Chapter 4: The System of National Income and Product Accounts

Chapter Outline

4.1 Measuring National Output

4.2 Components of GDP

- Consumption *(C)*
- Investment *(I)*
- Government spending *(G)*
- Exports *(X)* minus imports *(M)* or Net Exports *(NX)*

4.3 Equivalence of Three Measures of GDP

- Expenditure approach
- Production approach
- Income approach

4.4 GDP versus GNP

4.5 Measuring Gross National Income

4.6 GDP Growth and The Price Deflator

4.7 Measuring CPI Inflation

- The CPI index
- Rate of growth of the CPI index

4.8 Measuring National Inequality

Appendix: Advanced Material

- Chain weighted real GDP
- Measuring net national income
- Difficulties in using the CPI to accurately measure inflation

Learning Objectives

1. Understand how GDP is measured and why different measures of GDP are equivalent.
2. Recognise the deficiencies of GDP as a measure of welfare.
3. Derive (CPI) indexes and their rate of change.
4. Interpret measures of income inequality

4.1 Measuring National Output

The System of National Income and Product Accounts (NIPA) is the framework assembled by national statisticians for **measuring** economic activity.

In this chapter we look at national income accounting - that is how we measure total national spending and its components as well as national income and its components. The most important measure of economic production is Gross Domestic Product or GDP. Let us first provide a formal definition.

GDP is the measure of all currently produced final goods and services evaluated at market prices.

Note that GDP is a flow measure, hence it must have a time dimension: month, quarter, and year are the most common periods over which the flow of production is measured.

Let us emphasize the most important parts of the definition:

Currently produced: This includes only goods and services produced over the time period, and would exclude goods sold this period that had been produced previously. Hence this measure excludes sales of 'used' goods.

Final goods and services: This includes only goods and services sold to final users - whether these are consumers, firms or government. Households buy final consumer goods and services; firms buy investment goods to increase capacity, and government buys goods and hires services. Intermediate goods and services are excluded. For example, an auto manufacturer buys tyres to put on new cars for sale. These are intermediate goods and if we were to count those tyres as part of GDP, and then count the value of automobiles produced, we would double-count the value of tyres (since the value of the automobiles would include all the intermediate goods and services that go into producing the automobiles). For that reason, we count only the value of final goods and services.

Evaluated at market prices: We calculate the value of final goods and services at market prices. This means that GDP is calculated at nominal values. We use another measure of GDP to take account of the impact of price changes, called real GDP. Note that unless specifically designated as 'real GDP' when we say GDP we mean nominal GDP, calculated at current market prices. We will discuss real GDP below.

A system used for calculating the value of a nation's output and income has been developed, called the National Income and Product Accounts, or NIPA. Note that the statisticians who compile these accounts must make many decisions about what to include and what to exclude. While the decisions are not arbitrary, it is important to recognise that they are conventions - in other words, there is nothing sacrosanct about them, and the conventions could be changed by agreement.

For example, washing your own dishes at home is not included in GDP. However, if you hire your neighbour to wash your dishes, that should be counted in GDP as dishwashing services. (Note that we said 'should' because if you pay your neighbour 'under the table' and neither of you report it, the transaction might not get captured in the official numbers.) This makes some sense because in the first case there was no monetary exchange and no market price at which the service took place, while in the second there is the market price that you paid for the service. However, by excluding all the unpaid household services performed including cleaning, repairs

and upkeep, and child and elder care, the NIPA numbers exclude a huge proportion of the nation's production.

More importantly, it undercounts the contribution made especially by women to production, since they perform a disproportionate amount of unpaid work. Many economists have called for reform of the accounting conventions to include more unpaid work in order to give greater recognition to the social value of 'women's work'.

GDP also excludes black market, grey market, and much of the production in the informal sector. This has largely to do with the difficulty of collecting the data. Black market transactions are illegal, even though the good or service, *per se*, may be legal. For example, the sale of cigarettes on which duty has not been paid is illegal. On the other hand, the drug and sex trade involves illegal transactions in illegal goods and services.

In the grey market legal, non-counterfeit goods are sold outside normal distribution channels. For example, if a brand of cameras is very expensive in a particular country, an enterprising local trader may import them from a country where the price is low and sell them in competition with the official supplier(s) of the camera. Many nations do attempt to estimate such activity and even include at least some of it in official measures of GDP. Much of the informal activity is similar to household production discussed above. For example, in many developing nations, much of the food production does not reach formal markets—it is consumed by farmers and shared or sold in local markets without being subject to proper recording. Other activity is 'under the table', and unrecorded to escape taxes. While the size of the black market is sometimes estimated in countries, typically it is not included in their official measures of GDP. However in late 2014 the office of national statistics in Italy announced that the estimation of its GDP would in future include illegal activities, notably "drug trafficking, prostitution and smuggling services (cigarettes and alcohol)." (The Economist, 2014).

Another problem is that GDP is not necessarily a good measure of production as a contribution to economic well-being. For example, a factory might pollute the air and water supply while it is producing 'widgets' (widget is a generic term for a produced commodity). The social, health, and environmental costs are not deducted from the value of the widgets produced for the purposes of measuring GDP. However, if society had to hire workers and produce machinery in order to clean up the pollution coming from the widget factory, that would be counted toward GDP. Ironically, production of widgets would then count twice toward GDP, once for the value of the widgets produced and secondly for the value of cleaning up the environmental mess.

Furthermore, if neighbours of the widget factory get sick from the pollution, then the healthcare spending required to treat them also gets counted in GDP. For that reason, GDP can be a poor measure of economic well-being, as the polluting industries might actually make a negative contribution to our general earning standard even as they increase GDP.

Still another problem is inequality. It does not make any difference to the calculation of GDP whether almost all production goes to the top 10 per cent of individuals or households, so that the bottom 90 per cent gets next to nothing. The GDP measure simply adds up production without taking account of the distribution of the output. This can make GDP a bad measure for comparing earning standards across countries.

It is common to divide a nation's GDP by its population, to derive per capita GDP. We can then rank nations according to per capita GDP, classifying some as rich, some as middle income, and

some as poor. However, per capita GDP simply provides a measure of the average and that can be highly misleading as a guide to the standard of living of the typical resident of a nation.

For example, the average could be $35,000 per capita in two very different nations. In Country A, the share of GDP of the top 1 per cent might be 90 per cent, leaving the remaining 99 per cent to share only 10 per cent of the nation's output, while in Country B the distribution could be nearly equal, with 99 per cent of the population living within a few thousand dollars of the $35,000 average. Clearly, economic well-being would be more widely shared in Country B, with very few poor people but also few people living much above the average. There is a measure of inequality that measures distribution called the **Gini Coefficient**, which we discuss later in this Chapter.

There are alternative measures of economic well-being that attempt to get around these problems. Some try to measure household production. Others take account of inequality, poverty, and access to education and healthcare. Some measures deduct social, health, and environmental costs. For example, our hypothetical widget factory just discussed might actually make a net negative contribution to economic well-being - it would be beneficial to close the factory and thereby increase social welfare even while foregoing consumption of widgets.

As a real world example, tobacco smoking increases GDP due to sales of tobacco, spending to capture smoke to make indoor air cleaner, and tremendous amounts of spending on healthcare for tobacco users and all those who suffer from the effects of second-hand smoke. Eliminating tobacco use would undoubtedly enhance well-being but might reduce GDP. For these reasons, when addressing economic, social, and environmental well-being, we need alternatives to GDP.

Still, GDP is the most commonly used measure and it does have one big advantage: it focuses largely on monetary value of output. As we have discussed, the profit motive drives capitalistic production. It can be characterised as M-C-M', that is it begins with money (M) to produce commodities for sale (C) for more money (M'). For that reason, GDP is an appropriate measure for the capitalist sphere of production as it focuses on production for sale in exchange for money.

Still, it is not perfect even for that narrow purpose. For example, GDP does include imputed monetary values for some production that is not actually sold. The most important example is the 'services' of owner-occupied housing. The idea is that the homeowner 'consumes' housing services over the course of the period. If the home is not owned, we can use instead the rent paid as a value of the housing services consumed by the renter. The problem is that many families live in homes they purchased so there are no market transactions that takes place over the period.

Note that when a new home is purchased, that is counted as residential investment (included in the investment category, not the consumption category, see the next section). It would not make sense to count the **entire** market value of a home as consumption over the period. Further, most homeowners have purchased a 'used' home, so that purchase will not show up in either the investment category or the consumption category. For that reason, the imputed monetary value of the housing services over the period is counted as consumption – whether or not the home is new or used. Still, by including imputed values, our measure of GDP deviates from the ideal of capturing the total value of production that is sold at market prices over the period.

4.2 Components of GDP

The National Income and Product Accounts (NIPA) divide the nation's output into four main categories, and add a fifth to account for foreign production that is available to the nation's residents. These are: Consumption, Investment, Government Expenditure, Exports and Imports. Each of these can be further subdivided.

Consumption *(C)*

This includes domestic consumption by **households** of goods and services. Keep in mind from our definition of GDP that only currently produced final goods and services are included. Intermediate goods and services are excluded, as are sales of used goods.

Generally speaking, all current period spending on new goods and services by households is included as consumption. The only major exceptions are the purchase of a newly built house, which is included as investment spending (see below), and the inclusion of 'imputed' housing services of owner-occupied homes, which is counted as consumption.

What is most confusing for students is that household 'investment' in shares and bonds is not included in GDP at all. This is because shares and bonds are not currently produced goods and services. Indeed, purchase of financial assets of any type is treated by the NIPA System as saving, not as spending.

Investment *(I)*

This includes three main categories: capital investment by firms, inventory investment by firms, and real estate investment by households. Investment expenditure increases the productive capacity of the economy and expands what we think of as **potential GDP**. So it adds to current spending but increases the capacity of the economy to absorb increases in future spending without inflation.

Capital investment includes spending on plant and equipment - factories and machines, for example. Increasingly, investment includes purchases of software and other non-physical but long-lasting inputs to production.

As discussed, we do not want to include intermediate goods in GDP, so purchases by firms of inputs that are 'used up' in the production process are not included as investment - inputs such as electricity, oil and other natural resources, marketing services, and so on. Note that the precise division between an intermediate input and an investment is necessarily somewhat arbitrary, and so will rely on accounting conventions and will be related to the input's useful life.

Again, purchases of financial assets are not included as investment. For example, if one firm takes over another, that is not an investment for purposes of measuring GDP. Also note that if a household buys a car it is counted as consumption, but if a business buys a car it is counted as investment - even if the firm operates out of a home office of the same household!

The value of unsold goods is defined as inventory investment. An increase of inventories is also treated as an investment, even if the firm did not plan to increase its inventories. For example, a firm might have produced output that it was not able to sell by the end of the accounting period. If a firm sells more output than planned, its inventories are reduced. This is treated as negative

investment. Swings of inventory investment can be quite wide as it is difficult for firms to sell precisely the amount that they planned.

Finally, real estate investment includes new construction of residential and non-residential buildings. Sales of existing homes as well as existing commercial buildings are not included as investment. Sales of land also would not be counted as investment.

When in doubt whether the sale of an asset would be counted as investment or simply a purchase of an asset, a useful rule of thumb is to consider whether labour was used during the period to produce the asset. If it was, then this is investment; if not, then it is simply an asset purchase - which is treated as a portfolio adjustment, but not an investment. Newly produced machines, factories, houses, and apartment buildings all required current labour services to produce them, and hence, count as investment. Sales of stocks, bonds, existing houses, or existing factories do not use labour - at least in the current period - to produce them, so they are not investment.

Government spending *(G)*

This includes government purchases of final goods and services.

Note that it does not include government transfer payments, such as spending on welfare and social security. This is because if we were to include transfers we would double count since most transfer payments will be spent on consumption goods and services, hence, included in *'C'* as described above. Government transfer payments are not purchases of currently produced goods and services, so are not part of GDP.

Government purchases can be further divided between 'consumption' and 'investment' or capital expenditures. The division between these two subcategories is somewhat arbitrary. Government consumption expenditures are for goods and services that are used relatively quickly (fire-fighting services, postal delivery, and air traffic control), while government investment purchases are for long-lasting improvements (fire trucks, roads, and airports). Typically, any spending whose impacts are exhausted within a 12-month period are considered to be consumption, otherwise, they are classified as investment. Do not get confused by the use of the terms 'consumption' and 'investment' when applied to the division of government spending by type - these are under the *'G'* category and not under the *'C'* or *'I'* categories discussed above.

Exports *(X)* minus imports *(M)* or Net Exports *(NX)*

Exports are goods and services sold abroad; imports are goods and services produced abroad for domestic use. If imports are greater than exports, then net exports are negative; alternatively, if imports are less than exports, then net exports are positive. Again, these can be consumption-type goods or investment-type goods but if they are sold abroad or bought from abroad they are counted in the *NX* category, but not in the *C* or *I* category.

Exports add to domestic spending to stimulate production, whereas imports represent a drain on domestic spending.

4.3 Equivalence of Three Measures of GDP

GDP can be measured in three ways, namely the expenditure approach, the production approach and the income approach, and which, subject to the statistical discrepancy, should be equal.

The expenditure approach is conceptually the simplest because it works on the principle that total expenditures denote the value of the product that been bought, and given the inclusion of inventory investment in the definition of investment, it measures the value of total production. The production (or value added) approach is based on summing the gross outputs of every class of enterprise and then netting out intermediate consumption. The income approach works on the principle that the incomes of the productive factors (producers) must be equal to the value of their product, and determines GDP by finding the sum of all producers' incomes.

Expenditure approach

The first way to estimate GDP is to calculate the sum of final expenditures on goods and services measured in current market prices. As we discussed above, GDP ***(Y)*** is the sum of consumption ***(C)***, investment ***(I)***, government spending ***(G)*** and net exports ***(X – M)***.

(4.1) $$Y = C + I + G + (X - M)$$

Production approach

This approach measures gross value added. First it is necessary to measure the gross value of domestic output over say a year. This will include the value of output at all stages of production (see example below[4]). This will include intermediate consumption that are the costs of (raw) materials, supplies and services which were used up in the production of gross output. We then subtract the intermediate consumption from the gross value of domestic output to obtain the gross value added. If we do not subtract the intermediate consumption, then we are double counting.

Consider a three stage production process which culminates in the final sale of woollen coats to consumers. Initially sheep farmers incur costs of feed etc in rearing the sheep and pay wages to the shepherds and to the sheep shearers and then sell the wool to a woollen mill, which processes it by the employment of labour and other producers. The woollen mills then sell the processed wool to the manufacturer of the coats, which employs labour and other producers in the production of the woollen coats. For simplicity, we assume that the manufacturer sells these final goods to consumers. At each stage of the production process the value added by the producers must be calculated, so for example value added by the woollen mill is the value of sales of the processed wool minus the costs of buying the unprocessed wool and raw materials used to process the wool and the electricity costs incurred in the production process. Then we can write: value added in the production of woollen coats = gross value of output – value of intermediate consumption, which has been summed over all stages of production.

The sum of the value added across every class of enterprise is known as GDP at factor cost. GDP at factor cost plus indirect taxes less subsidies on products is GDP at producer price.

[4] If the production of all final output is vertically integrated, so a single firm is responsible for all stages of the production for each good or service, then there is no intermediate consumption.

Income approach

The third way of measuring GDP is to calculate the sum of primary incomes distributed by resident producers of goods and services. Thus this method adds together the producers' incomes that firms pay in exchange for their services, namely wages for labour, interest for capital, rent for land and profit for capitalists. This defines GDP at factor cost. It is then necessary to add indirect taxes minus subsidies to get a measure at market prices, and in turn depreciation (or capital consumption allowance) to obtain GDP.

Under the production approach, the value added at each stage of production is the additional income, which is generated, so the equivalence of the production and income approaches to the measurement of GDP is clear.

4.4 GDP versus GNP

GDP is the total value of goods and services produced within a nation regardless of the ownership of the firm producing them; GNP is the total value of goods and services produced by residents of the nation regardless of the location of the production.

GDP includes earnings from production in the domestic economy that goes to foreigners.

GNP does not, but includes foreign earnings of domestic firms and residents operating abroad. Thus the financial flows between the domestic and external sectors are not confined to net exports.

Until the early 1990s the USA tended to use GNP while many nations used GDP. However, since then the USA has conformed and adopted GDP although it still reports GNP. For the USA, there is no major difference between GDP and GNP because earning from production in the USA that go to foreigners is nearly balanced against foreign earnings of US residents. For many other nations, however, there is a large difference between GDP and GNP because, for example, their residents have large investments in factories operating abroad.

In the Appendix we show how net national income is measured (Advanced Material – Chain weighted real GDP).

4.5 Measuring Gross National Income

We initially examine **Gross National Income** (GNI) from the perspective of what can be done with income: an individual can consume it, pay taxes, or save it. As a simplification we ignore the difference between GNP and GDP, so we can write:

(4.2) $$Y = C + S + T = GDP = C + I + G + NX$$

We use Y to stand for income; C is consumption, S is gross saving and T is total taxes paid. We can think of S as a residual: it is all after-tax, (disposable) income that is not spent on consumption.

Another way of looking at GNI is from the point of view of which sector is receiving income: wages (W, which go to workers), profits (P, which goes to capitalists; note this is a gross concept which includes interest income) or taxes (T, revenue to government).

In that case we can write:

(4.3) $Y = W + P + T = GDP = C + I + G + NX$

Of course that also means that:

(4.4) $Y = C + S + T = W + P + T = GDP = C + I + G + NX$

We can easily manipulate the identity to obtain a useful identity:

Keynesian Saving Equation: $S = I + (G-T) + NX$

What is G-T? It is government deficit spending?

We'll make more use of identity (4.4) later.

4.6 GDP Growth and The Price Deflator

We have defined nominal GDP as a measure of the value of output at current market prices. We often want to measure economic growth, as measured by the growth of GDP over time. The problem is that prices, as well as output, change over time. If we find that GDP (nominal) today is 100 times greater than it was a hundred years ago, does that mean that we enjoy 100 times more physical output? Clearly not, if prices have risen. To take account of this, we often want to 'deflate' GDP, that is, to correct our measure for the change in prices to get an idea of 'real' economic growth.

The idea is simple, but in practice this is a very difficult thing to do. Let us start with the conceptual problem.

Suppose we want to compare GDP of 2015 to GDP of 2002 to see how much 'real' output grew over the thirteen-year period. To find nominal GDP in each year we take the 'current' market price of that year and multiply by the quantity produced that year. For exposition purposes, we are simplifying here by taking the quantity and price of a single aggregate good we call GDP:

(4.5a) $GDP_{2002} = P_{2002} * Q_{2002}$

(4.5b) $GDP_{2015} = P_{2015} * Q_{2015}$

where GDP_t measures GDP at current prices in year *t*, based on production level (Q_t) and market price (P_t).

However we are interested in a comparison of levels of 'real' GDP over time that corrects our measure for the change in prices. In that case, we have to decide which year's prices to use as a 'base'. We always calculate 'real GDP' over time in terms of a base year. We could choose 2002 or 2015 or any other year as the base. Let us say we choose to use the prices of 1985 (this makes it clear that we do not have to use prices of 2002 or of 2015).

Then we do the following calculation:

(4.6a) $RGDP_{2002} = P_{1985} * Q_{2002}$

(4.6b) $RGDP_{2015} = P_{1985} * Q_{2015}$

where $RGDP_t$ denotes real GDP in year *t* based on 1985 prices.

So long as we have used the same base year to calculate real GDP for both years, we can determine real GDP growth over the thirteen-year period, but the measure will reflect to some

degree the choice of the base year prices, when we consider many goods rather than a single good.

In practice, statisticians update the base year through time so that they will always use a fairly recent base year. Thus you would be unlikely to use 1900 as the base year to calculate real GDP for 2015! The older the base year used for calculations, the greater the problems encountered in calculating real GDP. We will return to these problems shortly. Before we do, there are two other useful concepts related to calculation of real GDP.

First there is the GDP deflator, which is an indicator of price changes. It is defined in year *t* as follows:

(4.7) $GDPD_t = GDP_t / RGDP_t$

where $GDPD_t$ denotes the GDP deflator for year *t*.

Changes in the magnitude of the GDP deflator over time give us a measure of prices changes for output as a whole. Note that it is possible for prices in general to go down as well as up. However, over the past century deflations have been relatively rare.

Our goal has been to develop a method for adjusting GDP for price changes. In practice it is much more difficult than suggested by the earlier discussion. As noted, we were using a simplification to calculate nominal GDP as 'Price times Quantity' of a single good.

However, GDP is defined as the value of total output measured at current prices. Conceptually we have a set (vector) of prices (one for each good or service sold) and a set (vector) of quantities (an entry for every item sold), and then we sum each individual sale (P^i*Q^i for the *i*th item) to obtain GDP. That does not seem too difficult—we simply recognise that output is heterogeneous and so it can only be aggregated in nominal terms, not in 'quantity' terms.

In practice, major problems are created if we try to measure the value of real GDP in terms of another year's prices. Let us say we again use 1985 as our base year, and apply 1985 prices to the goods and services sold in 2015. How do we put a 1985 price on an IPad sold in 2015? There were no IPads sold in 1985 and indeed nothing comparable existed.

To reverse the problem, how can we find a 1985 price for manual typewriters sold in 1900 to value real GDP that year (in terms of 1985 prices)? Clearly, the composition of output changes both in terms of what is sold and the quality of items sold (the typical personal computer sold today is very much faster than one sold in 1990 even though the nominal price has hardly changed). It should be obvious that the older the base year chosen, the more difficult the problem. That is why statisticians have favoured the use of a chain-weighted measure of GDP since it involves a lag of only a year. In the Appendix we discuss this measure in more detail (Advanced Material – Measuring net national income).

4.7 Measuring CPI inflation

The CPI index

In this section we look at the measurement of the prices of consumer goods (bought by households) and make brief reference to producer goods (bought by firms, including raw materials and intermediate goods to be used in production). These prices could go down, but the usual trend is for rising prices.

The index most commonly used to calculate inflation of consumer goods prices is the Consumer Price Index, or CPI. It is defined as follows:

CPI: An index based on the cost of a fixed basket of consumer goods and services.

In the construction of the CPI index, the statistician needs to decide what consumer goods and services to include, their respective quantities (weights) and how to calculate the corresponding prices. It is assumed that the chosen basket of goods and services is representative of the purchases made by a typical household. The statistician chooses a base year (much like the choice of the base year to be used in calculating real GDP). The CPI then represents the cost of a market basket of consumer goods and services.

The measure is usually expressed for a specific spatial area such as a capital city or a weighted-average of all capital cities in a nation.

The items included in the Australian CPI published by the Australian Bureau of Statistics are shown in Table 4.1. Within each major group there are many items included.

Table 4.1 Items in Australian CPI, September 2013

All groups CPI
Food and non-alcoholic beverages
Alcohol and tobacco
Clothing and footwear
Housing
Furnishings, household equipment and services
Health
Transport
Communication
Recreation and culture
Education
Insurance and financial services

Source: Australian Bureau of Statistics, Consumer Price Index, http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/6401.0

If the prices of all the items in the basket changed at the same rate from one period to the next, then the change in the cost of the basket would be easy to calculate, period by period. But, in reality, the individual prices generally change at different rates, so that relative prices are also changing. The statistician thus needs a single summary measure to determine whether the basket overall is rising in cost or not. That is the role that the price index plays. It is a weighted-average of the price movements in the given basket relative to some base period.

In compiling a summary measure such as the CPI, the statistician has various options. Two broad options are whether to use base-weighting or current-weighting to compile the index.

A base-weighted index examines the shifts in prices of the basket of goods and services using the base-period quantities purchased and is referred to as a *Laspeyres* index after the German economist who first compiled such measures. The base-weighted index allows us to see how much a basket that consumers bought in the base period would cost in the current period.

A current-weighted index uses the current quantity purchased of each good and service in the basket as the weight to compile the average measure. This is commonly called a *Paasche* index after the German statistician who developed this measure.

The current-weighted index allows us to see how much a basket that consumers buy in the current period would have cost in the base period.

Both measures provide different ways of estimating the change in the cost of the basket of goods and services over time. However, statisticians tend to favour the use of the *Laspeyres* index to calculate the CPI because it requires less information to be available. The only new information that is required is the current prices of the items in the basket. The quantities making up the basket and the corresponding base year prices are already known.

This allows for a more timely publication of the CPI, which is a central policy variable used by central bankers and treasuries in formulating monetary and fiscal policy, not to mention, its use in labour and other contracts and indexing the values of different transfers, such as some pensions and other benefits.

To simplify our analysis, imagine a basket of goods and services comprises two items (Bread and Cheese). Yes, the obvious question is don't these people wear clothes?!

Table 4.2 shows the hypothetical data we will be working with to illustrate the construction of the price index.

In Year 1, the price per unit of Cheese is $4 and 3 units are consumed overall. So total expenditure on Cheese in Year 1 is $12. The price of a loaf of Bread is $2 and 9 units are consumed in Year 1, making total expenditure on Bread $18. Overall, the basket of goods costs $30 in Year 1 (Column 3).

In Year 2, Cheese rises to $5 per unit and 4 units are consumed whereas Bread rises to $3 per loaf and 10 units are consumed. Overall, the basket of goods in Year 2 now costs $50 (Column 7).

Note that if we wanted to know what the quantities purchased in Year 1 would cost in Year 2, Column (8) provides that answer, $42.

We calculated that using the following data:

Cheese $5 x 3 = $15

Bread $3 x 9 = $27

Total = $42

The 3 and the 9 are the quantities of each good purchased in Year 1. Conversely, Column (7) shows the expenditure in Year 2 based on Year 2 prices and Year 2 purchases.

Similarly, if we wanted to know what the basket would cost in Year 1 based on Year 1 prices and Year 2 purchases we would look to Column (4).

Table 4.2 Hypothetical data for basket of goods and services

	Price Per Unit	Quantity	Expenditure	Expenditure based on Year 2 Quantities
	(1)	(2)	(3)	(4)
	$	Units	$	$
Year 1				
Cheese	4	3	12	16
Bread	2	9	18	20
Total			**30**	**36**
Year 2				
Cheese	5	4	20	15
Bread	3	10	30	27
Totals			**50**	**42**

What would be the price index values in this example?

Base-weighted CPI
Using base-weights (Year 1 quantities), we will set the index in Year 1 to 100, so we express the index as follows:

$CPI_{Year\ 1}$ = 100 x Total Expenditure in Year 1 (Column 3) divided by Total Expenditure in Year 1 (Column 3)

$CPI_{Year\ 1}$ = (100 x $30)/$30 = 100

In Year 2, the index would be (using Year 1 weights):

$CPI_{Year\ 2}$ = 100 x Total Expenditure in Year 2 (Column 8) divided by Total Expenditure in Year 1 (Column 3)

$CPI_{Year\ 2}$ = (100 x $42)/$30 = 140

Current-weighted CPI

Using current-weights (Year 2 quantities), the index in Year 1, which we will again set to 100 would be expressed as:

$CPI_{Year\ 1}$ = 100 x Total Expenditure in Year 1 (Column 4) divided by Total Expenditure in Year 1 (Column 4)

$CPI_{Year\ 1}$ = (100 x \$36)/\$36 = 100

In Year 2, the index would be (using Year 1 weights):

$CPI_{Year\ 2}$ = 100 x Total Expenditure in Year 2 (Column 7) divided by Total Expenditure in Year 1 (Column 4)

$CPI_{Year\ 2}$ = (100 x \$50)/\$36 = 138.9

Rate of growth of the CPI index

We have generated two CPI indexes (one base-weighted and one current-weighted) over two years, so we can calculate a measure of the overall movement in prices, and provide a measure of the change in the cost-of-living. The growth rate of the CPI measures the rate of inflation (if positive) or deflation (if negative), acknowledging that strictly inflation (deflation) is an on-going, rather than one off, increase (decrease) in the price level.

We can write the percentage rate of inflation (deflation) as:

(4.8) $$CPI_{Gt} = 100*[(CPI_t - CPI_{t-1})/CPI_{t-1}]$$

where CPI_t denotes the index magnitude in period (say, year) t and CPI_{Gt} denotes the growth of the CPI from period $t-1$ to period t. So a rate of change (growth) can be expressed as one hundred multiplied by the change in the index, divided by the initial value of the index.

It can be readily shown that the respective rates of change for the Base and Current Weighted Price Indexes between Year 1 and Year 2 are 40 per cent and 38.9 per cent.

You will appreciate that the current-weighted index takes into account changes in prices and the quantities purchased following these price changes, whereas the base-weighted approach considers price changes only and ignores the fact that people will change their expenditure patterns over time as relative prices change.

In practice, household expenditure patterns change and new goods and services are sold, so statisticians periodically revise the weights in the basket of goods and services in line with other information that they collect. They have complex methods to splice the new and the old indexes together. In the Appendix, we explore the biases associated with using the CPI to accurately measure inflation (Advanced Material – Difficulties in using the CPI to accurately measure inflation).

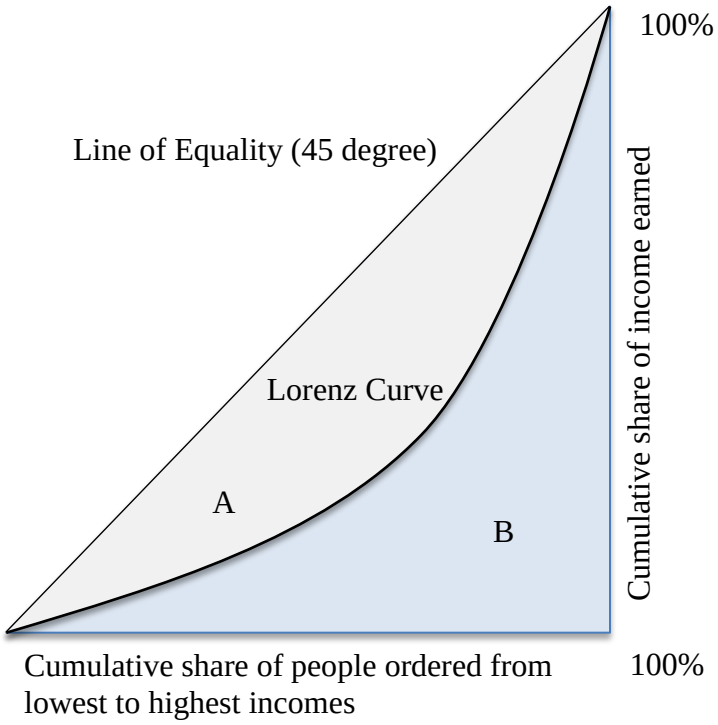
Finally it should be recognised that there are other published price indexes, including those based on wholesale and retail prices. For example, the US Producer's Price Index is based on the wholesale prices of approximately 3000 items, including raw materials and semi-finished goods.

4.8 Measuring National Inequality

As discussed above, our measures of national output (GDP) and income (GNI) do not directly take account of the distribution of output and income. Economists typically use the **Gini Coefficient** derived from a **Lorenz Curve** as an index of income distribution.

The Lorenz Curve plots the share of total income received (vertical axis) by the lowest X per cent of income earners (horizontal axis) (see Figure 4.1). It is easy to see that in our example the distribution is not equal because as we move from the origin at the left end of the horizontal axis, the share of income going to those with the lowest income initially increases slowly. As we move to the higher income people, the cumulative share of income increases more rapidly. The 45-degree line shows the case of perfect equality, so that 30 per cent of people have 30 per cent of total income; 60 per cent of people have 60 per cent of total income and so on.

Figure 4.1 The Lorenz curve



We can calculate the **Gini Coefficient** as a ratio using the two areas, A and B in Figure 4.1:

(4.9) Gini Coefficient = A/(A+B)

Different shaped Lorenz curves can generate the same value of the Gini Coefficient. In addition, there are different ways to measure income, for example before or after taxes, and before or after income transfers. Statisticians have developed a number of algebraic formulations of the Gini, but each yields the same value of the Gini Coefficient for a given dataset. There are also alternative indexes to the Gini Coefficient. It is important to realise that different indexes exhibit different properties and the choice of which index to use should be made in light of the objectives associated with measuring inequality.

A Gini Coefficient of zero means that income is perfectly equally distributed as the economy is lying on the Line of Equality. Alternatively, a Gini coefficient of one means that income is perfectly unequally distributed (that is, one person has all the income).

Table 4.3 shows the Gini Coefficients for all the nations that belong to the Organisation for Economic Co-operation and Development (OECD), for which comparable data is available for the years 2004 and 2012. The Gini Coefficients mostly range between the values of 0.25 to 0.50. There is considerable diversity among these nations with respect to income inequality. Sweden had the least inequality in 2004, while Mexico had a large degree of inequality.

Note also that inequality has increased in many nations between 2004 and 2012, while it declined in other nations (see the + and – signs).

Table 4.3 Gini coefficients for several OECD nations, 2004 and 2012

Country	2004	2012	Change
Australia	0.315	0.324	+
Austria	0.269	0.276	+
Belgium	0.287	0.262	-
Czech Republic	0.269	0.252	-
Estonia	0.346	0.326	-
Finland	0.267	0.261	-
France	0.283	0.306	+
Germany	0.285	0.289	+
Greece	0.336	0.340	+
Iceland	0.262	0.252	-
Ireland	0.323	0.302	-
Italy	0.331	0.326	-
Luxembourg	0.263	0.299	+
Mexico	0.474	0.482	+
Norway	0.276	0.253	-
Poland	0.381	0.300	-
Portugal	0.383	0.341	-
Slovak Republic	0.266	0.249	-
Slovenia	0.247	0.251	+
Spain	0.332	0.335	+
Sweden	0.234	0.274	+
United Kingdom	0.331	0.351	+
United States	0.360	0.389	+

Source: OECD Statistics.