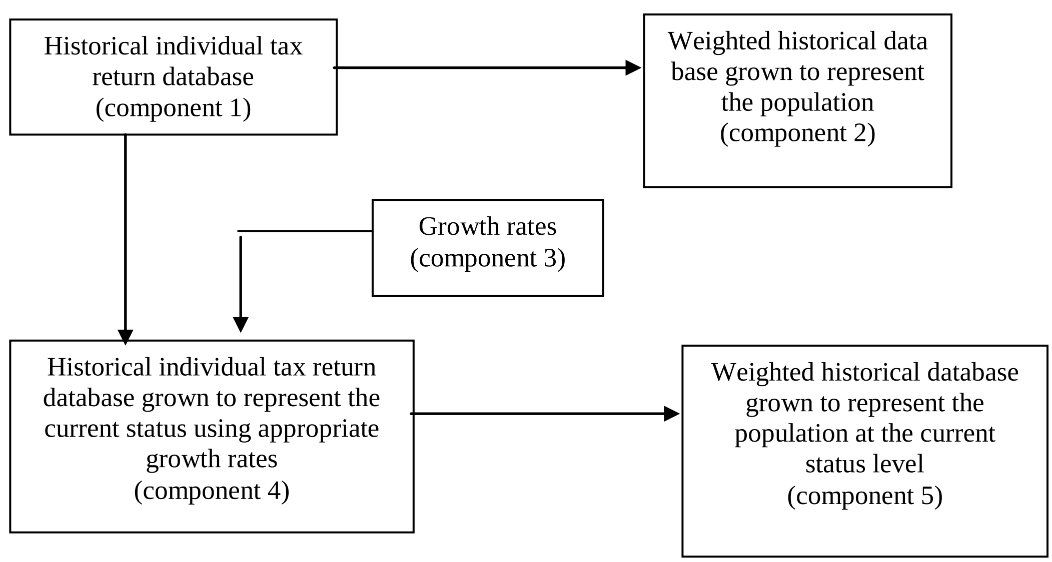
The fifth component of this module takes the historical data base that represents the current situation (the fourth component) and then applies appropriate individual weights to arrive at the total population, as shown in Table 6.10. This process is the repetition of the second component, but uses the historical database that has been grown to represent the current situation.

Table 6.10
The Weighted Projected Database of Mayo Town

SIN	Weight	Children under 6	Children 7-18	Wages ($)	Pension ($)	Investment ($)	Self. Emp. Income ($)	Total Income ($)	Donations ($)
1	1,221	0	1,221	0	15,364,614	0	1,055,100	16,419,714	424,106
2	236	0	0	0	0	31,667	10,921	42,588	80,865
3	744	744	0	57,911,810	0	0	2,172,823	60,084,632	350,315
4	397	0	0	0	4,916,104	0	3,260,067	8,176,172	287,205
5	1,473	0	1,473	0	18,555,195	0	6,040,958	24,596,153	1,495,032
6	531	531	531	34,701,694	0	71,423	1,805,202	36,578,319	273,022
7	852	0	852	0	509,742	107,314	6,211,814	6,828,871	808,706
8	1,174	0	0	0	1,221,627	368,584	1,304,771	2,894,981	0
9	1,072	3,216	1,072	11,429,373	0	0	1,456,414	12,885,788	927,597
10	868	1,736	0	15,640,696	0	2,336,883	3,583,395	21,560,974	853,090

The iteration process of building the basic data module diagrammatically is presented in Figure 6.2.

Figure 6.2
Basic Data Module



One can now link the typical taxpayer module, impact module, and basic data module into one big tax calculator to assess the effects of tax policy changes on the total population.

Once the tax return model and its parameters are set up, the model processes a sample return for each tax-filer. As mentioned above, the sample is taken from the basic database with historical and projected information incorporated into it. The tax liability for each sample record is then calculated using the tax code and linked to the specifications laid down in the table of parameters. The outcomes obtained from this process are then multiplied by the individual record weight. Table 6.11 presents a sample of outcomes from the simulation on the above database when a single rate tax structure of 25 % is introduced to replace multiple rates of 17%, 26 % and 29 %.

Table 6.11 Weighted Projected Data in Mayo Town

Iden-tifier	Taxable income (base)	Taxable income (option)	Tax on Income (base)	Tax on income (option).	Fed. Taxable (option)	Fed. Taxable (option)
1	13,404	13,404	2,279	3,351	(1,020)	(411)
2	173	173	29	43	0	0
3	68,820	68,820	15,581	17,205	13,455	15,254
4	20,118	20,118	3,420	5,030	1,401	3,059
5	15,974	15,974	2,716	3,994	(482)	834
6	61,779	61,779	13,539	15,445	9,412	11,501
7	7,925	7,925	1,347	1,981	(1,020)	(1,020)
8	2,388	2,388	406	597	0	0
9	10,614	10,614	1,804	2,653	(4,689)	(4,287)
10	21,351	21,351	3,630	5,338	(1,094)	665

The simulation process produces as its output either a specific table of distributional impacts by sectors of taxpayers or a data set to be used as a new master file. The distributional impact table is probably the most valuable result, since it provides a summary outcome of tax policy options by clearly identifying winners and losers in each case.

	Table 6.12		
	Distributional Impact		
		Sex	
Income Class	Data	Female	Male
$0-$20,000	Sum of FedTax (Base)	(20,820,701)	(20,571,847)
	Sum of FedTax (OPT)	1,879,523	(6,518,463)
	Sum of Impact	22,700,224	14,053,384
$100,000 and Over	Sum of FedTax (Base)		21,576,144
	Sum of FedTax (OPT)		22,599,726
	Sum of Impact		1,023,582
$20-$40,000	Sum of FedTax (Base)	7,368,426	6,526,518
	Sum of FedTax (OPT)	24,979,063	33,015,838
	Sum of Impact	17,610,637	26,489,319
$40-$60,000	Sum of FedTax (Base)	39,987,589	6,286,113
	Sum of FedTax (OPT)	59,062,878	9,103,373
	Sum of Impact	19,075,289	2,817,260
$60-$75,000	Sum of FedTax (Base)	22,772,044	22,713,251
	Sum of FedTax (OPT)	27,774,691	28,174,999
	Sum of Impact	5,002,647	5,461,747
$75-$100,000	Sum of FedTax (Base)		130,447,329
	Sum of FedTax (OPT)		144,111,819
	Sum of Impact		13,664,490
$100,000 and over	Sum of FedTax (Base)		21,576,144
	Sum of FedTax (OPT)		22,599,726
	Sum of Impact		1,023,582

It can be seen from Table 6.12, that the lower income group is going to be most negatively affected by one single rate proposal. Also, within the same income group, it is the male tax filers who are going to pay more tax. The people in the income group of $100,000 and more are the ones who will benefit more in comparison to other income bracket groups. Though this income group pays more in taxes, its average tax rate is lower than the lower income groups. Such an analysis help policy makers to see impacts quickly so that they can decide where to further fine tune the policies as well as who is the real beneficiary of these policy changes.

The above aggregate model provides a cross-sectional analysis of tax data. However, issues with an inter-temporal dimension require data for more than one year. Micro simulations can also be done for a multi year database. These types of models, described earlier, are known as longitudinal models, and require an extensive database.

6.5 Concluding Remarks

Today powerful computers are being made available for a fraction of their cost a few years ago. With the availability of new powerful programs to run iterative processes, these simulation results have greatly benefited policy analysis. There are several major advantages of micro simulation models:

- Microsimulation models can be operated at an appropriate level of decision making,
- These models can immediately reflect the effects of policy changes on each category by income group or age or sex,
- The models can be used to forecast income tax revenues in future years.

Chapter 7
Corporate Income Tax Models

7.1 Introduction

Microsimulation models can be used to analyze the tax liabilities of individual corporations and to estimate the tax revenue implications for governments under the current tax system and under proposed changes in tax policy. The models can also be used to simulate revenue impacts by sector, assets, income or other categories. These models can be further developed, using appropriate assumptions to forecast tax revenues in future years.

Revenue forecasting of corporate income taxes has never been easy compared with other taxes, given the non-linear features of corporate tax codes. Non-linear effects arise when changes in tax bases of individual corporations are not necessarily subject to the full statutory corporate tax rate, because of the current status of each individual corporation as well as its behavioral response to the external environment. This is due primarily because of the existence of some provisions embedded in tax codes. Examples include net operating loss carry-overs, rules for computing and claiming tax credits, the minimum corporate income tax provisions, capital cost allowances, interest deductions, and tax credit limitations (all of which may or may not apply to all or individual corporations.)[27]

This chapter starts with a simple corporate tax calculator and discusses the effect of key tax parameters on an individual corporate tax liability. Because of data confidentiality at the corporate level, aggregate industry-based data will be used simply to illustrate how simulations can be properly applied.

7.2 Data Development

A microsimulation model is a corporate income tax liability calculator. The model computes business income tax liability according to the corporate laws and regulations of the country in question. As such, the data is based on individual corporate income tax returns compiled yearly by the tax authority.

For analytical purposes, the data used by the model are stratified samples of corporate income tax returns. Samples are extracted from the total corporate income tax returns data files. The data sampling process undergoes the following steps, including the methods used in the selection of tax returns, data cleaning, and data completion.[28]

The first step is the return selection process. In this process, samples are designated on a stratified sampling basis. Each corporation is assigned a unique employer identification number, that is used as the basis for random selection. The tax return files are then categorized by the size of assets, income, a combination of both the size of asset and income, industry, region and so on. Samples should be representative and can be simulated to generate the impact on the nation as a whole. Income is usually defined as the gross proceeds of the corporation. Samples are also selected from different filing periods to account for non-calendar filing and filing extensions.

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[27] Geraldine Gerardi, Hudson Milner, Leslie Whitaker and Roy Wyscarver, "The Treasury Depreciation Model", Office of Tax Analysis, Department of Treasury, Compendium of Tax research 1987.

[28] See, e.g., the U.S. Internal Revenue Service, Corporation Income Tax Returns, (1994).

After completion of this initial process, the second step of data compilation is data cleaning. All files must go through consistency tests in order to identify incongruent records, which are then edited so that the end result is a new clean data series. Examples of non congruencies detected by the data cleaning process are arithmetic errors, incorrect tax data, questionable values (e.g., a bank with an extremely large number for the cost of goods sold) or improper sample codes. Once the data cleaning process is finished, the final step is data completion.

With the data completion process that aims to fill in the missing data, missing data is handled in several different ways. Apart from corporate tax files, two other sources of information are used to derive at the missing data: corporate financial data and imputation data. Corporate financial information is useful for reconciling corporate taxable income with corporate profits before taxes. Imputation data is obtained from calculations made on specialized models used for revenue estimation, such as the depreciation model.

7.3 Microsimulation Models

As previously mentioned, the microsimulation model is a corporate income tax liability calculator which can be used to analyze the tax impact of policy proposals on individual corporations and on the nation as a whole. In order to properly capture the effect of policy options at the individual corporate level, itemized tax models and calculators are needed.

For illustrative purposes, Table 7-1 presents a simple corporate income tax calculator. The amount of income tax payable by each corporation is calculated by the product of the corporation tax base and the corresponding tax rate. The tax base is defined as gross income minus the cost of goods sold, operating expenses, limited entertainment

expenses, interest payments, capital cost allowances, and other allowable expenses stipulated under income tax laws or regulations. Gross income includes sale of goods and services, rents, royalties, interest income and other investment income according to the law.

The model starts with gross income. From the gross income, deductions are made to arrive at the net income. If there is a provision for loss carried forward, the net operating loss in the previous years is subtracted from the net income to arrive at the taxable income in the current year. The taxable income is the base on which the statutory tax rate is applied. In this example, since the net operating loss is $700,000 and the taxable income after the net operating loss is $2,000,000, the tax payable becomes $600,000, given a statutory flat tax rate of 30%. Furthermore, as this firm receives an investment credit of $100,000, the total income tax liability is $500,000.

Table 7.1
A Simple Corporate Income Tax Model
(thousands of dollars)

Gross Income	50,000
Sales of Goods and Services	35,000
Other Incomes	15,000
Deductions	47,300
Cost of Goods Sold	35,000
Capital Cost Allowance	7,500
Interest Payments	800
Overhead Expenses	4,000
Net Income	2,700
Net Operating Loss from Prior Years	700
Taxable Income	2,000
Tax Payable	600
Investment Tax Credits	100
Total Income Tax Payable after Tax Credits	500

The computation of taxable income and tax payable may be straightforward. But what makes forecasting of corporate income tax a challenge is proper modeling of the gross receipts of business activities and the various itemized deduction and credit components that affect the taxable income of a firm under various methods and policy options.

In the next few sub-sections, we first simulate the impact of currency depreciation on the cash flow of a corporation and then discuss some of the key features of the corporate income tax structure which can present important corporate income tax revenue implications in simulations.

A. Impact of Currency Devaluation

An important factor that has to be carefully analyzed in the tax simulations is the effects of any foreseeable currency devaluation on tradable goods and corporate profits. This is especially important for the less developed countries. Examples can be found in the recent financial crises in Thailand, Indonesia, South Korea, the Philippines, Brazil, Russia, and so on. A sudden currency devaluation can influence both corporate profits and the tax liability, depending upon the exposure of the firm to currency devaluation.

Table 7.2 show that a corporation exports 100% of its produce, purchases 30% of its inputs as tradable, and raises 40% of its debt in overseas markets. If the domestic currency is devalued by 10 percent, the gross sales will increase by 10% from $4,000 to $4,400 in local currency. However, as this firm has only 30% of its inputs as tradable, the cost of inputs will increase from $2,000 to only $2,060, while debt will rise from $240 to $249.60. As the increase in the cost of goods is not as large as the increase in sales brought about by the 10% devaluation, the taxable income should increase by $330.4 (from $860 to $1,190.4) and, accordingly, the tax liability will increase from $258 to $357. After-tax profit will also increase from $602 to $833.28.

However, if the firm sells its entire product line in domestic markets and 30% of its business inputs are imported, the cost of goods will increase as a result of the currency devaluation, lowering the taxable income, tax liability, and net profits. Using the same example above, there would be no increase in gross revenue, but an increase in the cost of production brought about by the devaluation. The cost of tradable inputs and interest payments on foreign debt would both increase, thereby reducing the taxable income and tax revenue for the government. Currency devaluation can, therefore, be an important consideration for tax revenue forecasts.

Table 7.2 Impact of Currency Devaluation

~~**Parameters**~~	~~**Base Case**~~ **100 % foreign sales**	~~**Option**~~ **foreign sales** 100%	Impact	~~**Base Case**~~ **100% domestic sales**	~~**Option**~~ **100% domestic sales**	Impact
Currency Devaluation		10%			10%	
Gross Sales	4,000.00	4,400.00	400.00	4,000.00	4,000.00	0
Tradeable Goods	4,000.00	4,400.00		-	-	
Non-Tradeable Goods	-	-		4,000.00	4,000.00	
Total Business Inputs	2,000.00			2,000.00		
% of Tradeable Inputs	30%			30%		
Wages and salary	400.00			400.00		
Total Interest Payments	240.00			240.00		
Debt Foreign	40%			40%		
Interest Rates (Foreign)	6%			6%		
Interest Rates (Local)	6%			6%		
Depreciation	500.00			500.00		
Gross Sales	4,000.00	4,400.00	400.00	4,000.00	4,000.00	0
Costs of Goods Sold	3,140.00	3,209.60	69.60	3,140.00	3,209.60	69.60
Total Business Inputs	2,000.00	2,060.00	60.00	2,000.00	2,060.00	60.00
Tradeable Inputs	600.00	660.00		600.00	660.00	
Non-Tradeable Inputs	1,400.00	1,400.00		1,400.00	1,400.00	
Wages and Salaries	400.00	400.00	0	400.00	400.00	0
Depreciation	500.00	500.00	0	500.00	500.00	0
Total Interest Payments	240.00	249.60	9.60	240.00	249.60	9.60
Interest (Foreign)	96.00	105.60		96.00	105.60	
Interest (Local)	144.00	144.00		144.00	144.00	
Taxable Income	860.00	1,190.40	330.40	860.00	790.40	(69.60)
Tax Liability	258.00	357.12	99.12	258.00	237.12	(20.88)
Net Profits	602.00	833.28	231.28	602.00	553.28	(48.72)

B. *Capital Cost Allowance*

The issue of depreciation allowances is a major one in corporate taxation, given its effect on the behavior of enterprises over the short and long terms. Evaluating the impact of depreciation on corporate income tax liabilities can also be influenced by the use of alternative tax depreciation rules.

Depreciation expenses are deducted over a length of time, and the amount is determined by rules in the tax code. These depreciation deductions are known as capital cost allowances, which means that these are capital expenses incurred during the fiscal year. Since these represent costs of the assets used to generate the business income, the expenses for depreciation are deducted from the gross income to calculate the taxable income. The greater the amount of depreciation, the lower is the taxable income. The earlier the deductions taken, the greater is the savings for the taxpayer. Therefore, the timing and amount of the expenses allowed for deduction are equally important.

The length of the investment recovery period for tax purposes is, in principle, set in line with the asset's useful life period, which is determined by the tax guidelines. Thus, the impact of depreciation deductions on tax liability depends on both the tax rate and on the timing of these deductions.

The amount of depreciation is also determined by using particular depreciation methods such as straight line, accelerated, double declining, or sum-of-the-years'-digits methods. The straight-line depreciation charges an equal amount in each year. The accelerated depreciation permits a taxpayer to write off relatively more of the capital cost in the early years. The double declining method doubles the straight-line rate of depreciation in the first year and then applies the rate to the remaining depreciable cost each year. The sum-of-the-years'-digits method is another type of accelerated depreciation. For example, if the useful life of an asset is ten years, a sum of years over the ten-year period is 55. The depreciated amount in the first year equals 18.18% (i.e., 10/55) of the capital outlay. The percentages will decline over time from 16.36% (i.e., 9/55) in the second year to 14.55% (i.e., 8/55) in the third year, and so on. Numerical examples are shown in Table 7.3.

Microsimulation analysis provides a useful tool for modeling different depreciation rules and assessing their impact on the corporate income tax liability. The modeling of depreciation allowances is based on the amount of total investment for each type of asset within a particular industry, as well as the depreciation rules set by law.

Table 7.3
Depreciation Schedule

Year	1	2	3	4	5	6	7
Straight line							
3 year	0.3333	0.3333	0.3333				
5 year	0.2000	0.2000	0.2000	0.2000	0.2000		
7 year	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429
Accelerated method							
3 year	0.3333	0.4445	0.1481	0.0741			
5 year	0.2000	0.3200	0.1920	0.1152	0.1152	0.0576	
7 year	0.1429	0.2445	0.1749	0.1249	0.0893	0.0893	0.0893
Accelerated Method: (Double - declining method)							
3 year	0.6667	0.2222	0.0741	0.0247	0.0082	0.0027	0.0009
5 year	0.4000	0.2400	0.1440	0.0864	0.0518	0.0311	0.0187
7 year	0.2857	0.2041	0.1458	0.1041	0.0744	0.0531	0.0379
Accelerated Method: The Sum-of-the-years -digits							
3 year	0.5000	0.3333	0.1667				
5 year	0.3333	0.2667	0.2000	0.1333	0.0667		
7 year	0.2500	0.2143	0.1786	0.1429	0.1071	0.0714	0.0357

Example 1

Suppose that one is evaluating alternative depreciation rates and methods. The current tax code allows corporations to depreciate a particular kind of asset on a straight-line basis over a five-year period. Table 7-3 provides the depreciation schedule with alternative depreciation methods and rates.

Table 7.3 shows clearly that the tax savings is greater if an accelerated method is used so that the duration of the depreciated asset is shorter. Accordingly, the present value of tax liabilities declines as depreciation rates become larger, since investments are recovered more quickly.

Example 2

Table 7.4 shows that an investment of $3,000 is made in the year 0 by a representative firm of a given industry. Based on annual tax returns extracted from the master file, a net taxable income profile before depreciation is projected for an eight-year period. For each depreciation method, the corporate income tax liability can be modeled through time.

The depreciation schedules are usually specified under the assumption that new investments made in any fiscal year are in service for six months in that year. The convention is to assume one half reduction of the normal depreciation rate for the investment year and the remaining half in the final year, as illustrated in Table 7.4.

Suppose that tax liabilities are discounted at a 10% rate in order to obtain a single present value for the depreciation allowance for each alternative depreciation method. These results are shown in Table 7.4. It is clear that as investment recovery periods become longer, the tax savings for corporations get smaller and the present value of tax collection to the revenue authorities gets larger. Also, the present value of tax liabilities from a straight-line depreciation over five years is equivalent to that from a seven year accelerated depreciation.

Table 7-4

The Impact of Alternative Depreciation Methods on Tax Liabilities

Investment = 3000

Year	0	1	2	3	4	5	6	7	8
Straight Line (3 years)									
Net taxable income before depreciation		2500	3400	5100	5050	5300	5400	5500	6000
Depreciation		500	1000	1000	500				
Net taxable income.		2000	2400	4100	4550	5300	5400	5500	6000
Corporate Income Tax @34%		680	816	1394	1547	1802	1836	1870	2040
NPV tax flow @ 10%	$7,463.07								
Straight Line 5 years									
Net taxable income before depreciation		2500	3400	5100	5050	5300	5400	5500	6000
Depreciation		300	600	600	600	600	300		
Net taxable income.		2200	2800	4500	4450	4700	5100	5500	6000
Corporate Income Tax @34%		748	952	1530	1513	1598	1734	1870	2040
NPV tax flow @ 10%	$7,532.00								
Straight Line 7 years									
Net taxable income before depreciation		2500	3400	5100	5050	5300	5400	5500	6000
Depreciation		214	429	429	429	429	429	429	214
Net taxable income.		2286	2971	4671	4621	4871	4971	5071	5786
Corporate Income Tax @34%		777.24	1010.1	1588	1571	1656.1	1690	1724.1	1967
NPV tax flow @ 10%	$7,592.57								
Accelerated 3 years									
Net taxable income before depreciation		2500	3400	5100	5050	5300	5400	5500	6000
Depreciation		1000	1334	444	222				
Net taxable income.		1500	2066	4656	4828	5300	5400	5500	6000
Corporate Income Tax @34%		510	702.44	1583	1642	1802	1836	1870	2040
NPV tax flow @ 10%	$7,421.26								
Accelerated 5 years									
Net taxable income before depreciation		2500	3400	5100	5050	5300	5400	5500	6000
Depreciation		600	960	576	346	346	173		
Net taxable income.		1900	2440	4524	4704	4954	5227	5500	6000
Corporate Income Tax @34%		646	829.6	1538	1599	1684.4	1777	1870	2040
NPV tax flow @ 10%	$7,481.23								
Accelerated 7 years									
Net taxable income before depreciation		2500	3400	5100	5050	5300	5400	5500	6000
Depreciation		429	735	525	375	268	268	268	134
Net taxable income.		2071	2665	4575	4675	5032	5132	5232	5866
Corporate Income Tax @34%		704.14	906.1	1556	1590	1710.9	1745	1778.9	1994
NPV tax flow @ 10%	$7,533.82								

It may be noted that the cost of land may not be deducted at all, since it is not considered to be a depreciating asset. Nevertheless, the cost of improvements to land can generally be deducted as a depreciation expense over the life of the improvement.

At the macro level, depreciation policy proposals can also be evaluated through the simulation models based on the amount of total investment estimated by types of asset for different industries. In this case, a forecast of depreciation is necessary and would be determined by investment projections estimated by industry and by type of asset. The investment estimations should be made in accordance with general macroeconomic forecasts for the nation as a whole.

In so doing, data input for this type of model consists of investment data series by industry and by asset type, which may be obtained from various sources, such as national accounts, surveys of investment intent in plant and machinery and equipment expenses. Once the investment data file is set up, one can simulate those investments that may be deducted by corporations as depreciation allowances in accordance with the tax codes. An adjustment should be made for separating corporate from non-corporate investments, investment undertaken by non-profit organizations, and so on. This adjustment is necessary, if the models are to simulate what would be the impact on corporate income tax of a policy switch from one method of depreciation to another.

C. Net Operating Loss Carry-Overs

The reason for having loss carry-over allowances is based on the income averaging to avoid discrimination against risk-taking investments by corporations. For revenue forecasting purposes, loss carry-over effects should be appraised considering blocks of several fiscal years since corporate income tax changes may have a multi-yearly effect. Furthermore, changes in corporate taxable income of a particular year may have a non-linear effect on revenue receipts for the same year. Loss carry-overs may also influence the tax liabilities and government revenues for different fiscal years.

Like capital cost allowances, loss carry-over allowances affect timing of corporate income tax revenues. This is especially important when recession has just ended because of cumulative losses over years.

There are basically three ways in which the carry-over of net operating loss (NOL) may affect corporate income tax revenues:

- NOL generated in the current year is carried back to offset tax liability of previous years;
- NOL generated in prior years is carried forward to offset the current year's tax liability; and
- NOL generated in the current year is carried forward to offset future years' tax liability.

When NOLs are carried back, corporations are entitled to receive a refund. In the case of carry forward, NOLs are deferred to future taxable income with a lower present value.

Table 7.5 provides the same net taxable income profile over a seven-year period for a corporation. It then shows the impact on different cash flows under different net operating loss carry-over schemes. Assume three different carry-over allowances are simulated.

In the case of carry-back allowances, a net operating loss suffered in year 0 is applied to offset taxable income of three previous years. On a straight carry-back allowance basis, the corporation should receive a refund in year 0 equal to the

Table 7-5

Net Operating Loss Modeling

Year		-3	-2	-1	0	1	2	3
Discount Rate	10%							
Discounting Factor		0.75	0.83	0.91	1	1.1	1.21	1.33
Carry-back allowance								
Net taxable income		1300	2200	1500	-10000	1500	2200	1300
Corporate income tax @ 34%		442	748	510	-3400	510	748	442
Net operating loss (NOL)					-10000			
NOL carried back		1300	2200	1500	-5000			
Change in income		-1300	-2200	-1500				
Tax refunds @34% (year 0)		-442	-748	-510	-1700			
Total NOL carried back	5000							
PV (year 0) @10%	5,000							
Total Tax refunds	1700							
PV (year 0) @10%	$1,700							
Carry-forward allowance								
Net taxable income		1300	2200	1500	-10000	1500	2200	1300
Corporate income tax @ 34%		442	748	510	-3400	510	748	442
Net operating loss (NOL)					-10000			
NOL carried forward					-5000	1500	2200	1300
Real term year (0)						1364	1818	977
Change in income						-1500	-2200	-1300
Tax offset@34% (year 0)						-510	-748	-442
Total Tax refunds	1700							
PV (year 0) @10%	$1,414							
Carry back-forward allowance								
Net taxable income		1300	2200	1500	-10000	1500	2200	1300
Corporate income tax @ 34%		442	748	510	-3400	510	748	442
Net operating loss (NOL)					-10000			
NOL carried back/forward		1300	2200	1500	-10000	1500	2200	1300
Real term (year 0)		1730	2662	1650	0	1364	1818	977
Change in income		-1300	-2200	-1500		-1500	-2200	-1300
Tax refunds and Offset@34% (year 0)						-510	-748	-442
Total Tax refunds	3400							
PV (year 0) @10%	$3,114							

amount of taxes paid in previous years, and then the taxpayer is liable to tax payments in future years until the total NOL is fully depleted. The corporation is therefore liable to tax payments in the next three years period during which positive taxable income is assessed.

Second, we consider the case of the carry-forward allowance. Taxes paid by the corporation before the loss is assessed are not refundable. However, NOL in year 0 is used to offset taxable income for three coming years. Therefore, the corporation is not liable for any tax payments in year zero and for the next three years.

Third, the example displays the total effect of a full NOL carry-over when the total net operating loss occurs in year zero, offsetting all taxable income assessed through the seven-year period.

As evident from the results in Table 7-5, NOL deferred to future years has a relatively lower present value. Considering NOL applied to offset the same taxable income assessed in years 3 and -3 under a full carry back/forward allowance basis, the loss carry back has a real value of $1,730 for year 0, while the real value for year 3 is only $977.

In summary, in cases where deductions exceed taxable income and NOLs are generated, the real value of deductions is maximized and the present value of tax receipts to government is reduced when the carry-back averaging method is allowed. This effect must be taken into consideration by corporations in investment decision making and by governments in forecasting future tax revenues.

As mentioned earlier, microsimulation models are based on stratified samples taken from the individual annual tax returns. The tax liability for each sample is calculated using the tax laws and regulations. The results can be further complicated by minimum tax provisions in some countries. For example, Mexico imposes an asset tax, a kind of minimum income tax. It is imposed on the net asset value at the 1.8% rate. The tax liability of a firm is the greater of the corporate income tax and the asset tax. In addition, when the income tax is more than the asset tax, the excess amount can be considered as tax credits for the next ten years.[29] The above results are then multiplied by sampled weights to arrive at the total tax revenues for the country as a whole. The key for forecasting well is proper modeling of the behavioral response of each representative firm in a rational way using its financial profiles over recent years.

Example:

Individual corporate tax returns are difficult to obtain, because of the issue of data confidentiality at the corporate level. For illustrative purposes, an industry aggregate of tax return data taken from U.S. corporate statistics is assumed to be an individual corporation as shown in Table 7.6. In the base case, the total receipts amounted to $893,992,210. After subtracting various deductions, taxable income becomes $21,737,337. With progressive tax rates ranging from 15% to 35% under the current tax system, the corporate income tax amounted to $3,108,068. Because of an investment tax credit of $682,079, the amount of tax payable after credits was $2,425,989.

One can use the model to simulate revenue implications if a flat tax rate of 30% is imposed on income in excess of $5 million. As seen in Table 7.6, the tax liability of the corporation would increase from $2.43 million to $4.34 million.

[29] S. van Wijnbergen and A. Estache, "Evaluating the Minimum Asset Tax on Corporation: an Option Pricing Approach," Journal of Public Economics, (1999).

Table 7.6
Corporate Income Tax Simulation Model
(dollars)

Table of Tax Parameters

	Income	Rates	Income	Rates
Corporate Tax Rate				
Income Range	-	15%	-	0%
	10,000,000	25%	5,000,000	30%
	20,000,000	35%	20,000,000	30%
Depreciation Schedule				
Durable Equipment		8		8
Structure		18		18

Corporate Tax Return	Base	Option
Total Assets	391,652,292	391,652,292
Depresiable Assets	84,869,065	84,869,065
Less: Accumulated Depreciation	43,992,518	43,992,518
Land	5,788,707	5,788,707
Other Assets	344,987,038	344,987,038
Total Liabilities	391,652,292	391,652,292
New Investment	0	6,820,786
Total Receipts	893,992,210	893,992,210
Business Receipts	871,691,735	871,691,735
Other receipts	22,300,475	22,300,475
Total Deductions	872,254,873	872,254,873
Costs of Sales and Operations	720,921,810	720,921,810
Compensation of Officers	13,768,857	13,768,857
Taxes Paid	10,036,224	10,036,224
Interest Paid	14,231,531	14,231,531
Depreciation	7,660,854	7,660,854
Other Deductions	105,635,597	105,635,597
Total Receipts less Total Deductions	21,737,337	21,737,337
Net Operating Loss Deduction	0	0
Income Subject to Tax	21,737,337	21,737,337
Corporate Income Tax	3,108,068	5,021,201
Investment Credit	682,079	682,079
Total Income Tax after Credits	2,425,989	4,339,123

7.4 Macroeconomic Forecasting Models

Another approach to estimate corporate income tax liabilities or revenues for governments is macro-based modeling.[30] This approach is essentially to forecast corporate taxable income and corporate income tax liabilities by regression analysis. Corporate income tax liabilities are estimated by multiplying corporate taxable income and the weighted average corporate income tax rate, and then deducting various credits stipulated under the Income Tax Act. In the case of Canada, the Large Corporations Tax is further added to income tax liabilities in order to obtain total corporate tax liabilities or revenues for governments.

The key variable for determining corporate income tax liabilities is corporate taxable income which is, in turn, derived from applying a series of adjustments to book profits before taxes. Data on book profits before taxes are normally available from either the tax authority or statistics bureau. This data, however, is usually adjusted and reconciled with the estimates of corporate taxable income published regularly by the national statistics bureau, as in Canada.[31] Adjustments may include excess of capital cost allowance over book depreciation, exploration and development expenses, current year net operating losses (which may be used to lower taxable income in future years) prior year net operating losses (used to reduce taxable income in the current year) resource allowance, net taxable capital gains and allowable losses reported for tax purposes, as well as the impact of base-broadening measures introduced in various tax reforms or budgets. Time series of corporate taxable income are adjusted for all the years of the study period to reflect the same tax base.

[30] See, e.g., Department of Finance Canada, Fiscal Policy Division, "Corporate Income Tax Forecasting Model", (May 1992).

[31] Statistics Canada, Corporation Taxation Statistics, (Catalogue 61-208 Annual), and "Reconciliation of Book Profit to Taxable Income and Income Taxes" in Table 1.

For the purpose of forecasting, each of the above adjustment items to corporate profits before taxes is included in the regression analysis, which may be expressed as follows:

$$T(i) = F[E(i), Y(i), K(i-1), Q(i), P(i)]$$

where T(i): adjustments made to corporate profits in determining taxable income;
E(i): qualifying expenditures in the current year;
Y(i): qualifying income in the current year;
K(i-1): stock of the unused portion of deductions carried forward;
Q(i): policy dummy variable.
P(i): profitability term.

The current-year qualifying expenditures (E) and qualifying income (Y) are included to account for certain types of expenditures and income deducted from or added to taxable income. The term K(i-1) is added to represent the previous year's net operating losses claimed in the current year and/or the unused portion of net operating losses carried forward to reduce the future taxable income. Important policy or economic changes are incorporated into the model as dummy variables. Finally, the profitability term captures the corporation's ability to utilize a larger or smaller portion of its allowable deduction as its profitability position improves or deteriorates.

Estimates of the above various reconciliation items are added or deducted from corporate profits before taxes in order to arrive at the estimated corporate taxable income in this model. The corporate taxable income is considered to be the corporate income tax base.

An equation of corporate income tax liabilities is further specified as a function of corporate taxable income times the weighted average corporate income tax rate, and then adjusted for various tax credits.[32] The equation has to be stochastic rather than an identity, in order to take into account factors such as imprecise additions or deductions to the above estimated taxable income and the behavioral response of corporations.

This macroeconomic model provides a highly aggregate forecasting tool for corporate income tax liabilities without industry or asset-wide details. The tax base also limits the modeling capability of the various policy options. Nevertheless, it is an alternative tool to forecast corporate tax revenues for the country as a whole.

[32] In the case of Canada, tax credits may include the general investment tax credit, the scientific research tax credit, the exploration tax credit, and the Cape Breton investment tax credit.

Appendix

Stacking Order

The correct interpretation of tax revenue information containing more than one estimated figure requires a careful consideration of the order in which total revenue estimation is computed. A clear determination of the "stacking order" used to present revenue estimations is important for avoiding potential misleading analyses.

There are three basic ways to present revenue estimation proposals:

(a) Stacking First: Each policy proposal is estimated separately and then compared with current legislation figures;

(b) Stacking Last: Each policy proposal is estimated assuming all other proposals are already considered in law;

(c) Stacking Up: Proposals are estimated using a sequential order in which each one assumes that previous proposals are already considered in law.

Even though different tax proposals are estimated separately to raise the same revenues, the final interaction effect is likely to be different depending on the stacking order adopted for evaluating each proposal.

Example

Consider the following tax system:

- Income base: 1000
- Tax rate: 40%
- Credits: Offset 10% of tax liability

Under the current system, tax revenue equals: (1000 * 0.4) * (1-0.1) = 360

Now, consider the following policy proposals:

- Expand income base to 1500
- Cut tax rate to 30%
- Repeal all tax credits

Under the proposed system, tax revenue equals: (1500 * 0.3) = 450

Change in revenue is: Δ = 450 - 360 = 90

At the time of presenting the revenue estimates results and for assessing the impact of each proposal, the effects of different stacking orders is summarized in the following table.

The package proposal has a different impact on the total revenue collection when evaluated separately in different stacking order. Nevertheless, the marginal effects for different stack orders add up to the same amount. To avoid misinterpretations and bias in policy analysis, analysts agree to set a specific stacking order sequence when presenting revenue estimation summary tables. For example, the ordering pattern used by US officials during the 1988 tax reform to stack-up corporate income tax proposals was the following: rate changes, credit changes, capital recovery, base broadness and at the end minimum tax proposals. However, the general pattern used to evaluate some other taxes was the “stacking last” criteria.

Stacking order

			Total Revenue	Marginal Revenue Change
1	Reduce rates	(1000 * 0.3) * (1- 0.1)	270	-90
2	Repeal credits	(1000 * 0.3)	300	30
3	Broaden base	(1500 * 0.3)	450	150

Change in revenue: **90**

1.	Repeal credits	(1000 * 0.4)	400	40
2.	Broaden base	(1500 * 0.4)	600	200
3.	Reduce rates	(1500 * 0.3)	450	-150

Change in Revenue: 90

1.	Broaden base	(1500 * 0.4) * (1-0.1)	540	180
2.	Reduce rates	(1500 * 0.3) * (1-0.1)	405	-135
3.	Repeal credits	(1500 * 0.3)	450	45

Change in revenue: 90

Chapter 8
Value-Added Tax Models

8.1 Introduction

The value-added tax has been adopted increasingly by countries around the world.[33] This is especially true in developing countries, where governments are replacing turnover tax and some excise taxes with the consumption-type value-added taxes (VAT), because of the growing concern about economic efficiency and tax simplicity in a competitive and integrated world economy.[34] The main argument for switching over to this form of tax is that VAT is a stable source of revenue and it allows for collection of taxes in an efficient manner.

The potential tax revenue of a VAT depends very much upon the scope of the tax base, the tax rate, and the general level of tax compliance. The tax base is determined by the extent to which goods and services are covered under the VAT. Besides the tax base, the complexity of the tax system and the effectiveness of the tax administration can also influence the degree of compliance.

In this chapter, we first describe the fundamental credit invoice mechanism under the VAT system and the revenue implications when exceptions occur. We then present detailed models to simulate and forecast tax revenues.

[33] At present, 118 countries have implemented value added tax systems. The U.S. is the only industrial country in the world without having a value added tax. Part of the reasons is that the U.S. has retail sales tax systems at the state level and they are very effective in tax administration.

8.2 A Credit Invoice System

VAT is a multi-stage sales tax system wherein tax is applied to all sales of goods and services at all stages of production and distribution. With the consumption-type VAT, vendors charge a tax on sales and receive credits for taxes that were paid on the purchases of business inputs used in the production of taxable sales. Table 8.1 illustrates the business transactions with VAT at a single 8% rate, while the price of sales is assumed to be tax-exclusive.

Table 8.1

VAT on Furniture Production and Trade Distribution
(dollars)

	Purchases	Sales	Value Added	Tax on Sales	Input Tax Credit	Net Tax
	(1)	(2)	(3)	(4)=(2)*8%	(5)=(1)*8%	(6)=(4)-(5)
Forester	0	250	250	20	0	20
Logger	250	350	100	28	20	8
Sawmill	350	450	100	36	28	8
Manufacturer	450	800	350	64	36	28
Retailer	800	1,000	200	80	64	16
Total	-	-	1,000	228	148	80

In the above example, the forester sells the logs to the logger for $250. The value added by the forester in his production is $250 if he has no business inputs other than his own labor. In the next stage, the input to the logger is $250, and the processed log is sold to the sawmill for $350. Although the logger collects $28 of the tax on sales, he also receives an input tax credit of $20, the amount on his inputs used to produce the log. Under the VAT system, the net tax remitted by the logger to the tax authority would be only $8. This is the same amount of the tax paid that is levied on the value

[34] Glenn P. Jenkins and Chun-Yan Kuo," A VAT Revenue Simulation Model for Tax Reform in Developing Countries", Harvard University Development Discussion Paper No. 522 and Taxation Research Series No. 26, (December 1995), and a revised version (September 1997)

added by this vendor. The same process applies to the sawmill, the manufacturer and the retailer. The total VAT collection will be $80 (=20+8+8+28+16).

The key in this tax system is that vendors in each production and distribution stage are credited for the taxes paid on inputs used to produce taxable goods or services. What is not credited or refunded is the tax that is imposed on sales to final consumers. Therefore, under the VAT system, sales on final consumption end up being taxed, which is, in fact, equivalent to the single stage retail sales tax that is, the tax on final sales at the retail level (i.e., 80 = 1,000* 8%). Hence, this tax system is essentially the same as a pure retail sales tax on final consumption, but administered differently.

As the size of the tax base is dependent upon the scope of the sector or goods and services included in the tax system, the VAT system is generally loaded with tax exemptions and zero-rated goods and services that affect the tax base. These measures arise because of various political and socio-economic considerations, administrative reasons, and technical obstacles. The level at which tax exemptions are given and the number of goods and services that are zero-rated determine the scope of the tax base. However, with the enactment of these two categories at different levels of the production and distribution chain, the revenue implications are quite different.

Since virtually all VAT jurisdictions impose the tax at a destination principle, imports are taxed in the same way as domestically produced goods, and exports are not subject to tax. The vendors are all credited for taxes paid on their inputs. Zero-rated exports are always considered part of the consumption-type VAT system.

Under the VAT, most zero-rated goods consist of primary agricultural produce, books, children's clothes and footwear. As previously mentioned, zero-rated means that the VAT is not levied on the selling price of these items, however, the vendor receives full credit for the taxes paid on his business inputs. For example, if the zero rating happens to be in the second stage, firm two charges no sales tax but receives all the input credits, as shown in Table 8.2A.

Table 8.2. A

Revenue Implications of Zero rated at second stage

	Tax on sales	Input Tax credit	Net Tax
Firm one	20	0	20
Firm two	**0**	20	-20
Firm three	36	0	36
Firm four	64	36	28
Firm five	80	64	16
Total	**200**	**120**	**80**

Table 8.2.B

Revenue Implications of Zero rated at last stage

	Tax on sales	Input Tax credit	Net Tax
Firm one	20	0	20
Firm two	28	20	8
Firm three	36	28	8
Firm four	64	36	28
Firm five	**0**	64	-64
Total	**148**	**148**	**0**

If zero-rated products or sectors occur in intermediate stages of the production and distribution chain, the system will pick up VAT where it left off. The revenue implication is that firm three, in our example, will not have any input tax credit to deduct any subsequent tax due, since it did not pay tax on its purchase. However, if the zero-rating is at the retail level (i.e., firm five), the government will not collect any revenue, and there will be no tax burden on consumers as presented in Table 8.2B. Thus, the amount of revenue collection for the government depends also on the stage of the production process on which the zero-rating is levied. The measure may have some cash flow implications for taxpayers.

In contrast to zero-rating, an exemption under VAT has different revenue implications for the government, as no credit is provided to the vendor for VAT paid on its purchases of business inputs. Exemptions can also be levied at all levels of the distribution chain and can have different revenue implications. For administrative simplicity, the government usually exempts small traders.[35] Domestic sales of banking services and risk pooling of insurance services are also exempted, because of technical difficulties in taxing them.[36] When these goods and services are exempted, VAT is not applied to their sales. Unlike a zero-rating, however, the firm does not receive any input tax credit under the exempt system.

If an exemption is placed in the intermediate level, for example in firm two, the firm does not charge tax on sales. Nor does it receive any input tax credit. The VAT system will pick up the tax where the chain is broken and collect even more revenue. More revenue arises at the next stage, as the firm does not have a credit for the input tax that is embodied in part of the purchase price, thus yielding more tax revenue for the government. In other words, there is a cascading effect, for the government collects more revenue than it otherwise would as shown in Table 8.3A.

Table 8.3A
Revenue Implications of Exemption of second stage

	Tax on sales	Input Tax credit	Net Tax
Firm one	20	0	20
Firm two	**0**	**0**	**0**
Firm three	36	0	36
Firm four	64	36	28
Firm five	80	64	16
Total	**200**	**100**	**100**

Table 8.3B
Revenue Implications of Exemption at last stage

	Tax on sales	Input Tax credit	Net Tax
Firm one	20	0	20
Firm two	28	20	8
Firm three	36	28	8
Firm four	64	36	28
Firm five	**0**	**0**	**0**
Total	**148**	**84**	**64**

If the exemption is at the final retail sales, as in firm five, the tax on sales will not be collected, but the government will still have tax revenues collected from the previous

[35] Small traders are usually exempted, as there are just too many of them contributing a very insignificant amount of total VAT revenue. At the same time, the processing of small retailers take too much time for the administrative system to be cost effective.

stages of the production and distribution chain, since the input taxes paid by the retailer are not credited, as shown in Table 8.3B.

8.3 Alternative Approaches to Estimate the VAT Base

There are three approaches to the estimation of the VAT base.

Aggregate Approach

The first approach is the National Accounts Approach. Starting from the Gross Domestic Product (GDP), the VAT base is estimated by subtracting exports and adding imports to reflect the domestic consumption following the destination principle. Considering the fact that the consumption-type of VAT excludes wages and salaries paid to public servants and allows businesses to have an input tax credit for capital investment, the base should also be reduced by the amount of fixed gross capital formation. Further adjustments to the base are made to account for zero-rated and exempt goods and services. For exempt goods and services, cascading effects should also be accounted for.

Residential construction is an important sector in the economy. While buying a house may represent a major investment for households, the flow of services provided by the house is a part of consumption and, accordingly, should be included in the tax base. For conceptual simplicity, taxing the new house is in fact equivalent to the present value of taxing the housing services over the life of the house.

[36] New Zealand and Singapore are the only countries that tax the underwriting activity of general insurance. Nevertheless, there are methods proposed to tax financial intermediation and insurance services. See, e.g., S.N. Poddar and M English, "Taxation of Financial Services under a VAT: Applying the Cash-Flow Approach", Tax Policy Services Group, Ernst & Young, Toronto, (March 1993); and A Schenk, "Taxation of Financial Services under a Value-Added Tax: A Critique of the Treatment Abroad and the Proposals in the United States", Tax Note International, (Sptember 1994).

The basic methodology for estimating the VAT base under the aggregate approach can be expressed as follows:

Starting point:

GDP = Consumption + Gross Capital Formation
+ Government Expenditures + Exports – Imports

Subtract:

- Trade Balance (i.e., Exports – Imports)
- Gross Capital Formation
- Wages and Salaries in Government Sector
- Private and Government Expenditures Abroad
- Wages and Salaries Paid to Public Servants
- Zero-rated Consumption Expenditures
- Exempt Consumption Expenditures
- Imputed Rents for Owner Occupied Dwellings
- Commodity Indirect Taxes Replaced by VAT

Add:

- Business Inputs Purchased by Exempt Sectors
- New Residential Construction

This approach was used to estimate potential VAT revenue by the U.S. Department of the Treasury in 1984.[37] The International Monetary Fund also used the same approach to estimate the revenue potential of the VAT for numerous countries.[38]

[37] Department of Treasury in the U.S., Tax Reform for Fairness, Simplicity, and Economic Growth, Volume 3, Value-Added Tax, The Treasury Department Report to the President, (November 1984).

[38] See, e.g., H.H. Zee and J.P. Bodin, "Aspects of Introducing a Value-Added Tax in Sri Lanka", paper prepared for the International Monetary Fund, Fiscal Affairs Department, (August 1992).

Sectoral Approach

With this approach, the tax base is estimated by adding the value added generated by each sector in the economy. Starting with the sector output, one has to first net out the intermediate inputs, capital purchases, imports and exports for each respective sector. Various adjustments for zero-rated or exempt commodities are also made in order to arrive at the value added base by sector.

Measurement of the VAT base for each sector can be summarized as follows:

Tax Base = Sales (Gross Product Adjusted for Imports, Exports and Inventories)
– Sales of Zero-Rated or Exempt Goods
– Purchases of Intermediate Inputs
– Purchases of Capital Goods
+ Purchases of Inputs to Produce Exempt Goods
– Commodity Taxes Replaced by VAT

The results provide the sectoral impact. However, there is a practical difficulty in constructing the tax base following this approach due to lack of available data for exports and imports broken down by sector.

Input Output Approach

Under the input-output approach, the tax base is estimated by employing the equivalence of the value added tax base to a retail sales tax levied on the final selling price of goods and services. The starting point for constructing the VAT base is the detailed information available for domestic consumption, which can be obtained by netting the personal and government expenditures abroad from their total expenditures contained in the final demand matrix of the Input-Output tables.[39] Only those domestic expenditures in the final demand categories that are meant for personal and government use, not those for the further production of goods and services for commercial purposes, are considered as final consumption for constructing the VAT base.

The methodology to construct the base under this approach is summarized as follows:

Starting point:

Detailed domestic consumption expenditure by goods and services

Subtract:

- Zero-rated goods and services
- Exempt goods and services
- Adjustments for exempt business activities
- Commodity indirect taxes to be replaced
- Other adjustments

This approach provides a useful analytical tool for quantifying revenue implications of various tax measures. It can also be used for analyzing the tax incidence and one-time price effect of the introduction of the VAT.

8.4 Input-Output Model Simulations

The input-output approach is adopted in this chapter. In this section, we first describe the database and then develop models for revenue simulations.

[39] A detailed description of the input-output tables can be found in Statistics Canada, The Input-Output Structure of the Canadian Economy, 1961-81, Catalogue 15-510, (December 1987).

Database

The approach relies heavily upon input-output (I-O) tables for constructing the tax base. Other data sources, however, are often used as complementary sources of information, including national accounts, survey statistics (such as family expenditure surveys), trade margins and annual economic growth rates by sector.

I-O tables are generally broken down into three basic components: the “make” matrix; the “use” matrix; and the “final demand” matrix. The "make" matrix provides a description of various commodities produced by each industry valued at producers’ prices. The “use” matrix details total commodity inputs -- including intermediate inputs and primary inputs -- used by each industry in order to generate output in each industry. The “final demand” matrix contains commodity details for various final expenditure entities/categories. These expenditure categories include personal expenditures, business investments, government expenditures (current and capital expenditures), exports and imports, and government revenues from the sales of goods/services. These final demand expenditures can be used to calculate GDP with the expenditure approach.

One can also calculate the GDP from the income approach. The GDP equal to the factor payments plus tax margins shown in both the “use matrix” and the “final demand matrix” of the I-O tables.

Data contained in I-O tables is usually expressed in terms of producer prices, that is, the prices at which the producer values the transactions. It is important to point out that the difference between producer and purchaser prices of a given commodity is explained by the additional costs incurred by the purchaser in the form of both trade distribution and tax margins.

That is,

Purchaser Price = Producer Price + Wholesale and Retail Margins
+ Transportation Margins + Commodity Indirect Taxes

Simulation Models

The first step in constructing the VAT base is to arrange all the expenditures, including personal and government expenditures, intermediate and capital expenses under the current tax rules. The amount of personal and government expenditures are shown in the final demand matrix of the I-O tables. As mentioned earlier, these final expenditures are of primary consideration in the construction of the VAT base, since they are destined for final use. Suppose that a new house is subject to tax under the VAT. Capital expenditures (with the exception of residential construction) are not considered part of the tax base, since they are used as business inputs into the production of final goods.[40] Furthermore, since trade and distribution margins of retailers, wholesalers and transportation operators are part of the expenditures eventually paid by the final consumers, they should be all included in the VAT base.

Let us consider a case in which a country has a sales tax imposed on the manufacturer's sale price of goods and is now contemplating to replace it by a VAT extended to the retail level.[41] Suppose that it is revenue-neutral tax reform. Because of taxes in the early stage of production and distribution chain, the current sales tax applies to a range of intermediate inputs and capital goods in the economy. With the assumption that all sales and excise taxes are shifted fully forward, the tax imposed on business inputs should be embodied in the prices of goods purchased by households and governments. In order to derive the VAT base, the current tax embodied in the gross expenditures,

[40] Residential construction refers to the value of newly constructed houses, other than land value.

[41] For countries that already have a VAT system in place, one can follow the same example, but skip the computation of the manufacturer's sales tax. Examples can be found in the appendix of this chapter, Daniel Alvarez-Estrada, "VAT Revenue Forecasting Model for 1997 Based on Mexico Input-Output Table", paper prepared for Tax Analysis and Revenue Forecasting Program, International Tax Program, Harvard University, (1997).

which are the figures we usually observe, should be removed, since the existing tax is being replaced.

As domestic expenditures paid by the final consumers are usually expressed in purchaser prices, the total spending by commodity includes the prices of goods and sales taxes imposed by the existing tax system. The tax may be separated in two components. The first is the direct tax that is imposed at the manufacturer's level, but it is shifted directly to final consumers without further processing. The tax may be shown explicitly in published form and, if not, it can be estimated by commodity from the final demand matrix. In any event, we have to remove the current sales taxes included in the personal and government expenditures contained in the I-O tables.

To estimate this direct sales tax, one has to first estimate the current sales tax base by commodity. This is accomplished by removing the retail trade margins (column 4 of Table 8.4) and wholesale trade margins (column 5 of Table 8.4) from purchasers' expenditures on each good or service.[42]

The current sales tax base by commodity i (column 9 of Table 8.4) can be calculated as follows:

$$B_i = E_i \Big/ \left[(1 + rm_i) \cdot (1 + wm_i) \cdot (1 + \alpha_i \rho_i)\right] \qquad (8\text{-}1)$$

where B_i = The sales tax base exclusive of the tax for commodity i (Column 9)

E_i = Expenditure on commodity i at retail price (column 3);

rm_i = Retail margin for commodity i (column 4);

wm_i = Wholesale margin for commodity i (column 5);

α_i = Taxable proportion for commodity i (column 6);

ρ_i = Sales tax rate for commodity i (column 7).

The simulation starts with the current consumer expenditure at the retail price (column 3). At this price level, the retail margin (column 4) and the wholesale margins (column 5) are taken out by dividing the retail expenditures by the respective retail and wholesale margins in order to arrive at the tax base inclusive of the tax, but exclusive of the margins (column 8).

The next step is to apply the taxable portion (column 6) to the tax rate which is applied (column 7) in order to arrive at the tax base exclusive of tax and of all margins. The expected sales tax revenue by commodity can then be calculated by multiplying the tax base (column 9) by the taxable proportion (column 6) and the tax rate (column 7) in order to generate the tax revenue with a full compliance (column 10).[43]

The second element of the current sales tax is the indirect tax that is paid on business inputs by producers. If significant, a further adjustment is needed, since the indirect taxes are included in the producers' prices for goods and services purchased by households and governments.[44] A crude estimate of these indirect taxes expressed as a percentage of retail prices is obtained by dividing the total amount of current sales taxes paid by businesses by the total household and government expenditures plus exports.

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[42] In certain countries, different tax rates are applied to domestic and imported goods. Sales by manufacturers and importers inclusive of tax should be separated by commodity and by type of purchaser.

[43] The taxable proportion is the ratio of the taxable sales to the total sales of each commodity.

[44] A detailed methodology can be found in C.Y Kuo, T. McGirr and S.N. Poddar, "Measuring the Non-Neutralities of Sales and Excises in Canada", Canadian Tax Journal, (May/June 1988).

Table 8.4

Sales Tax Simulations

COMPLIANCE RATE	→	**60%**					Under the Current sales tax System				Under the Proposed VAT System		
		Purchaser Expend. at Retail Price ($ million)	**Retail Margin**	**Wholesale Margin**	**Taxable Portion**	**Table 8.4 Tax Rate**	**Tax Base Inclusive of Tax**	**Tax Base Exclusive of Tax**	**Expected Sales Tax Revenues @100% Compl**	**Expected Sales Tax Revenues @60% Compl.**	**VAT Taxable Portion**	**VAT Base**	**Eff. VAT Base @60% Compliance**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
CONSUMER EXPENDITURE													
1	Mining Products	75	10%	5%	90%	10%	64.94	59.57	5.36	**3.22**	1.00	68.81	**41.28**
2	Food	3,000	15%	10%	10%	10%	2,371.54	2,348.06	23.48	**14.09**	0.25	742.57	**445.54**
3	Beverages	370	20%	15%	100%	20%	268.12	223.43	44.69	**26.81**	1.00	308.33	**185.00**
4	Tobacco Products	120	20%	10%	100%	30%	90.91	69.93	20.98	**12.59**	1.00	92.31	**55.38**
5	Clothing & Footwear	1,200	20%	10%	75%	20%	909.09	790.51	118.58	**71.15**	1.00	1,043.48	**626.09**
6	Gasoline	250	10%	5%	0%	0%	215.63	215.63	0.00	**0.00**	1.00	250.00	**150.00**
7	Other Manufacturing Poducts	1,750	20%	5%	75%	20%	1,388.89	1,207.73	181.16	**108.70**	1.00	1,521.74	**913.04**
8	Communication and Tranportations	900	15%	0%	90%	15%	782.61	689.52	93.09	**55.85**	1.00	792.95	**475.77**
9	Business and Personal Services	2,000	20%	0%	0%	0%	1,666.67	1,666.67	0.00	**0.00**	1.00	2,000.00	**1,200.00**
10	Other Products and Services	900	15%	5%	60%	15%	745.34	683.80	61.54	**36.93**	1.00	825.69	**495.41**
BUSINESS EXPENDITURE													
Investment:													
1	Residential Cnstruction	1,300	0%	0%	60%	15%	1,300.00	1,192.66	107.34	**64.40**	1.33	1,590.21	954.13
2	Non-Residential Construction	2,700	0%	0%	60%	15%	2,700.00	2,477.06	222.94	**133.76**	0.00	0.00	**0.00**
3	Machinery and Equipment	2,500	0%	10%	25%	10%	2,272.73	2,217.29	55.43	**33.26**	0.00	0.00	**0.00**
Intermediate Inputs Acquired by the Following Industries:													
1	Agriculture	400	0%	0%	15%	15%	400.00	391.20	8.80	**5.28**	0.00	0.00	**0.00**
2	Mining	800	0%	0%	55%	15%	800.00	739.03	60.97	**36.58**	0.00	0.00	**0.00**
3	Manufacture	6,000	0%	0%	45%	15%	6,000.00	5,620.61	379.39	**227.63**	0.00	0.00	**0.00**
4	Construction	1,400	0%	0%	55%	20%	1,400.00	1,261.26	138.74	**83.24**	0.00	0.00	**0.00**
5	Transportation & Communications	700	0%	0%	20%	15%	700.00	679.61	20.39	**12.23**	0.00	0.00	**0.00**
6	Trades	800	0%	0%	50%	20%	800.00	727.27	72.73	**43.64**	0.00	0.00	**0.00**
7	Finance & Insurance	200	0%	0%	30%	20%	200.00	188.68	11.32	**6.79**	0.85	160.38	**96.23**
8	Others	150	0%	0%	50%	15%	150.00	139.53	10.47	**6.28**	0.00	0.00	**0.00**
GOVERNMENTAL EXPENDITURE													
1	Mining Products	10	0%	5%	90%	10%	9.52	8.74	0.79	**0.47**	1.00	9.17	**5.50**
2	Food	45	15%	10%	10%	10%	35.57	35.22	0.35	**0.21**	0.25	11.14	**6.68**
3	Beverages	5	0%	10%	100%	20%	4.55	3.79	0.76	**0.45**	1.00	4.17	**2.50**
4	Tobacco Products	5	15%	10%	100%	30%	3.95	3.04	0.91	**0.55**	1.00	3.85	**2.31**
5	Clothing & Footwear	10	0%	10%	75%	20%	9.09	7.91	1.19	**0.71**	1.00	8.70	**5.22**
6	Gasoline	5	10%	5%	100%	30%	4.33	3.33	1.00	**0.60**	1.00	3.85	**2.31**
7	Other Manufacturing Poducts	100	0%	5%	75%	0%	95.24	95.24	0.00	**0.00**	1.00	100.00	**60.00**
8	Communication and Tranportations	80	10%	0%	90%	0%	72.73	72.73	0.00	**0.00**	1.00	80.00	**48.00**
9	Business and Personal Services	60	15%	0%	0%	0%	52.17	52.17	0.00	**0.00**	1.00	60.00	**36.00**
10	Other Products and Services	55	15%	0%	60%	15%	47.83	43.88	3.95	**2.37**	1.00	50.46	**30.28**
TOTAL													
1	Consumer	10,565.00					8,503.73	7,954.86	548.87	329.32	9.25	7,645.88	4,587.53
2	Business	15,650.00					15,422.73	14,441.56	981.17	588.70	0.85	160.38	96.23
3	Government	375.00					334.98	326.04	8.94	5.37	9.25	331.33	198.80
GRAND TOTAL		26,590.00					24,261.44	22,722.46	1,538.98	923.39			4,882.55
									Compliance rate	0.60			

NOTES:

Column

(8)	= (3) / [1 + (4)] / [1 + (5)]
(9)	= (8) / [1 + (6) * (7)]
(10)	= (9) * (6) * (7)
(11)	= 0.6 * (10)
(13)	= (9) * [1 + (4)] * [1 + (5)] * (12)
(14)	= (13) * Compliance Rate Parameter

The total expected sales tax revenue for all commodities and entities is usually not the same as the actual tax collections. This results from a number of factors such as incorrect measurements, bad debt allowances, tax free allowances for small importers, tax evasion, small suppliers' exemptions, and the inability of the tax administration to fully administer the tax system. The compliance rate reflects the difference between expected and actual collections. In this example, the general compliance ratio is 60%, which is equal to the current sales tax collections -- $925 million -- divided by the expected sales tax revenues -- $1,539 million.

Thus, the total current sales tax revenues for the country (R), in the above example, can be expressed as follows:

$$R = \sum_i R_i = \sum_i B_i \cdot \alpha_i \rho_i \cdot \theta_i \qquad (8\text{-}2)$$

where

R_i = Sales tax revenue for commodity i (column 10)

θ_i = Compliance rate for commodity i

α_i = Taxable proportion for commodity i (column 6)

ρ_i = Sales tax rate for commodity i (column 7)

B_i = Sales tax- exclusive base for commodity i (column 9)

The next step is to estimate the potential revenue collection for the VAT extended to the retail level. If the government is also liable under the VAT, then the VAT base is simply calculated by adding domestic personal and government expenditures at retail prices. The starting point in calculating the VAT base is the tax base of the current sales tax (column 9). This tax base is augmented by the corresponding wholesale (column 5) and retail margins (column 4) for each commodity and then multiplied by the VAT taxable portion (column 12) in order to arrive at the VAT base at the full compliance level (column 13).

The taxable proportions under the VAT are determined by the VAT policies under consideration. When the proposed VAT zero-rates or exempts certain commodities, the full value of zero-rated goods and services has to be removed from the potential VAT base (i.e., $\alpha^{vat}_{i} = 0$). Further adjustments have to be made to the VAT base in order to take into account the effects of those cases in which tax-exempt sectors are not allowed to claim taxes paid on their business inputs.

When constructing the VAT base, special attention should be paid to imputed rents for owner occupied dwellings using the I-O tables. In cases in which VAT is levied on the purchase price of new houses, it is essential to exclude the imputed rents as part of personal expenditures in order to avoid double counting.

It is also important to note that expenditures on new houses are shown in I-O tables as a business capital expenditure category, rather than as a personal expenditure item. As the value of land does not represent value added, this item has been excluded from I-O tables and national accounts, but it should be included in the VAT base. In the example presented in Table 8.4, the value of land is assumed to account for 25% of the amount of residential construction (see column (12) of residential construction).

A similar treatment should be applied to the government sector, since goods and services purchased by the government are taxable.[45]

The total potential VAT base for the country (B^v) can be expressed as follows:

$$B^v = \sum_i B_i^v \cdot (1 + rm_i) \cdot (1 + wm_i) \cdot \alpha_i^v + \sum_j K_j \qquad (8\text{-}3)$$

Where

B_i^v = VAT base for commodity *i (column 9)*

α_i^v = VAT taxable proportion for commodity *i (column 12)*

K_j = Business inputs purchased by tax-exempt sector *j*

The compliance ratio for the VAT may not necessarily be the same as the one estimated for the current sales tax compliance. For example, some elements introduced by the VAT system might be expected to create higher compliance rates for different taxpayers. These include lower tax rates, the compliance incentive created by the credit system, or greater administrative enforcement. Conversely, the VAT compliance rate can also be adjusted downward, if it is expected that the introduction of the system will increase tax evasion behavior.

After the tax base has been adjusted to reflect the compliance variable, the total expected VAT revenues for the economy (R^{vat}) are equal to the summation of all the adjusted tax bases across commodities and sectors multiplied by the proposed VAT rate and compliance rate. That is:[46]

$$R^v = B^v \cdot \rho^v \cdot \theta^v \qquad (8\text{-}4)$$

Where

θ^v = VAT compliance rate

ρ^v = VAT rate

Using the same numerical example, and assuming the same compliance rate as the current sales tax system, the proposed VAT will have a tax base of approximately $4,882.55 million (see Column (14) of Table 8.4). This implies that the government would need an 18.9% VAT rate in order to raise the same amount of sales tax revenues as the current sales tax system.

The methodology described above estimates total VAT revenues generated as a result of final personal and government annual expenses on an accrual basis. Actual revenue collection for the government may differ from accrual estimations, due to payment lag

[45] Wages and salaries paid to public servants are not subject to the VAT.
[46] If compliance rates differ among commodities, they should be accounted for separately.

times in the VAT system. Collection lags arise because tax codes may allow different time periods to file returns for different groups of taxpayers.

In order to transform the VAT accrual estimations into actual collections, annual estimations of the VAT base for each commodity may be converted to monthly base figures using sales and other relevant data to reflect seasonal patterns (e.g., high sales in the Christmas season). Also, the appropriate collection lag time should be included for each group of filers. Filing of tax returns for large firms is normally required on a monthly basis, while for smaller firms, filing may be allowed on a quarterly or annual basis.

8.5 Summary

- The value added tax has been increasingly adopted by countries around the world in which governments are replacing turnover tax and some excise taxes by the consumption-type of VAT.

- There are different methods for calculating VAT liabilities. The invoice credit method is the one used in most VAT jurisdictions.

- There are three ways to estimate VAT base: the aggregate approach; the sectoral approach; and the input-output approach.

- The aggregate approach starts with the GDP. The VAT base is estimated by subtracting exports and adding imports in order to reflect the consumption base following the destination principle. The basic methodology is:

  VAT Base = GDP
  – Trade Balance (i.e., Exports – Imports)
  – Gross Capital Formation
  – Private and Government Expenditures Abroad

- Wages and Salaries Paid to Public Servants

– Zero-Rate Consumption Expenditures

– Exempt Consumption Expenditures

– Imputed Rents for Owner Occupied Dwellings

– Commodity Indirect Taxes Replaced by VAT

+ Business Inputs Purchased by Exempt Sectors

+ New Residential Construction

- In the sectoral approach, the base is estimated by adding the value added by each sector in the economy and hence reflects the sectoral contribution of the economy. Measurement of the VAT base can be expressed as follows:

  Tax Base = Sales (i.e., Gross Product Adjusted for Imports, Exports and Inventories)

  – Sales of Zero-Rated or Exempted Goods

  – Purchases of Intermediate Inputs

  – Purchases of Capital Goods

  + Purchases of Inputs to Produce Exempted Goods

  – Commodity Taxes Replaced by VAT

- Under the input-output approach, the VAT base is estimated by employing the equivalence of the value-added tax base to a retail sales tax levied on the final selling price of goods and services. Thus, the starting point for constructing the VAT base is the detailed information on domestic consumption, which is obtained by netting the personal and government expenditures abroad from the total expenditures contained in the final demand matrix of the input-output tables. The basic methodology to construct the base under this approach is summarized as follows:

  VAT Base = Detailed domestic consumption expenditures by goods/services

– Zero-rated goods and services
– Exempt goods and services
– Adjustments for exempt business activities
– Commodity indirect taxes being replaced
– Other adjustments

This approach can be used to calculate the general compliance ratio, to simulate the revenue implications of various tax measures, and to analyze the incidences of the consumption tax.

Appendix

A Revenue Forecasting Model for the Mexican VAT

Introduction:

Mexico introduced its federal value added tax in January 1980. The basic tax system is similar to the European consumption type VAT. It is a credit invoice method. The purpose of this appendix is to demonstrate an application of the input-output method in Mexico, a country which already has a VAT system in place. The empirical results are drawn from the analysis by Daniel Alvarez-Estrada, "VAT Revenue Forecasting Model for 1997 Based on Mexico Input-Output Table".[47]

Tax Scope:

VAT is levied on all sales of goods, services, rentals, and imports of goods and services. There are, however, a number of exceptions that are either zero-rated or exempted under the VAT system in Mexico.

In addition to exported goods and services, zero-rated goods include animals, vegetables, fruits, specified basic foods, water, tractors used exclusively to operate farm equipment, fertilizers, pesticides and herbicides used exclusively in farming, and international freight and air passenger service, among others.

Exempt sales include land, residential building and construction materials, books, magazines, sales by nonprofit labor unions, education, medical services, services provided by state and local governments, taxi, urban transportation services, mortgage and business loans, life insurance and insurance for agricultural risk, etc.

[47] Daniel Alvarez-Estrada, "VAT Revenue Forecasting Model for 1997 Based on Mexico Input-Output Table', paper prepared for the Tax Analysis and Revenue Forecasting Program, International Tax Program, Harvard University, (1997).

These exceptions, stipulated under the VAT law and regulations, provide basic information regarding the scope of the VAT base.

Tax Rates:

The general VAT rate was 10% when implemented. The rate was raised to 15% in January 1996. However, the rate in border zones is 10%. The border zones are defined to include the 20-kilometer area along the northern and southern international borders.

Basic Data:

The 1993 Input-Output Tables were the latest data available for the Mexican economy and were used in this simulation. The tables include detailed private consumption expenditures – broken down by 72 commodity categories, with further breakdown for some categories. The same kind of detailed commodity breakdowns were provided for government expenditures. Detailed intermediate inputs were also available for 1993. Capital expenditures are separated into residential construction, non-residential construction, transportation equipment and other machinery and equipment.

Growth factors from 1993 to 1997 were estimated based on the historical performance and future prospects for private consumption, government expenditures, and business intermediate requirements and capital expenditures, respectively. Using different growth factors was relevant, because each category tended to grow at a different pace.

Methodology and Empirical Results:

The 1993 detailed expenditures by commodity for household, government and business entities are displayed in Column (1) of Table A8-1. These expenditures were grown up to 1997 by the respective growth factors, as shown in Column (2).

Using the above information about zero-rated and exempted goods and services, one can construct the taxable proportion of each commodity or sector under the VAT. This is shown in Columns (4), (5), and (6). The VAT base inclusive of tax under the 1993 VAT system is then derived and presented in Column (7).

Due to the fact that two VAT rates apply to goods and services in two different zones, the tax base is estimated for the border zones and the rest of the country, which are shown in Columns (8) and (9). The corresponding VAT base is presented in Columns (10) and (11), and the total base is shown in Column (12). The corresponding expected VAT revenue by commodity or sector is shown in Column (13), (14) and (15), respectively. The total VAT revenues are estimated to be approximately 3,241 billion pesos. As the government was expected to collect only 97,445 million pesos, the compliance ratio for the Mexican VAT system can be calculated at approximately 58.3%.

Sensitivity Analysis:

The model developed above can be used to simulate the revenue potential if the VAT rates are changed. This would occur because of policy changes. The model can also be used to simulate revenue implications because of changes in the tax compliance rate. This would arise because of changes in the effectiveness of the Mexican tax administration or the complexity of the tax system. Some results are shown in Table A8-2. This kind of information is very useful for policy makers and tax administrators.

Chapter 9
Excise Tax Models

9.1 Introduction

Excise taxes are imposed on a small number of goods in order to raise revenue and to discourage their consumption for health, environment and other reasons.[48] The application of excise taxes is different compared with taxes levied on general consumption of goods or services. For example, VAT is a multi-stage sales tax extended to the retail level. The tax base is generally broad with few tax rates. Trade taxes have been gradually reduced at rates across commodities, reflecting increasing global trade liberalization. On the other hand, excises are usually applied to specific commodities, such as alcoholic beverages, tobacco, fuel or motor vehicles. They are levied at an early stage of production and distribution channel, and thus have a narrow base with high rates in order to raise a significant amount of revenue.

Revenues collected from excises have been significant in developing countries, ranging from 10 to 20% of their total tax revenues. There are several reasons to explain the importance of excise taxation as a good source of stable government revenue. First, excise taxes are imposed on a few selected goods or services and collected from a small number of producers. As some commodities are levied on specific taxes, they are easy to administer and thus administrative cost for the governments is generally low.

[48] See, e.g., Emil M. Sunley, "The Design and Administration of Alcohol, Tobacco, and Petroleum Excises: A Guide for Developing and Transition Countries", working paper for International Monetary Fund, Fiscal Affairs Department, (March 1998).

Second, since the demand elasticities for excisable goods are relatively low, the government can raise a stable and significant amount of revenue from excises. Examples include excises levied on tobacco products and alcoholic beverages because of the addictive nature of these products.

Third, some excises are levied on luxury goods such as furs, jewelry, and motor vehicles in developing countries. These taxes on luxury items have been levied on the grounds of progressivity.

Fourth, excises are also considered to be corrective taxes, as they may be imposed to correct the external effects produced by the consumption of certain goods. This tax tries to internalize the external cost of its consumption. For instance, taxes levied on alcoholic beverages and tobacco products are imposed to alleviate the external costs produced by car accidents, lung cancer treatment financed through public funds. Excises on motor fuels are to curb pollution and road congestion generated by vehicles.

There are two alternative ways to tax excisable goods: specific taxes and ad valorem taxes. Their impacts are different. To analyze the effects, we first examine the case of the single good market and then multiple goods market.

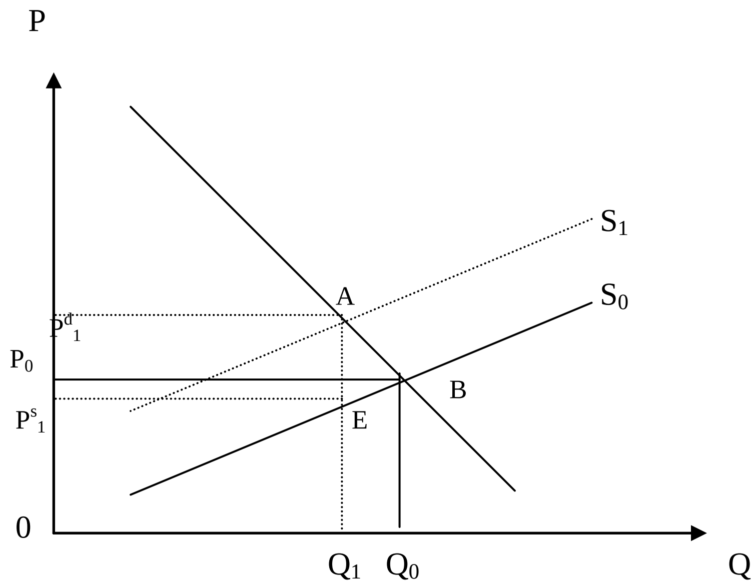
9.2 Impact of the Excise in the Single Market

To analyze the effect of an excise tax in the single good market, we examine two alternative types of excises: specific and ad valorem taxes.

A. Specific Taxes

When a specific tax (T) is imposed on a good (e.g., computer) as shown in figure 9.1, the supply curve is shifted upward by raising the cost of production from S_o to S_1. The quantity of computers produced and sold is reduced by ΔQ from Q_0 to

Figure 9.1
Effect of a Specific Tax on a Single Commodity



Q_1. While the price paid by consumers increases by ΔP^d , from P_0 to P^d_1, the price received by suppliers falls by ΔP^s , from P_0 to P^s_1. Thus,

$$P^d_1 = P^s_1 + T \qquad (9\text{-}1)$$

Let $\in$ and η stand for the own price elasticities of supply and demand, respectively. As a result of imposing a specific tax, changes in supply price and demand price can be expressed as:

$$\Delta P^s = [\eta/(\varepsilon - \eta)]*T \qquad (9\text{-}2)$$

$$\Delta P^d = [\varepsilon/(\varepsilon - \eta)]*T \qquad (9\text{-}3)$$

The total tax revenue (R) is represented in the area of $P^d_1AEP^s_1$, that can be calculated as follows:

$$R = T * Q_1$$

$$= T * Q_0 *\{1 + (T/P_0)*[\varepsilon\eta/(\varepsilon-\eta)]\} \qquad (9\text{-}4)$$

There are problems associated with specific taxes, even though it is easy to administer. In the presence of inflation, as the base does not account for inflation, the tax base will be eroded. As the consequence, a general increase in price will reduce tax revenue in real terms. In such a situation, tax authorities are constantly adjusting the tax rates in order to keep up with inflation. However, such frequent adjustments with the tax rates tend to reduce the level of confidence of the investors.

Specific taxes may also pose equity problems if the same amount of tax is imposed on goods, which are similar in type but different in quality. For example, a bottle of an expensive wine is taxed at the same amount of excise as a cheap wine.

An excise tax will create an efficiency loss in the economy. The excess burden (EB) can be measured as:

$$EB = - (1/2) * T^2 * (Q_0/P_0) * [\in\eta/(\in-\eta)] \qquad (9\text{-}5)$$

An Example

Suppose that the initial price of gasoline is 60 cents per liter and the quantity sold and bought is 500 liters. How much revenue will the government collect if a specific tax of 15 cents is imposed? Assume that $\varepsilon = 2$ and $\eta = -1$.

- When the tax is imposed, the supply price will go down by 5 cents and thus the quantity supplied will be reduced by 83.3 litters. The government will collect a total of $62.5. The calculations are performed as follows:

$\Delta P^s = [\eta/(\varepsilon - \eta)]*T = -5$ cents;

$\Delta P^d = 10$ cents;

$\Delta Q^s = \varepsilon*\Delta P^s*[Q_0/P_0] = -83.3$ litters

Tax Revenue = $T*Q_1 = 0.15 * (500-83.3) = \$62.50$

- The result is the same as above if equation (9-4) is applied:

$$R = T* Q_0 *\{1 + (T/P_0)*[\varepsilon\eta/(\varepsilon-\eta)]\}$$
$$= 0.15*500*\{1 +(0.15/0.60)*[(2)*(-1)/(2+1)]\}$$
$$= \$62.50$$

B. *Ad valorem Tax*

Under ad valorem tax system, the amount of tax is expressed as a percentage of the supply price, as shown in Figure 9.2:

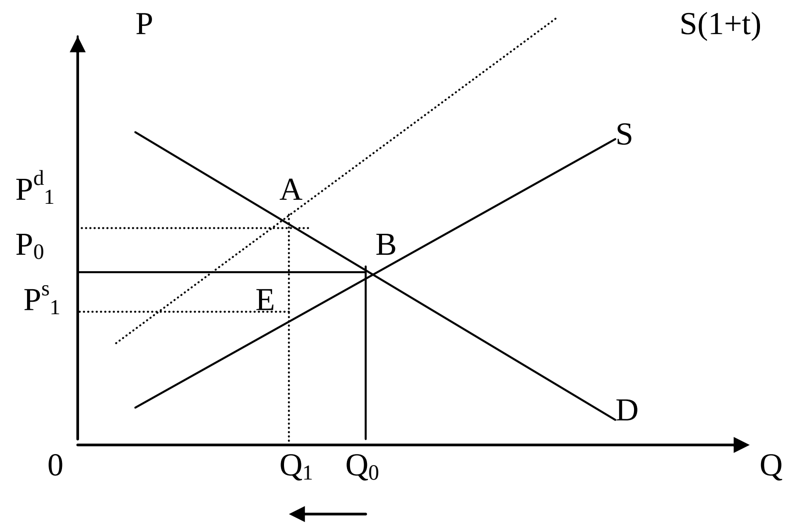
$$P^d = (1 + t)* P^s \quad (9\text{-}6)$$
$$\Delta P^d - \Delta P^s = t*P^s = t*(P_0 + \Delta P^s)$$

where t is the tax rate. The tax revenue will increase at the pace as prices, keeping the real tax value unchanged.

If ε and η stand for the own price elasticities of supply and demand, respectively, one can obtain changes in prices and quantity supplied:

$$\Delta P^s = \{\eta/[\varepsilon - \eta(1+t)]\}*t*P_0 \quad (9\text{-}7)$$
$$\Delta P^d = \{\varepsilon/[\varepsilon - \eta(1+t)]\}*t*P_0 \quad (9\text{-}8)$$

Figure 9.2
Effect of An ad valorem Tax on a Single Commodity



The total tax revenue can be derived below:

$$TR = t*P_1^s*Q_1$$
$$= t*(P_0 + \Delta P^s) *(Q_0 + \Delta Q^s)$$
$$\cong t*P_0*Q_0 + t^2* P_0*Q_0 \{\eta (1+\varepsilon)/[\varepsilon-\eta(1+t)]\} \qquad (9\text{-}9)$$

The amount of excess burden (EB) can be calculated as follows:

$$EB = - (1/2)\, t^2\, P_0\, Q_0 * \{\in\eta/[\in-\eta(1+t)]\} \qquad (9\text{-}10)$$

The tax incidence, which gives the share of the tax borne by consumers, is $\in/(\in-\eta)$.

Implications

- When “t” increases, the total tax revenue will first rise and then fall.

- Tax revenue will be lower if demand is more elastic. This is because consumers will shift quickly to other goods as the price goes up. On the contrary, revenue will be easy to collect from goods whose demand is inelastic.

- If supply is perfectly elastic (i.e., horizontal supply curve), then the total revenue can be expressed: $R = t*P_0*Q_0 + t^2 * P_0*Q_0\ \eta$. Under this situation, if demand is unit elastic, the total tax revenue will reach maximum when the tax rate is 50%.

Example A:

Suppose that the initial price of gasoline is 60 cents per liter and the quantity sold and bought is 500 liters. How much revenue can the government collect if a tax rate of 25% is imposed on gasoline? Assume that $\varepsilon = 2$ and $\eta = -1$.

- When the tax is imposed, the supply price will go down by 4.62 cents and thus the supply price is 55.38 cents.

$\Delta P^s = \{\eta/[\varepsilon - \eta(1+t)]\}*t*P_0 = -4.62$ cents;

$t*P^s = t*(P_0 + \Delta P^s) = 0.25*(60 - 4.62) = 13.85$ cents

$\Delta Q^s = \varepsilon*\Delta P^s*[Q_0/P_0] = -77$ litters

Tax Revenue = $t*P_1^s*Q_1$ = \$0.1385*(500-77) = \$58.59

- The result is about the same if the formula (9-9) is used:

$$TR \cong t*P_0*Q_0 + t^2 * P_0*Q_0\ \{\eta\ (1+\varepsilon)/[\varepsilon-\eta(1+t)]\}$$

$$\cong 0.25*0.6*500+(0.25)^2*0.6*500*\{(-1)*3/3.25\}$$
$$= \$57.69$$

Example B:

Some analysts suggest that the tax on coffee applied in Kenya should be higher than the current rate of 5%. In 1996, the crop was 104,000 tones, and the farm-gate price was Ksh 36,400/ton. In the short run, the supply elasticity is estimated to be as low as 0.2, while the demand elasticity may be close to -2. With this information, Kenyan authorities want to estimate the impact of an increase in the *ad valorem* tax rate from 5% to 10% and then 20% on the supply and demand prices of coffee, the quantities produced, total revenue collection, and the excess burden.

- Using the equations given above, the results expressed in thousands of Ksh are obtained as follows:

Tax Rates	**5%**	**10%**	**20%**
Q_1	103.10	102.27	100.80
P^d	36.56	36.70	36.96
P^s	34.82	33.37	30.80
R	179,404	340,702	617,344
EB	823	3,155	11,648

- As shown from the results obtained, raising revenue through higher tax rates applied to coffee carries very high efficiency costs. Since excess burden rises with the square of the tax rate, a low tax rate on a broad base will be less inefficient than a high tax rate on a low base.

- Higher tax rates can yield substantial tax revenue to the government, unless demand and supply are price elastic.

9.3 Impact of Excises in Multiple Markets Case

Goods often have substitutes or complements. Examples of close substitutes and complements include:

- cars and pickups; small and medium-sized cars
- tea and coffee
- butter and margarine
- cigarettes and rolling tobacco
- taxable goods and smuggled goods
- beer, wine and spirits
- automobiles and gasoline

A useful measure to analyze the behavior of multiple markets is the cross elasticity of demand, which can be expressed as follows:

$$\eta_{yx} = (\text{\% change in quantity demanded of Y})/(\text{\% change in price of X})$$

A positive cross-price elasticity means that an increase in the price of X causes an increase in the quantity demanded for Y, which means goods X and Y are substitutes. If cross-price elasticity is negative, both goods turn out to be complements, since an increase in the price of X will decrease the quantity demanded for Y.

The main implication for excise tax policy design is that close substitutes should be taxed at about the same rate, in order to prevent tax base erosion. To assess the revenue impact of an increase in a specific excise tax imposed on a given commodity within a multiple market structure, the demand for good i (Q_i) can be expressed as follows:

$$Q_i = f(P_1, P_2, P_3, \quad , P_i, \ldots., Y, \text{taste}) \qquad (9\text{-}11)$$

where Y stands for income.

Suppose that specific taxes (T_i) are imposed on various goods. The total revenue (R) from these excises can be obtained by:

$$R = \sum_i T_i Q_i \qquad (9\text{-}12)$$

Assume that the supply of various goods is perfectly elastic, the amount of tax increase per unit is equal to the increase in demand price. That is, $dT_i = dP_i^d$. If only tax levied on commodity 1 changes, one can obtain the change in the total tax revenue by differentiating R with respect to T_1:

$$dR/dT_1 = \Sigma_i T_i*(dQ_i/dT_1) + Q_1 \qquad (9\text{-}13)$$

The percentage increase in total tax revenue can be calculated as:

$$dR/R = (dT_1/R) [\Sigma_i T_i*(dQ_i/dT_1) + Q_1]$$

$$= (dT_1/P_1)\{P_1Q_1/R + \Sigma_i [\eta_{i1}*(T_iQ_i/R]\} \qquad (9\text{-}14)$$

where η_{i1} stands for the demand elasticity of the ith goods with respect to the price of good 1.

Example 1:

Suppose that the price of beer (P_1) is \$20 per case and the amount of beer sold (Q_1) is 30 cases. Given that:

	Beer	Wine	Soda	Total
Tax Revenue	100	60	40	200
$(T_iQ_I)/R$	0.5	0.3	0.2	1.00
η_{i1}	-0.7	0.1	0.1	-

What would be the effect on the total tax revenue if the price of beer increase by 1 dollar?

- Using equation (9-14), the increase in total tax revenue can be calculated as follows:

dR/R = (1/20)*[20*30/200 + (-.7)(.5) +(.1)(.3)+(.1)(.2)]
= 0.135

- The total tax revenue will rise by 13.5% from $200 to $227.

- If substitutes between beer and wine or soda were not taken into consideration, then dR/R = .1325 and the total revenue will be underestimated by $0.50. The amount of underestimates depends upon the magnitudes of cross elasticities.

Therefore, imposing a tax on a good with a fairly large number of substitutes implies that the tax base can easily be eroded; and, hence tax revenues are expected to decrease. Excise tax policy analysis should focus not only on single markets in isolation, but should also analyze the behavior in the markets of close substitutes for the taxed goods.

<u>Example 2</u>:

Table 9.1 shows essential data for the market of beer and soft drinks in Kenya. Coefficients under η_{ie} and η_{ic} measure the elasticity of demand with respect to the price of expensive beer and with respect to cheap beer, respectively. What would happen to total tax revenue if (a) the tax on expensive beer were raised from 100% to 136% and if (b) the tax on cheap beer were lowered to 136%?

Table 9.1

Background information — **ESTIMATING REVENUE WITH CROSS PRICE EFFECTS**

	Price	*Tax Rate*	*Ret. Val*	*% Spen.*	*nie*	*nic*	***Tax Rev.***
Stout	28	75%	1000	1.0%	0.1000	0.0250	429
Expensive Beer	15	100%	2000	2.0%	-0.7000	0.0250	1,000
Cheap Beer	10	150%	6500	6.5%	0.1200	-0.8000	3,900
Spirits		200%	250	0.3%	0.0500	0.0150	167
Wine		200%	250	0.3%	0.0500	0.0150	167
Soft Drinks		50%	2500	2.5%	0.0100	0.0000	833
Other Goods		10%	87500	87.5%	-0.0148	-0.0158	7,955
Total							14,450

Increase Expensive Beer tax from 100% to 136%

	With Cross Elasticities				***Without Cross Elasticities***			
	%Ch. Pr.	***%Ch. Q.***	***%Ch. Tax***	***Tax Rev.***	***%Ch. Pr.***	***%Ch. Q.***	***%Ch. Tax***	***Tax Rev.***
Stout	0.0%	1.8%	0.0%	436	0.0%	0.0%	0.0%	429
Expensive Beer	18.0%	-12.6%	36.0%	1,189	18.0%	-12.6%	36.0%	1,189
Cheap Beer	0.0%	2.2%	0.0%	3,984	0.0%	0.0%	0.0%	3,900
Spirits	0.0%	0.9%	0.0%	168	0.0%	0.0%	0.0%	167
Wine	0.0%	0.9%	0.0%	168	0.0%	0.0%	0.0%	167
Soft Drinks	0.0%	0.2%	0.0%	835	0.0%	0.0%	0.0%	833
Other Goods	0.0%	-0.3%	0.0%	7,933	0.0%	0.0%	0.0%	7,955
Total				14,714				14,638

Decrease Cheap Beer tax from 150% to 136%

	With Cross Elasticities				***Without Cross Elasticities***			
	%Ch. Pr.	***%Ch. Q.***	***%Ch. Tax***	***Tax Rev.***	***%Ch. Pr.***	***%Ch. Q.***	***%Ch. Tax***	***Tax Rev.***
Stout	0.0%	-0.1%	0.0%	428	0.0%	0.0%	0.0%	429
Expensive Beer	0.0%	-0.1%	0.0%	999	0.0%	0.0%	0.0%	1,000
Cheap Beer	-5.6%	4.5%	-9.3%	3,694	-5.6%	4.5%	-9.3%	3,694
Spirits	0.0%	-0.1%	0.0%	167	0.0%	0.0%	0.0%	167
Wine	0.0%	-0.1%	0.0%	167	0.0%	0.0%	0.0%	167
Soft Drinks	0.0%	0.0%	0.0%	833	0.0%	0.0%	0.0%	833
Other Goods	0.0%	0.1%	0.0%	7,962	0.0%	0.0%	0.0%	7,955
Total				14,249				14,244

A: An increase in the excise tax on the expensive beer would raise retail prices by 18% from 30 to 30.54 Ksh. Given that η_{ie} = -0.7, the quantity demanded for expensive beer will change by –12.6% (= -0.7*18%). As the change in the tax rate is 36%, the total tax revenue will be: $R_1 = R_0 * (1+ dQ/Q_0) * (1+dT/T_0)$; the total expensive beer tax revenue is equal to: 1,000*(1.36)*(1-0.126) = 1,189. Without cross-price effects, the tax revenue collected from other goods remains the same.

When cross-price effects are considered, an increase in the expensive beer tax will cause the tax revenue from other goods to change. The tax revenue from cheap beer is expected to rise, as drinkers shift from expensive to cheap beer. Overall spending on beer and spirits rises, leaving less to spend on other goods, and so revenue from tax on other goods falls. As a result of the cross-price effect, total tax revenue rises to Ksh 14,714 from Ksh 14,450, as shown in Table 9.1.

A decrease on the tax levied on cheap beer will produce the opposite effect, as tax revenue decreases from Ksh 14,450 to Ksh 14,244 considering no cross price-effects, and decreases to Ksh 14,249 when cross-price effects are taken into account.

9.4 Effect on Revenue when Income Rises

One of the most desirable features of a tax system is the positive responsiveness of tax revenues to changes in income. As explained in Chapter 3, an elastic tax system provides governments with a sound base of fiscal resources without the need of introducing continuous discretionary changes into the tax base to keep up with income increases. In order to build up a tax system with the above characteristics, excise taxes should be imposed on commodities with a high-income elasticity of demand.

Income elasticity of demand measures the change in quantity demanded with respect to income:

$$\eta_{xI} = (\text{\% change in quantity demanded of good X})/(\text{\% change in income})$$

Example:

Figures shown in Table 9.2 are obtained from the Kenyan household budget survey. Presented in the first block is the percentage of income spent on the four selected items by low, medium, and high income category. Assuming that average incomes for each category are Ksh 1,500, Ksh 5,000, and Ksh 15,000, respectively, total spending per commodity is shown in the second block of figures. In order to calculate income elasticities, one should first calculate the percentage rise in income from category to category, as presented in the first part of the third block. Income elasticities are calculated as the ratio of the percentage change in spending divided by the percentage change in income. The last column of the third block represents average elasticity.

The results suggest that an excise tax on transport and communication services will provide an elastic source of revenue to the Kenyan government, since the average income elasticity looks relatively high. This sector is therefore an attractive candidate for the imposition of an excise tax, since the average income elasticity is higher than one.

Table 9.2

Calculation of Income Elasticity of Demand

% Income Spent	Low	Mid	High
Food	41.0	35.6	25.0
Drink and Tobacco	4.4	4.4	2.3
Fuel and Power	3.7	4.4	4.8
Transport & Communications	3.8	7.9	14.3

Spending in Ksh	Low	Mid	High
Food	615	1,780	3,750
Drink and Tobacco	66	220	345
Fuel and Power	56	220	720
Transport & Communications	57	395	2,145
Average Income	1,500	5,000	15,000

	% Increase		Elasticity		
	Low-Mid	Mid-High	Low-Mid	Mid-High	Average
Food	189.4%	110.7%	0.81	0.55	0.68
Drink and Tobacco	233.3%	56.8%	1.00	0.28	0.64
Fuel and Power	296.4%	227.3%	1.27	1.14	1.20
Transport & Communications	593.0%	443.0%	2.54	2.22	2.38
Average Income	233.3%	200.0%			

Figure 9.3 depicts the response of excise tax revenues to a change in income (e.g., personal disposable income). As income increases, the demand curve shifts to right by a distance of AC. The quantity produced rises and so does the cost of production per unit. The rise in price leads to a fall in the quantity demanded by the amount measured by BC.

Given:

$$dQ = dQ^S - dQ^d \quad (9\text{-}15)$$

and:

$$Q^S{}_1 = Q^d{}_1 = Q^S \quad (9\text{-}16)$$

Then:

$$\in = dQ^S/dP^S * P^S/Q^S; \quad \text{or} \quad dQ^S = \in*(dP^S/P^S) * Q^S \quad (9\text{-}17)$$

$$\eta = dQ^d/dP^d * P^d/Q^d; \quad \text{or} \quad dQ^d = \eta*(dP^d/P^d) * Q^d \quad (9\text{-}18)$$

Substituting dQ^S and dQ^d into equation (9-15), we have:

$$dQ = \in*dP^S/P^S*Q^S - \eta dP^d/P^d*Q^d \quad (9\text{-}19)$$

Since:

$$P^d = (1+t)\, P^S$$

$$dP^d = (1+ t)\, dP^S$$

$$dP^d/P^d = [(1+t)\, dP^S]/[(1+t)\, P^S] = dP^S/P^S \quad (9\text{-}20)$$

Using equations (9-16), (9-19), and (9-20):

$$dQ = dP^S/P^S *Q^S * [\in - \eta] \quad (9\text{-}21)$$

$$dP^S = (dQ/Q^S) *P^S * [1/(\in -\eta)] \quad (9\text{-}22)$$

Substituting equation (9-22) in (9-17):

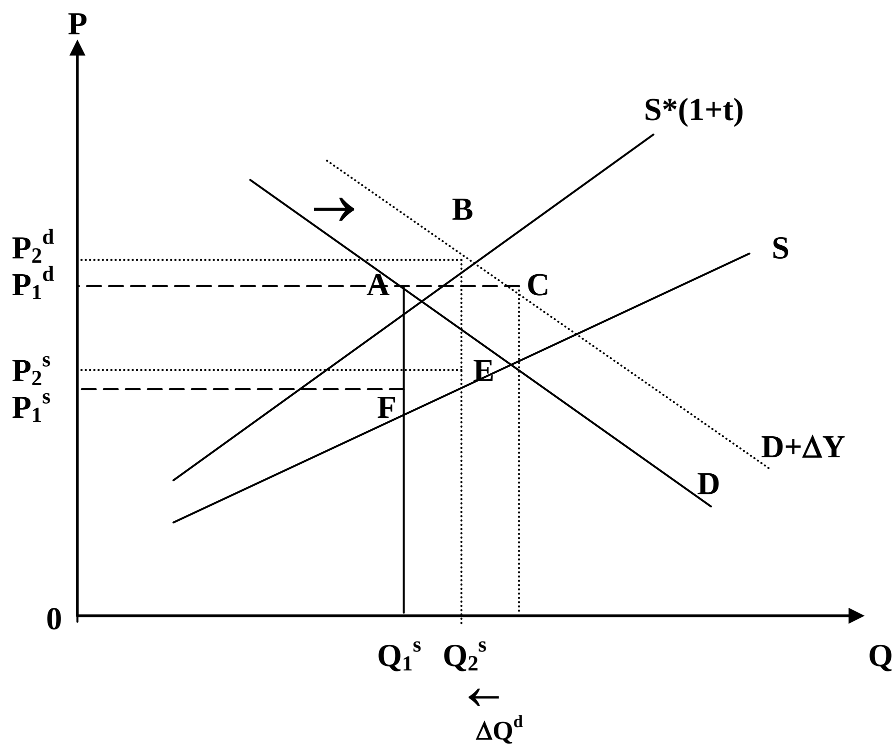
$$dQ^S = dQ*[\in/(\in-\eta)] \quad (9\text{-}23)$$

Substituting (9-21) and (9-22) into (9-14):

$$dR \approx t * P^S * Q^S *[dQ/Q^S] * [(1+\in)/(\in-\eta)] \quad (9\text{-}24)$$

Where t is the tax rate, η is measured at A in Figure 9.3 and $\in$ is measured at point F on S_1, dQ/Q^S is the proportionate increase in demand, or the proportion by which the demand curve is shifted outwards. Q^S is $Q^S{}_1$, and P^S is $P^S{}_1$ as a first approximation.

Figure 9.3
Excise Tax Response to a Change in Income



9.5 Empirical Estimation of Elasticities

A. Gasoline

Using gasoline as an example, a general form of the demand function of a excisable good can be expressed below:

$$Q_{g,t} = f\,(P_{g,t},\ P_{d,t},\ Y_t,\ Q_{g,t-1}) \qquad (9\text{-}25)$$

where Q_g : gasoline consumption per capita
$P_{g,t}$: price of gasoline

$P_{d,t}$: Price of diesel, substitute

Y_t : income per capita

$Q_{g,t-1}$: gasoline consumption per capita in the previous period (consumers adjust with a lag)

The regression result for Madagascar during the period 1978-96 is:[49]

$$\begin{aligned} \text{Ln}(Q_{g,t}) = &- 0.0655 - \underset{(1.96)}{0.2622}\ \text{Ln}(P_{g,t}) + \underset{(0.34)}{0.0789}\ \text{Ln}(P_{d,t}) \\ &+ \underset{(1.25)}{0.4142}\ \text{Ln}(Y_t) + \underset{(5.11)}{0.7172}\ \text{Ln}(Q_{g,t-1}) \end{aligned}$$

where parenthesis is t-statistic.

The results show that the short run elasticity for gasoline is - 0.26 and the long run elasticity is - 0.93 (= -0.262/(1 – 0.717)).

In the developed countries, the low own-price elasticity of demand was found very low, ranging from - 0.1 to – 0.2. The income elasticity of demand for gasoline is also less than one.

B. Tobacco products

Many researches have undertaken research studies on the estimation of short-run and long-run elasticities in the U.S. They range from - 0.2 to - 0.4 for short-run elasticity and from - 0.5 to - 0.8 for long-run elasticity.

One interesting case study undertaken in Canada in 1993 had the following major findings:[50]

[49] H.J. Haughton, "Estimating Demand Curves for Goods Subject to Excise Taxes", EAGER/PSG – Excise Project, Harvard Institute for International Development, (1998).

[50] Department of Finance Canada, "Tobacco Taxes and Consumption", (June 1993).

- Two models were developed to assess changes in the demand for cigarettes and fine-cut tobacco.

- The short run price elasticity of demand is - 0.9 for cigarettes and - 0.3 for fine cuts.

- Unlike other empirical studies, the demand for cigarettes is less elastic in the long run (- 0.7) than in the short run. This implies that smokers initially react to a price increase, but over time they return to their past consumption levels because of the habitual nature of tobacco consumption.

- Fine-cut tobacco is an inferior good (i.e., an increase in income reduces consumption).

- Fine-cut tobacco is found to have a strong substitute for cigarettes (1.3). That is, an increase in the price of cigarettes would result in a significant increase in the demand for fine-cut tobacco.

- Teenagers were found to have a higher elasticity of demand than adults.

- In the 1991 budget, an increase of 3 cents per cigarette excise tax resulted in a 27% increase in total taxes, which led to a 19% increase in the retail price. As a consequence, tax-paid cigarette consumption was estimated to fall by 17% in the short run and 12% in the long run.

- A significant increase in the level of tax lead to a reduction on tax-paid tobacco consumption and an increase in the market for illicit tobacco. In the Canadian case, the cigarettes were exported to the U.S. and then smuggled into Canada. The government lost a substantial of tax revenues in 1991. In the end, the government lowered the excise tax.

9.6 Summary

- Excises are imposed on a small number of goods in order to raise revenue and to discourage their consumption for health, environmental and other reasons. Examples of such goods include alcohol, fuel, tobacco, and motor vehicles.

- Excise taxes are attractive taxes because they are easy to administer, provide stable revenues, and are often used to correct externalities.

- Excises are imposed in two ways: specific taxes or ad valorem taxes. Specific taxes are easy to administer, since the base is determined by the number of physical commodities. In the presence of inflation, the base becomes eroded by specific taxes. Ad valorem taxes are levied as a percentage of the price of the commodity, thereby maintaining revenue collection in real terms.

Appendix
Calculation of Elasticity

The total amount of taxes that the government collects with an excise tax is ultimately determined by the elasticity of demand of the good or service on which the tax is levied. The estimation of elasticity represents one of the most important components for the forecast of excise taxes.

The price elasticity of demand is defined as:

$$\eta = \%\Delta Q^d/\%\Delta P^d = (\Delta Q^d/\Delta P^d) * (P^d/Q^d)$$

Demand for a good is more elastic when more substitutes are available and its consumption accounts for a large share of a consumer's budget. Substitutes are more likely to be available in the long run, which implies that the elasticity of supply is larger compared with the short-run elasticity.

Tax bases are easily eroded when excise taxes are levied on commodities with a high demand elasticity. This is because consumers can easily switch their consumption pattern towards goods and services that are substitutes and have lower taxes.

The price elasticity of supply is defined as:

$$\in = \%\Delta Q^s/\%\Delta P^s = (\Delta Q^s/\Delta P^s) * (P^s/Q^s)$$

Again, the time dimension is important when analyzing supply elasticity. In the long run, the price elasticity of supply is relatively high compared with the short run elasticity. The elasticity of supply becomes infinite in cases in which the supply curve is totally horizontal.

***Example*:**

Table A9.1 contains some useful information about the output of sisal in Kenya, along with the price received by sisal farmers and the Nairobi Consumer Price Index. To estimate the price elasticity of supply for sisal, prices should first be recalculated in 1990 shillings. Real prices of sisal are obtained by dividing the nominal price for a given year by the consumer price index of that particular year.

The price elasticity of supply is calculated by dividing the percentage change in quantity by the percentage change in real price. The average price elasticity value is 0.38, which is typical of agriculture supply elasticity.

Table A9.1

Calculation of Elasticities						
	1986	1987	1988	1989	1990	Mean
Consumer Price Index	354.6	379.5	420	464.4	523	
SISAL						
Price (Ksh/kg)	7.43	7.05	7.45	8.92	11.79	
Sold to market board ('000 t)	41.5	37	36.9	37.4	39.9	38.42
Price in 1990 Ksh	10.96	9.72	9.28	10.05	11.79	10.36
Predicted price	11.54	9.81	9.78	9.97	10.69	
% change in quantity		-12.2%	-0.30%	1.3%	4.8%	
% change in price		-12.80%	-4.7%	7.7%	14.8%	
Supply Elasticity		0.95	0.06	0.17	0.33	0.38

An alternative way to calculate price elasticity is with regression analysis. From the basic demand function we know that:

$$Q_i^d = f\,(P_i, P_o, Y, \text{tastes, income distribution, etc.})$$

where Q^d : Quantity of good i demanded in the market

P_i : Price of good i

P_o : Vector of prices of other goods

Y : Income

Given this basic demand relationship, a regression equation can be obtained by regressing quantity demanded for a given good with some independent variables, such as prices or income.

The general form of the regression model used to calculate price elasticity may be expressed as follows:

$$Ln\ Q_i = a + b * Ln\ P_i + ...$$

where Q_i : Quantity demanded good i

P_i : The price of good i

a, b : Constants to be estimated

By using the log term function, b coefficient represents the price elasticity.

***Example*:**

Table A9.2 contains information related to prices and quantities for petrol and diesel produced by a given country from 1980 to 1990. The total GDP series at factor costs is also provided. The first step is to construct real prices and a real income series by using the GDP deflator. Real series obtained are labeled under "1990 P". The second step is to determine the log terms series. Finally, quantities are regressed with real price, real income, and time in a log form model.

Using the ten year period, the regression outputs are shown in Table A9.2. The results obtained from the petrol regression model give a price elasticity of demand for petrol --- 0.50. For the diesel model, price elasticity turns out to be -0.41. Price elasticities obtained should be similar to those calculated by obtaining the average of year-to-year elasticity calculation, as shown in Table A9.1. It should be noted that, even though the demand price elasticities obtained by the regression analysis seem reasonable, the regression output should be still considered an approximation, as the ten year data series is not large enough, and the series shown are presented in an aggregate way.

The calculation of price elasticities, as is true with most of the forecasting techniques, is an information-intensive task. As shown in Table A9.2, the basic information needed in order to calculate price elasticity for any commodity consists of the time-series for the quantity demanded, prices in the marketplace, income information, and the price deflator. Information regarding the quantity demanded is obtained basically from manufacturers' surveys. Prices in marketplaces are usually extracted from either manufacturers' or retailers' data sources, such as surveys, publications, magazines, etc. Information related to income is obtained from GDP national accounting information and price deflator series, usually available from national account statistics.

Table A9.2

Calculation of Elastisties

Regression Analysis

Back ground information

YEAR	Petrol Price (Ksh/l)	Petrol Sales (000t)	Diesel PRICE (Ksh/l)	Diesel Sales (000t)	Pop. (M)	GDP at Factor cost	GDP deflator	Petrol 1990 P. (Ksh/l)	Diesel 1990 P. (Ksh/l)	GDP 1990 p. Kpm
1979						2031	0.742			5581
1980	4.39	300.8	3.06	408.5	15.84	2298	0.813	11.01	7.67	5763
1981	5.98	298.5	4.23	375.6	16.36	2668	0.895	13.62	9.64	6078
1982	7.06	269.3	5.2	373.1	16.91	3078	1	14.4	10.6	6276
1983	7.52	256.4	5.48	388.9	17.48	3452	1.105	13.88	10.11	6370
1984	7.94	257.7	5.79	420.1	18.06	6852	1.224	13.23	9.65	6417
1985	8.13	267.8	5.94	447.7	18.66	4375	1.325	12.51	9.14	6733
1986	7.74	295.1	5.47	481	19.29	5115	1.462	10.79	7.63	7134
1987	8.16	321.8	5.54	572.7	19.93	5648	1.54	10.8	7.34	7478
1988	8.54	325	5.67	537.3	20.6	6472	1.677	10.38	6.86	7869
1989	9.03	376.7	5.99	543.6	21.28	7426	1.834	10.04	6.66	8256
1990	11.7	339	8.55	555.4	22.01	8634	2.039	11.7	8.55	8634

Petrol model

LN Petrol Sales	LN Petrol 1990 P.	LN GDP 1990 P.	Year
5.71	2.4	8.66	1980
5.7	2.61	8.71	1981
5.6	2.67	8.74	1982
5.55	2.63	8.76	1983
5.55	2.58	8.77	1984
5.59	2.53	8.81	1985
5.69	2.38	8.87	1986
5.77	2.38	8.92	1987
5.78	2.34	8.97	1988
5.93	2.31	9.02	1989
5.83	2.46	9.06	1990

Diesel Model

LN Diesel Sales	LN Diesel 1990 P.	LN GDP 1990 P.	Year
6.01	2.04	8.66	1980
5.93	2.27	8.71	1981
5.92	2.36	8.74	1982
5.96	2.31	8.76	1983
6.04	2.27	8.77	1984
6.1	2.21	8.81	1985
6.18	2.03	8.87	1986
6.35	1.99	8.92	1987
6.29	1.93	8.97	1988
6.3	1.9	9.02	1989
6.32	2.15	9.06	1990

1. Petrol Regression model

Regression output

Constant:		190.347	
Std Err of Y Est:		40.828	
R Squared		0.931	
No. Of Observations:		11	
Degrees of Freedom		7	
X Coefficient (s)	-0.499	2.994	-0.106
Std. Err of Coef.	0.121	0.582	0.023
T-statistics	-4.11	5.143	-4.577

2. Diesel Regression model

Regression output

Constant:		-77.59	
Std Err of Y Est:		51.13	
R Squared		0.941	
No. Of Observations:		11	
Degrees of Freedom		7	
X Coefficient (s)	-0.41	-0.243	0.044
Std. Err of Coef.	0.117	0.734	0.029
T-statistics	-3.48	-0.33	1.508

Chapter 10
Trade Tax Models

The importance of trade taxes to overall total government tax collection has been declining in the developed countries. Recent trade liberalization and regional trade blocks such as NAFTA, Mercosur, the European Community, and the South-Asia Trade Agreement are expected to continue to lower the dependence of government revenues on trade taxes.[51] Nevertheless, trade taxes still account for nearly one third of total tax revenues in the less-developed countries. This dominant role of trade taxes, as a major revenue source for governments, can be attributed to the following factors. First, trade taxes are generally easy to collect, as they are levied and administered at a few specific points throughout the border of a country. When trade taxes are levied on a unit basis, the tax administration is further eased. Second, trade taxes provide a useful economic policy tool for governments in achieving certain economic goals. Import substitution policies, for example, are potentially achieved when taxes are properly levied on imported goods. Third, trade taxes have an influence on the foreign exchange market in the economy and also contribute to savings and earnings in foreign currencies.

The international trade sector can be important for governments, since trade tax revenue is directly related to the size of the trading sector in the economy. The larger the trade sector as a percentage of GDP, the greater the taxable capacity of the economy. Even though the importance of trade taxes has declined over time with the gradual openness of economies to foreign trade, trade taxation is still considered an important source of revenue for developing countries and, hence, a careful analysis of the trade tax and its revenue forecasting should be undertaken.

[51] In the mid-1980s, taxes on trade accounted for an average 35% of the total revenue, as compared to 23% and 17% in Asia and Latin America/the Caribbean, respectively.

As trade taxes are levied on commodities, an analysis of revenue forecasting is closely related to the price elasticity framework developed in the early chapters.

10.1 Application of Import Tariffs: Geometry

Import tariffs are levied on imported goods. To assess the effects of a tariff on the domestic economy, two different scenarios are analyzed: a tariff without domestic production, and a tariff with domestic competing production. In both cases, it is assumed that a country is small in the world economy and is thus unable to influence the world price. It is also assumed that the exchange rate remains unchanged when tariffs are imposed.

The first case assumes that there is no domestic production of the imported good, which means that the total demand is met by imports from abroad. This is shown in Figure 10.1(A). In this case, the supply curve is completely elastic, since any amounts of imports of a given good are available to the domestic economy at world prices. Domestic price (P_d) is given by the exchange rate (E_m) multiplied by the world price (P_w) and the quantity demanded, or imported, is represented by Q_0. After a tariff (t) is introduced, the domestic price increases to $E_m * P_w (1+t)$, and therefore the quantity demanded declines from Q_0 to Q_1. Revenue collected by the tariff is shown by the area MAFN, quantified by Q_1*t. The efficiency loss to the economy from the imposition of the tariff is represented by the triangle ABF.

The second case presents the introduction of a tariff when part of the domestic demand is met by domestic production and the rest is met by imports from abroad. Figure 10.1(B) displays the effects of the tariff. The introduction of a tariff increases the domestic prices of imports from $E_m * P_w$ to $E_m * P_w (1+t)$ in such a way that the domestic supply curve shifts upward from ABC to AHJ.

Figure 10.1 (A)

Tariff Without Domestic Production

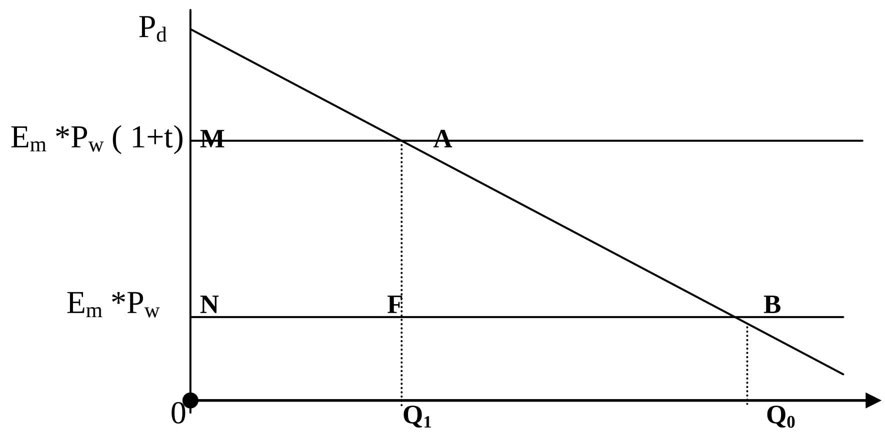
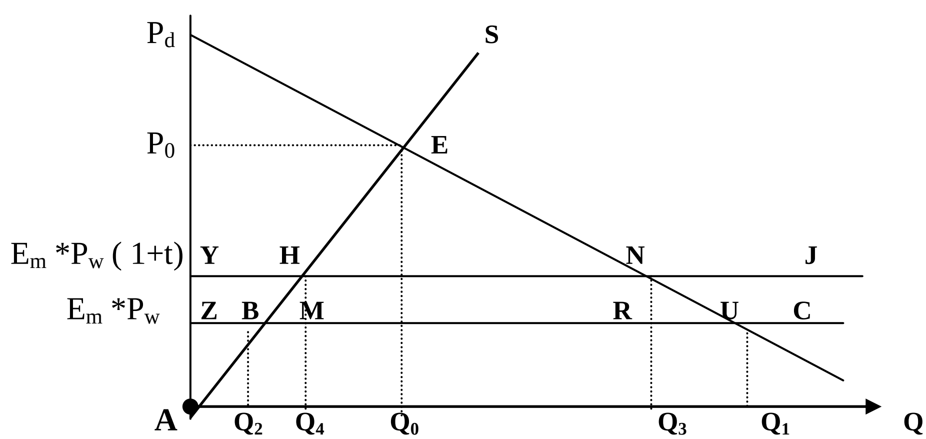


Figure 10.1 (B)

Tariff With Domestic Production



Due to an increase in price brought about by the tax, the domestic production increases from Q_2 to Q_4, while quantity demanded of importables decreases from Q_1 to Q_3. The decrease in the quantity of imports is given by the distance Q_2Q_1 to Q_4Q_3. Tax revenue is graphically represented by the area HNRM, and numerically calculated by $E_m * P_w$ $t*(Q_3-Q_4)$, and the efficiency cost to the economy is represented by the two triangles BHM and RNU.

In summary, when a tariff is imposed:[52]

(a) it raises the price paid by consumers by the amount of tax and thus reduces consumption;
(b) it enables domestic producers to produce more, as price for the taxed commodity increases;
(c) imports fall, and the government collects some revenue; and
(d) there is a deadweight loss to the economy.

10.2 Application of Import Tariffs: Formula

When an ad valorem tariff is imposed on an import, the total tariff revenue (R) can be calculated as follows:

$$R = tP_{cif}\, Q_1^m \qquad (10\text{-}1)$$

where t : Tariff rate on imports,
P_{cif} : Import price (including cost, insurance and freight),
Q_1^m : Quantity imported after imposition of tariff.

The formula (10-1) can then be arranged to:

$$R = tP_{cif}\, (Q_0^m + \Delta Q^m) \qquad (10\text{-}2)$$

[52] See, e.g., Stephen R. Lewis, Jr., Taxation for Development, (Oxford: Oxford University Press, 1984), Chapter 9.

Where Q_0^m : Quantity imported before tariff,

η^m : Elasticity of demand for imports.

It should be noted that the price elasticity of demand for imports (η^m) is given by:

$$\eta^m = \eta\,(Q_o^d / Q_o^m) - \in (Q_o^s / Q_o^m) \qquad (10\text{-}3)$$

where η : Price elasticity of the domestic demand for importables,

Q_o^d : Domestic demand for importables,

Q_o^m : Demand for imports,

$\in$: Price elasticity of domestic supply of importables,

Q_o^s : Domestic supply of importables.

The demand elasticity of imports (η^m) is always greater than the elasticity of the domestic demand for importables (η) in absolute value.

With equation (10-3), the total tariff revenue for the case where there is no domestic production can be derived as follows:[53]

$$R = tP_{cif}\,Q_0^m + t^2P_{cif}\,Q_0^m\,\eta \qquad (10\text{-}4)$$

In the case where there is competing domestic production, the total tariff revenue can be calculated below:[54]

$$R = tP_{cif}\,Q_0^m + t^2P_{cif}\,Q_0^m\,\eta^m \qquad (10\text{-}5)$$

[53] The percentage change in prices is equal to the tariff rate imposed on imports. Furthermore, $\eta^m = \eta$ in this case.

[54] The formula can be derived from imposing an ad valorem excise tax obtained in the previous chapter: $R = tP_0Q_0 +$

Example:

Q: Imports of spirits in Kenya are valued at about Ksh 80 million, and Ksh 20 million worth are produced domestically. Suppose that the price elasticity of demand for spirits is -1, and the local supply elasticity is 0.8. How much revenue can the government raise if a tariff of 25% is introduced?

A: Substituting the numbers into equation (10-3) yields the elasticity of demand for imports:

$$\eta^m = (-1)\,[(80+20)/80] - (0.8)\,[20/80] = -1.45$$

The total tax revenue can be estimated by using equation (10-5):

$$R = (0.25)\,(80) + (0.25)^2\,(80)\,(-1.45) = \text{Ksh } 12.75 \text{ million.}$$

10.3 Imposition of Export Duties

If export duties are imposed on goods, the total amount of export duties can be derived in the same manner as for import tariffs. That is,

$$R = t * P_{fob} * Q_1^e$$

$$= t\, P_{fob}\, Q_0^e + t^2\, P_{fob}\, Q_0^e\, \varepsilon^e \qquad (10\text{-}6)$$

Where t : Export duty rate,

P_{fob} : Export price,

Q_0^e and Q_1^e : Quantity of exports before and after imposition of export duty,

ε^e : Supply elasticity of exports.

$t^2 P_0Q_0 * \eta\, (1+\in) / [\in-\eta\, (1+t)]$. In this case, η^m is greater than η in absolute value term.

10.4 Revenue Forecasting[55]

This section deals with the revenue forecasting of import tariffs when the forecast for the GDP growth rate and the change in the price of imports relative to the GDP deflator are given. The impact on the tariff revenue for the following year, say, 1997, can be calculated through the following two equations:

$$\%\Delta Imports = (\%\Delta GDP) * \eta_{gdp}^{m} + (\%\Delta P_{gdp}^{m}) * \eta_{p}^{m} \qquad (10\text{-}7)$$

$$R_{1997} = R_{1996} * [1 + (\%\Delta Imports) * \eta_{m}^{r}] \qquad (10\text{-}8)$$

Where η_{gdp}^{m} : Import elasticity with respect to GDP,

η_{p}^{m} : Import elasticity with respect to the prices of imports relative to the GDP deflator,

η_{m}^{r} : Tariff revenue elasticity with respect to imports,

ΔP_{gdp}^{m} : Change in the price of imports relative to the GDP deflator,

R_{1996} : Tariff revenue of 1996.

The key is to estimate η_{gdp}^{m}, η_{p}^{m}, and η_{m}^{r} . These elasticities can be obtained through regression analysis.

Example:

Q: Table 10.1 displays detailed information of revenue collection from import duties forecast for the year 1996 in India. Information related to the value of imports and tax duties collected is expressed in nominal terms. GDP is expressed in 1993 prices. Two price indices are also provided: the import price index and the GDP deflator. What would be the revenue from import tariffs for 1996, assuming an annual GDP growth rate of 2% and a price increase of imports relative to the GDP deflator at 3% for 1996?

A: The methodology followed to forecast revenue from import duties involves a three step process. First, the elasticity of demand for imports is obtained by regressing real imports (i.e., imports in nominal dollars divided by the import price index) with real GDP and relative prices (i.e., the import price index divided by the GDP deflator) in log form. Results from this regression are presented below:

$$\text{Ln (Imports)} = -3.7248 + \underset{(11.15)}{1.1592} \text{ Ln (GDP)} - \underset{(1.96)}{0.4059} \text{ Ln (Relative Prices)}$$

$$R^2 = 0.9207$$

where parentheses indicate the t-statistic error of coefficients. They are all statistically significant at the 5%level. In other words, the import elasticity with respect to the GDP is 1.1592, while the price demand elasticity for imports is about - 0.4059.

The second step is to estimate the elasticity of tariff revenues with respect to imports. Regressing real tariff revenues (i.e., nominal import duties divided by the GDP deflator) with respect to real imports in log terms yields:

---

[55] See appendix to this chapter for step by step calculation.

Table 10.1
Revenue estimation from import taxes
Regression Analysis

Background Information										**Regression Models**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Year	Imports Nominal	Imports 1993 Price	Exchange rate	Import Duties Nomial	Import Duties 1993 Pri	GDP 1993 P.	Import price index	GDP Deflator	Relative Prices	Log Imports	Log Import Duties	Log GDP	Log relative prices
1981	125.49	309.55	7.91	34.09	95.79	3440.00	40.54	35.59	1.1391	5.7351	4.5621	8.1432	0.1302
1982	136.08	338.42	8.97	42.02	107.06	3650.00	40.21	39.25	1.0245	5.8243	4.6734	8.2025	0.0242
1983	142.93	347.09	9.67	50.45	119.63	3763.00	41.18	42.17	0.9765	5.8496	4.7844	8.2330	-0.0238
1984	158.31	416.50	10.34	55.69	125.20	4071.00	38.01	44.48	0.8545	6.0319	4.8299	8.3116	-0.1572
1985	171.34	350.75	11.89	69.94	142.41	4228.00	48.85	49.11	0.9947	5.8601	4.9587	8.3495	-0.0053
1986	196.58	409.71	12.24	95.26	180.25	4400.00	47.98	52.85	0.9079	6.0154	5.1943	8.3894	-0.0967
1987	200.96	477.23	12.78	114.71	202.74	4588.00	42.11	56.58	0.7443	6.1680	5.3119	8.4312	-0.2954
1988	222.44	460.16	12.97	136.36	221.36	4786.00	48.34	61.60	0.7847	6.1316	5.3998	8.4735	-0.2424
1989	282.35	503.84	14.48	157.55	236.49	5296.00	56.04	66.62	0.8412	6.2223	5.4659	8.5747	-0.1729
1990	353.28	512.00	16.65	179.08	248.00	5661.00	69.00	72.21	0.9555	6.2383	5.5134	8.6414	-0.0455
1991	431.98	534.63	17.97	505.68	634.08	5965.00	80.80	79.75	1.0132	6.2816	6.4522	8.6937	0.0131
1992	478.51	512.43	24.47	550.77	600.82	6018.00	93.38	91.67	1.0187	6.2392	6.3983	8.7025	0.0185
1993	633.75	633.75	30.65	237.17	237.17	6279.00	100.00	100.00	1.0000	6.4517	5.4688	8.7450	0.0000
1994	731.01	716.68	31.37	222.40	202.18	6531.00	102.00	110.00	0.9273	6.5746	5.3092	8.7843	-0.0755
1995	887.05	844.81	31.37	264.65	218.72	6844.00	105.00	121.00	0.8678	6.7391	5.3878	8.8311	-0.1418

1. Regression real imports on real GDP and relative prices.

Regression Output

Constant		-3.7248
Std. Err of Y est.		0.08679
R Squared		0.920781
No. of Observations:		15
Degrees of freedom		12
X Coefficient(s)	1.159163	-0.40589
Std. Err of Coe	0.1039	0.2074
T - statistic	11.151	-1.956

2. Regression real revenues on real imports

Regression Output

Constant	-1.256
Std. Err of Y est.	0.4725
R Squared	0.309
No. of Observations:	15
Degrees of freedom	13
0	
X Coefficient(s)	1.0670
Std. Err of Coef.	0.4423
T - statistic	2.412

3. Revenue Forecasting

Assume GDP growths at 2% and relative price increase by 3% for 1996

% change of imports	=	0.011007
Revenue 1996	=	267.758

$$\text{Ln (Tariff Revenues)} = -1.256 + 1.0670 \text{ Ln (imports)}$$
$$(2.41)$$
$$R^2 = 0.309$$

This indicates that imports are statistically significant at the 5% level. The elasticity of tariff revenues with respect to imports is 1.067.

The third step is the following. With an annual GDP growth rate of 2% and a relative price increase of 3% for 1996, the import duty in 1996 can be forecast using the above estimated elasticities:

$$\%\Delta \text{ in Imports} = (2\%)*(1.1592) + (3\%)*(-0.4059) = 0.011007$$

$$R_{1996} = 264.65 * [1+ (0.011007 * 1.0670)] = 267.758 \text{ Rp.bn.}$$

10.5 Effect of Change in Tariff Rates on Revenue

Figure 10.2 shows the effect on revenue collection when a change in the tariff rate is introduced. Assuming that the supply curve is completely elastic and that there is no domestic supply, with an increase in the tariff rate from t_1 to t_2, the quantity of imports demanded decreases from Q_1 to Q_2. Revenue collected before the tariff rate increase is represented by the area CEHF. Revenue collection under the new tariff rate is given by ABGF, which means that the government loses area DEHG, but gains area ABDC. Therefore, the revenue impact from a change in the tariff rate can be measured in the following way:

$$\Delta R = (t_2 - t_1)*P_{cif}*Q_2 + t_1*P_{cif}*\Delta Q$$

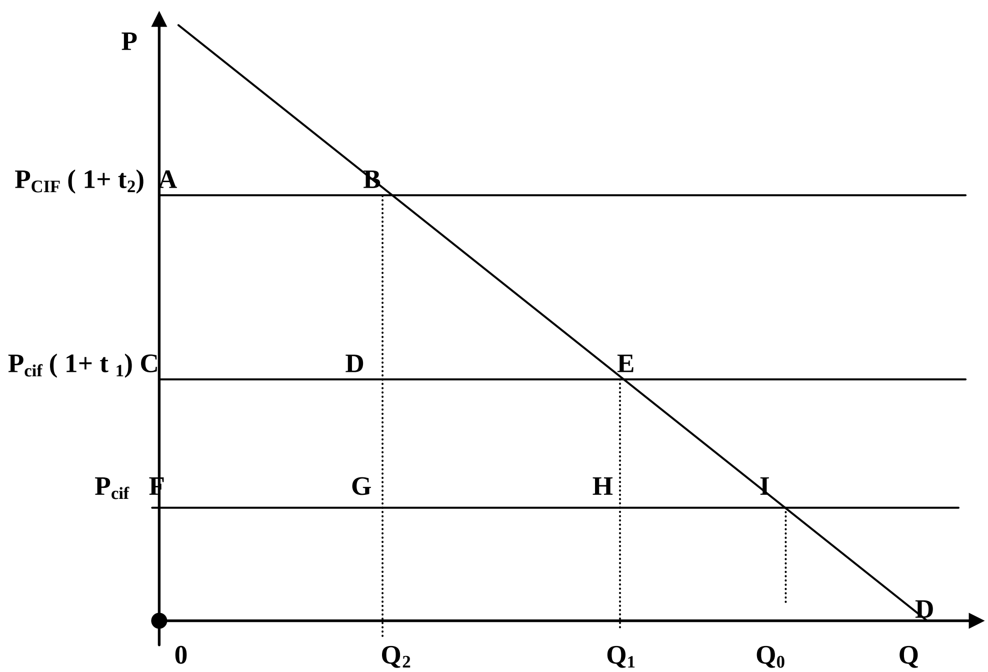
$$= \Delta t*P_{cif}*(Q_1 + \Delta Q) + t_1*P_{cif}*\Delta Q \qquad (10\text{-}9)$$

Given the elasticity of demand for imports $\eta = (\Delta Q/\Delta P) * (P/Q)$, substituting $\Delta Q = \eta\Delta P*(Q/P)$ into equation (10-9) yields:

$$\Delta R = \Delta t * P_{cif} \{Q_1 + \eta\Delta P*Q_1/[P_{cif}(1+t_1)]\} + t_1* P_{cif} * \eta\Delta P*Q_1/[P_{cif}(1+t_1)]$$

Figure 10.2

Effect on Revenue from a Change in Tariff Rate



Because the total tariff revenue before the change in tariff rate is $R = t_1 * P_{cif} * Q_1$ and the change in the price of goods caused by the change in the tariff rate is $\Delta P = P_{cif} (\Delta t)$, the impact on revenue expressed in percentage can be calculated as follows:

$$\Delta R/R = (\Delta t / t_1) * [1 + \eta\Delta t/(1+ t_1)] + \eta\Delta t / (1+t_1) \qquad (10\text{-}10)$$

When there is domestic supply and the tariff rate increases from t_1 to t_2, a similar formula can be derived for the impact on revenue:

$$\Delta R/R = (\Delta t / t_1) * [1 + \eta^m\Delta t/(1+ t_1)] + \eta^m\Delta t / (1+t_1) \qquad (10\text{-}11)$$

where η^m is the demand elasticity for imports.

Example:

Consider again the case of spirits in Kenya -- assume the government is analyzing the revenue impact of an increase in the tariff rate from 25% to 35%. With the price elasticity of demand calculated at -1 and using equation (10-10), the change in revenue is obtained by:

$$\Delta R/R = (0.10/0.25) [1 + (-1)(0.10/1.25)] + (-1)(0.10/1.25) = 0.288$$

Thus, an increase in the tariff rate from 25% to 35% is expected to raise revenue collection for the government by 28.8%.

Now, suppose that Kenya also produces spirits locally. The formula used to compute the effect of a change in the tariff rate is equation (10-11), but one has to first calculate η^m. The results are presented below:

$$\eta^m = (-1) [(80+20)/80] – (0.8) [20/80] = -1.45$$

$$\Delta R/R = (0.10/0.25) [1 + (-1.45)(0.10/1.25)] + (-1.45)(0.10/1.25) = 0.2376$$

Since the elasticity of demand for imports is –1.45, the effect on tariff revenue would be an increase of 23.76%. Given the initial tariff revenue at the tariff rate of 25% of Ksh 12.75 million, the revenue after the change in tax rate is estimated at Ksh 15.78 million (= Ksh 12.75*1.2376).

10.6 Effect of a Devaluation in Domestic Currency on Revenue

The level of market exchange rate in an economy has an important bearing on the tax base for tariff revenues. Given the relative importance of revenue collection from tariffs in developing countries, movements in the exchange rate and changes in the value of imports can have a large impact on total tax revenue collection in these economies.

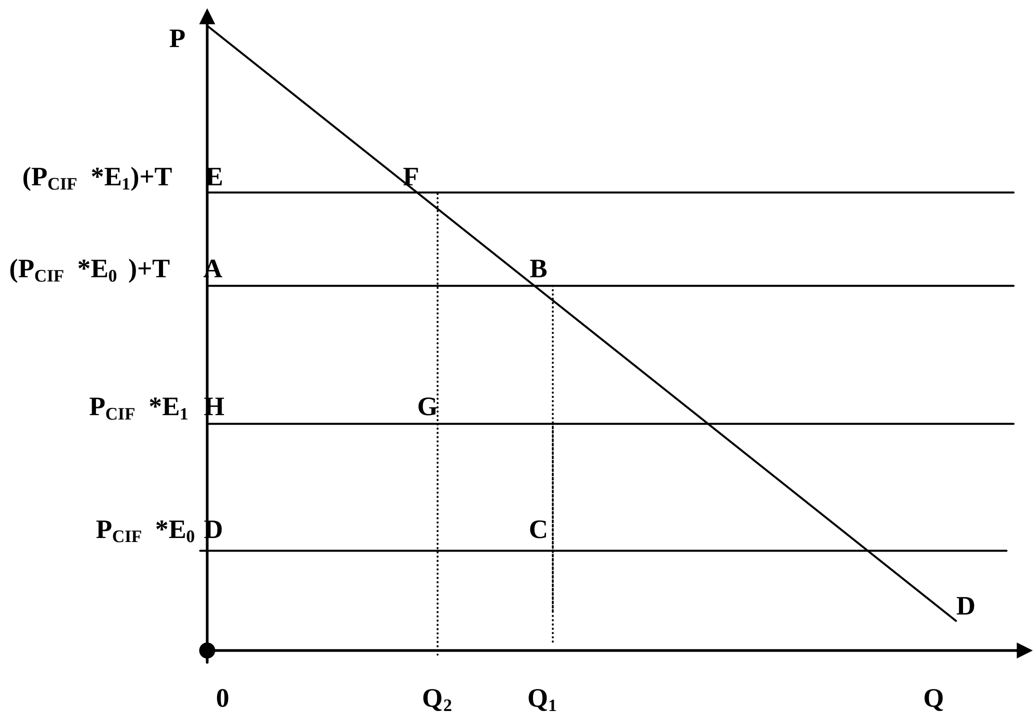
Exchange rate is defined as the price of a foreign currency. A devaluation of the domestic currency implies that imports from abroad become more expensive for domestic purchasers, while exports are cheaper for foreign buyers.

The effect of devaluation on revenue collection from an import tariff (T) is shown graphically in Figure 10.3. Given an initial foreign exchange rate equal to E_0, the imposition of a tariff on imports will yield tax revenue equal to the area within points ABCD. A devaluation of domestic currency from E_0 to E_1 makes the price of importable goods greater, given by $(P_{cif} * E_1)+T$, which influences the demand for imports, which is reduced from Q_1 to Q_2. With the new domestic price of importables, the area EFGH represents revenue collection.

A devaluation of the exchange rate has two effects on revenue collection from tariffs. On the one hand, an increase in the price of imports relative to other goods implies a reduction in the tax base of tariffs, as the quantity of imports demanded,

Figure 10.3

Effect on Revenue of a Real Devaluation of Domestic Currency



decreases. On the other hand, an increase in the domestic price of imports caused by a devaluation of the domestic currency has a positive effect on the tax base for tariffs, as the value of imports expressed in domestic currency will go up. However, the total effect on tax revenue -- that is, whether area EFGH (collection after devaluation) is greater than ABCD (collection before devaluation) -- will depend on the magnitude of both effects combined together.

When a tariff on imports is levied on a unit basis, tax revenues will, however, fall, as the tax base becomes eroded by a decrease in quantities imported, without any increase in the domestic value of imports.

In order to quantify the effect on tax revenue collection when tariffs are imposed, either in specific or ad valorem terms, through a devaluation of domestic currency, the following set of equations is developed.

The price of imports expressed in domestic currency is given by:

$$P_d = P_w * e \qquad (10\text{-}12)$$

Where P_d : Price expressed in domestic currency,

P_w : Price expressed in foreign currency,

e : Exchange rate, defined as the price of a foreign currency.

Change in domestic price of imports can be expressed as:

$$\Delta P_d = P_w * \Delta e \qquad (10\text{-}13)$$

Dividing equation (10-13) by equation (10-12) yields:

$$\Delta P_d / P_d = \Delta e / e \qquad (10\text{-}14)$$

A. Case of a Specific tariff

When a specific tariff (T) is levied on imports (Q), the total revenue can be calculated by:

$$R = T * Q_0 \qquad (10\text{-}15)$$

As a result of currency depreciation, the change in tariff revenue is given by:

$$\Delta R = T * \Delta Q_O \qquad (10\text{-}16)$$

Given that $\eta = (\Delta Q/\Delta P) * (P/Q)$, hence $\Delta Q = \eta \Delta P * Q_0/(P_0+T)$, where P_0 is the price exclusive of tariff. Substituting ΔQ into equation (10-16), and dividing equation (10-16) by equation (10-15):

$$\Delta R/R = \eta(\Delta P/P_0) * P_0/(P_0 + T) \qquad (10\text{-}17)$$

Substituting equation (10-14) for equation (10-17) yields:

$$\Delta R/R = \eta(\Delta e/e) * P_0/(P_0+T) \qquad (10\text{-}18)$$

Given the fact that the elasticity of demand for imports has by definition a negative sign, an increase in devaluation will produce a negative impact on revenue collection. Therefore, with a specific tariff on imports, devaluation of the domestic currency will make tax revenue collection from tariffs decrease, as quantities imported from abroad decline. To avoid this erosion of the tax base, governments have to continuously introduce discretionary changes into the specific tariff system in order to maintain or increase revenue collections in real terms.

B. Case of an Ad Valorem Tariff

In contrast to the specific tariff case, ad valorem tariffs are levied on the value of imports, rather than on the quantities imported. By using Figure 10.3, revenue collected from an ad valorem tariff (t) on imports is given by:

$$R = t\, P_{cif} * e_0 Q_0 \qquad (10\text{-}19)$$

As a result of currency devaluation, equation (10-19) can be expressed as:

$$\Delta R = t\, P_{cif} (e_0\, \Delta\, Q_0 + Q_0\, \Delta e_0) \qquad (10\text{-}20)$$

Since the change in quantity imported is equal to $\Delta Q = \eta \Delta P/P0 * Q0$, $P = Pcif\ e0\ (1+ t)$, and $\Delta P = P_{cif}\ \Delta e_0\ (1+ t)$, $\Delta P/P_0 = \Delta e_0 / e_0$ equation (10-20) becomes:

$$\Delta R = t\ P_{cif}\ (\ e_0\ \eta \Delta P/\ P_0 * Q_0 + Q_0\ \Delta e_0\ )$$
$$= t\ P_{cif}\ (\eta \Delta e_0 * Q_0 + Q_0\ \Delta e_0\ )$$
$$= t\ P_{cif}\ Q_0\ \Delta e_0\ (1+ \eta) \qquad (10\text{-}21)$$

Dividing equation (10-21) by equation (10-19) and using equation (10-14):

$$\Delta R/R = = (1 + \eta) * \Delta e_0/e_0 \qquad (10\text{-}22)$$

In contrast with the specific-tariff case, the net effect on tax revenues of a devaluation in the domestic currency depends not only on the negative impact on quantities imported, but also on the positive effect on the increase in the amount of domestic currency.

Example:

Q. Assume that a tariff of Ksh 80 per box is imposed on imports of wine for a given developing country. The initial price of wine is Ksh 200 per box, the price elasticity of demand is estimated to be -1, and there is no domestic production of wine in the economy. What is the effect on revenue collection if the currency Ksh is devaluated from 20 Ksh/Fr. to 30 Ksh/Fr in terms of francs?

A. Using equation (10-18):

$$\Delta R/R = (-1)(10/20) * [200/(200+80)] = -0.357$$

A devaluation of 50% in the domestic currency will reduce revenue collection from the tariff on wine by 35.7%. As implied in equation (10-18), any increase in the devaluation rate of the domestic currency will produce a negative impact on revenue collection from a specific tariff, assuming everything else remains constant. The results obtained from the sensitivity analysis presented on Table 10.2 provide the same conclusion as obtained from equation (10-18). Table 10.2 presents different percentage changes in revenue collection if the currency is devalued from Ksh 10 to Ksh 150 per unit in the case of a specific tariff regime under different elasticity of demand measures from -0.1 to -1.5. It becomes clear from the results that changes in revenue collection from the currency devaluation are always negative at any tariff value or elasticity level.

Assume instead the case of an ad valorem tariff of 15% levied on the value of wine imports. Substituting the same information in equation (10-22):

$$\Delta R/R = (10/20) * [1 + (-1)] = 0$$

The same devaluation of domestic currency will have no impact on revenue from the imposition of an ad valorem tariff on imports of wine.

Table 10.2

EFFECT OF REAL DEVALUATION

SENSITIVITY ANALYSIS

A: SPECIFIC TARIFF

Elasticity of demand for imports

Tariff	-0.1	-0.5	-1	-1.2	-1.5
10	-4.76%	-23.81%	-47.62%	-57.14%	-71.43%
25	-4.44%	-22.22%	-44.44%	-53.33%	-66.67%
40	-4.17%	-20.83%	-41.67%	-50.00%	-62.50%
60	-3.85%	-19.23%	-38.46%	-46.15%	-57.69%
80	-3.57%	-17.86%	-35.71%	-42.86%	-53.57%
95	-3.39%	-16.95%	-33.90%	-40.68%	-50.85%
110	-3.23%	-16.13%	-32.26%	-38.71%	-48.39%
130	-3.03%	-15.15%	-30.30%	-36.36%	-45.45%
150	-2.86%	-14.29%	-28.57%	-34.29%	-42.86%
160	-2.78%	-13.89%	-27.78%	-33.33%	-41.67%

B: AD-VALOREM TARIFF

Elasticity of demand for imports

Tariff rate	-0.1	-0.5	-1	-1.2	-1.5
1%	45.00%	25.00%	0.00%	-10.00%	-25.00%
5%	45.00%	25.00%	0.00%	-10.00%	-25.00%
10%	45.00%	25.00%	0.00%	-10.00%	-25.00%
12%	45.00%	25.00%	0.00%	-10.00%	-25.00%
15%	45.00%	25.00%	0.00%	-10.00%	-25.00%
18%	45.00%	25.00%	0.00%	-10.00%	-25.00%
20%	45.00%	25.00%	0.00%	-10.00%	-25.00%
25%	45.00%	25.00%	0.00%	-10.00%	-25.00%
30%	45.00%	25.00%	0.00%	-10.00%	-25.00%

10. 7 SUMMARY

- Although the importance of trade taxes relative to total government tax collections has been declining in the developed countries, trade taxes still account for nearly one third of total tax revenue in the developing countries. This is due to the following factors:

  a) trade taxes are generally easy to collect, as they are levied and administered at a few specific points throughout the border of a country;
  b) trade taxes provide a useful economic policy tool for governments to achieve certain goals of economic development;
  c) trade taxes have an influence on the foreign exchange market in the economy and also contribute to savings and earnings in foreign currencies.

- When a tariff is imposed, it will:

  a) raise the price paid by consumers by the amount of tax, thus lowering consumption;
  b) enable domestic producers to produce more, as prices for the taxed commodity increase;
  c) reduce imports, while the government would collect some revenue;
  d) impose a deadweight loss on the economy.

- The methodology developed to forecast revenue from the imposition of import duties involves a three step process. First, one must estimate the elasticity of demand for imports by regressing real imports (i.e., imports in nominal dollars divided by the import price index) with real GDP and relative prices (i.e., the import price index divided by the GDP deflator) in log form. Second, estimate the elasticity of real tariff revenue (i.e., tariff revenues in nominal dollars divided by the GDP deflator) with respect to the tax base (i.e., imports). Third, forecast the future tariff revenue by using estimated annual GDP growth rates and relative prices of imports.

- A devaluation of the domestic currency has an important bearing on tariff revenue. In the case of a specific tariff, devaluation will lower revenue collection. In the case of an ad valorem system, the net impact on tax revenue will depend upon the magnitude of η in absolute value.

Appendix

Steps in Calculating Tax Revenue from Imports

Example 1

Table 10.3 Shows the revenue collected from trade taxes:

Table 10.3
Revenue estimation from import taxes
Regression Analysis

Background Information										Regression Models			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Year	Imports		Exchange rate	Import Duties		GDP 1993 P.	Import price index	GDP Deflator	Relative Prices	Log Imports	Log Import Duties	Log GDP	Log relative prices
	Nominal	1993 Price		Nomial	1993 Pri								
1981	125.49	309.55	7.91	34.09	95.79	3440.00	40.54	35.59	1.1391	5.7351	4.5621	8.1432	0.1302
1982	136.08	338.42	8.97	42.02	107.06	3650.00	40.21	39.25	1.0245	5.8243	4.6734	8.2025	0.0242
1983	142.93	347.09	9.67	50.45	119.63	3763.00	41.18	42.17	0.9765	5.8496	4.7844	8.2330	-0.0238
1984	158.31	416.50	10.34	55.69	125.20	4071.00	38.01	44.48	0.8545	6.0319	4.8299	8.3116	-0.1572
1985	171.34	350.75	11.89	69.94	142.41	4228.00	48.85	49.11	0.9947	5.8601	4.9587	8.3495	-0.0053
1986	196.58	409.71	12.24	95.26	180.25	4400.00	47.98	52.85	0.9079	6.0154	5.1943	8.3894	-0.0967
1987	200.96	477.23	12.78	114.71	202.74	4588.00	42.11	56.58	0.7443	6.1680	5.3119	8.4312	-0.2954
1988	222.44	460.16	12.97	136.36	221.36	4786.00	48.34	61.60	0.7847	6.1316	5.3998	8.4735	-0.2424
1989	282.35	503.84	14.48	157.55	236.49	5296.00	56.04	66.62	0.8412	6.2223	5.4659	8.5747	-0.1729
1990	353.28	512.00	16.65	179.08	248.00	5661.00	69.00	72.21	0.9555	6.2383	5.5134	8.6414	-0.0455
1991	431.98	534.63	17.97	505.68	634.08	5965.00	80.80	79.75	1.0132	6.2816	6.4522	8.6937	0.0131
1992	478.51	512.43	24.47	550.77	600.82	6018.00	93.38	91.67	1.0187	6.2392	6.3983	8.7025	0.0185
1993	633.75	633.75	30.65	237.17	237.17	6279.00	100.00	100.00	1.0000	6.4517	5.4688	8.7450	0.0000
1994	731.01	716.68	31.37	222.40	202.18	6531.00	102.00	110.00	0.9273	6.5746	5.3092	8.7843	-0.0755
1995	887.05	844.81	31.37	264.65	218.72	6844.00	105.00	121.00	0.8678	6.7391	5.3878	8.8311	-0.1418

Step 1: Covert all data from Nominal to Real terms

- Covert the data from nominal to real prices, including the nominal in (a) import values (column 1); (b) import revenue (column 4); and (c) GDP (column 6) to real terms (columns 2,5,6). The conversion formulae is: Real = (Nominal/deflator) *100. The deflator to be used for converting import values to real imports and tariff revenue to real imports is :
- Real GDP = as GDP is already in 1993 prices in this example, one does not need to deflate it anymore;
- Real import (column 2)= [imports in nominal dollars/ import price index] = (Column 1/Column 7) *100
- Real import duties (column 5) = [nominal import duties/ GDP deflator]= (Column 4 /Column 8) *100

Step 2: Calculate the relative price

- Relative prices (column 9) = [import price index / GDP deflator] = (Column 7/ Column 8)

Step 3: Estimate various elasticities

- Estimates of the following three elastcities are required to forecast tariff revenues for future years:

  1. Elasticity of imports to GDP;
  2. Elasticity of imports relative to prices;
  3. Elasticity of tariff revenues to imports.

- The data in real prices are first converted into log form and then regressed to obtain respective elasticities. (See box of Table 10.2).

- Once the elaticities are known, the numbers are substituted into the formulae in Step 4 to get the forecast revenue.

Step 4: Forecast tariff revenue for future years (Table 10.4)

- Forecast revenue = (1+ % change in imports*elasticity of revenue to imports)*(tariff revenue in previous year);

  where % change in imports = (% change in GDP) * (elasticity of imports to GDP)
  + (% change in relative prices) * (elasticity of imports to relative prices).

Example 2: Excel format to do sensitivity analysis

$ sign **<u>before</u>** the letter (Say A35 => $A35) => row changes but the column stays the same;

$ sign **<u>after</u>** the letter (Say A35 => A$35) => column changes but the row stays the same.

Table 10.4

A	B	C	D	E	F	G	H	I
			% Change in relative price:					
1	% change in GDP		0%	1%	2%	3%	4%	5%
2		0%	**264.650**	263.504	262.358	261.212	260.065	258.919
3		1%	267.923	266.777	265.631	264.485	263.339	262.192
4		2%	271.197	270.050	268.904	267.758	266.612	265.466
5		3%	274.470	273.324	272.177	271.031	269.885	268.739
6		4%	277.743	276.597	275.451	274.305	273.158	272.012
7		5%	281.016	279.870	278.724	277.578	276.432	275.286
8		6%	284.290	283.143	281.997	280.851	279.705	278.559
9	E. of imports to gdp=		1.159163					
10	E. of imports to relative price=			-0.40589				
11	E. of revenue to imports =			1.067				
12	Previous years revenue=			264.65				

The format to calculate D2 (shaded area) = (1+((D$1*$A$10)+($C2*A9))*A11)*A12