Lecture Notes on National Income Accounting

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1. National Income Accounting

The purpose of National Income Accounting is to obtain some measure of the performance of the *aggregate* economy. In microeconomics we study phenomena for which there are natural analogues in the real world; we have all paid a price and held an apple. In macroeconomics, however, the phenomena are constructs informed by theory. You cannot observe a price level or GNP. In empirical work, however, we do have to measure these things. We must then be careful as to their definition, for the actual practice of collection can differ from what we expect the variables to be.

As economists our primary concern is with agents' welfare. Hence our concern with standards of living or utility. But we cannot measure utility. The next best thing is to consider consumption. Note, however, that one can enjoy higher utility today by consuming all of one's wealth. This suggests that we should focus on consumption levels that are *sustainable*. This amount that can be consumed per period while maintaining wealth intact. Measuring an economy's permanent income would be quite difficult, however, so we focus on current receipts. In most periods this is not a big problem, since in the aggregate borrowers and lenders cancel out. Some might argue, however, that aggregate US consumption in the 1980's was above sustainable levels, as evidenced by the trade deficits. A similar case can be made now about the stock market-led boom of the late 1990's.

Our measure of aggregate performance should reflect supportable consumption. Therefore we should exclude intermediate production. This follows from the principle that it is output and not inputs that yield utility. Similarly we must net out that portion of output devoted to replacing depreciating capital, since it does not afford extra output. But this introduces a distortion into the National Income

Accounts, for new investment goods may not be identical to those they replace. Technical change is often embodied in capital goods, so that new capital goods are more productive than those they replace. So a portion of replacement investment is really an addition to the capital stock.[1] This is, however, very difficult to measure. Moreover, our concern is with economic depreciation (as opposed to physical. Hence many economists prefer to use GNP rather than NNP, in order to avoid relying on a shaky imputation.

1.1. GNP and Its Components

How then is GNP defined? It is the market value of final goods and services produced by nationals within the period. Let us examine the components of the definition. Why market value? We use market values so that we may add up different goods (of course in socialist countries, where prices do not clear markets, valuation becomes problematical; outputs must be valued at factor cost). We use final goods so that we do not double count. The fact that it is production by nationals implies that the profits of US corporations from overseas operations, or the earnings of US workers abroad, will count as our income (this is the basic difference between GNP and GDP; the latter counts all final goods and services produced within a country's borders). This definition excludes such factors as housewife's services (non-marketed) and illegal transactions. But some non-market items are included:

- wages in kind
- agricultural output in kind
- imputed rent from owner occupied housing
- interest from financial intermediaries

while some excluded items (can you guess why?) are:

- capital gains and losses
- government transfer payments

[1] The best way to think about this is, perhaps, personal computers. Replacing a pc with a 486 chip with a pc that has a Pentium 400 chip involves more than just replacement. The latter is many times more productive. But how many times?

- interest paid by the government or consumers

Notice that during prohibition, liquor sales were not part of GNP, though now they are. Can you explain the differential treatment of interest?

Notice all the government spending is valued arbitrarily, as there is no market for government services. Hence they are valued at cost. Also, all government expenditure is treated as final goods and services even though some components are really intermediate goods.

Why is investment included in GNP? Recall that intermediate goods are excluded. But they represent resources used to make final output; they are not available for consumption. Investment goods are. Net investment could be consumed without depleting our wealth. We invest to increase our wealth, but this represents a decision that postponing consumption is more valuable than consuming today. So including investment (except for replacement investment) does not violate our notion of maximum sustainable consumption level.

It is useful to think of a given period's total output in terms of an input-output table. Our concern is with the disposition of a sector's output among various uses, and the sources of the inputs that went into its production. Consider Table 1.

Table 1: Input-Output Table of the National Economy

	1, ...	j	............n	C	I	G	E	$Total$
1 . . .								
i		A_{ij}		A_{iC}	A_{iI}	A_{iG}	A_{iE}	O_i
. . . . .								
primary inputs		M_j L_j K_j T_j		M_C L_C K_C T_C	M_I L_I K_I T_I			M L K T
Total		X_j		C	I			Ω

Looking across row i we have the disposition of sector i's output for the given period (say a year). We simply allocate all of the production in a given period to all potential uses, both intermediate and final. Measuring in terms of dollars of the current year (suppressing the time subscript) we have:

$$O_i \equiv \sum_{j=1}^{n} A_{ij} + A_{iC} + A_{iI} + A_{IG} + A_E \tag{1.1}$$

where O_i is the output of sector i, A_{ij} is the output of sector i that is used in the production of sector j, and the subscripts C, I, G, and E, refer to consumption, investment, government spending, and exports (of final goods and services).

We can also allocate all of the sources used in production. We include not only the intermediate goods used in production, but also all payments to factors of production. If we look at column j, on the other hand, we observe the sources of production for that sector:

$$X_j = \sum_{i=1}^{n} A_{ij} + M_j + L_j + K_j + T_j \tag{1.2}$$

where M are complementary imports, L and K are labor and capital services used in production of output j, and T refers to indirect taxes. Note that the capital services used in producing j are imputed by subtracting the value of all other inputs and indirect taxes from the value of output.[2]

The careful reader will be wondering what happens to output that is not sold. It must go somewhere, but it is clearly not consumption, government spending, or exports. The only place left is investment. This makes some sense, in that firms have purchased output that they will use for future sales. Inventories are held by firms in order to meet sudden shifts in demand. It is an investment undertaken to retain the goodwill of customers. But some inventories are unintended. These too are treated as investment, since it would be extraordinarily difficult to separate out (and there would still be no place to put it).

Notice that we obtain aggregate C, I, G, and E by vertical summation, i.e.:

$$C = \sum_{i=1}^{n} A_{iC} + M_C + L_C + K_C + T_C \tag{1.3}$$

while primary inputs are obtained via horizontal summation:

$$M = \sum_{j=1}^{n} M_j + M_C + M_I + M_G + M_E \tag{1.4}$$

[2] Note also that we will include in K all payments for capital replacement used in production of good j.

which allows us to obtain total output via either vertical or horizontal summation:

$$\Omega = \sum_{i=1}^{n} X_j + C + I + G + E = \sum_{j=1}^{n} O_i + M + L + K + T \tag{1.5}$$

But we know that $X_i = O_i$, so that we get:

$$C + I + G + E = M + L + K + T \tag{1.6}$$

Subtracting M from both sides and denoting $E - M$ net exports, NX, we get GNP at market prices:

$$GNP^{mp} = C + I + G + NX = L + K + T \tag{1.7}$$

Notice that 1.7 expresses GNP at market prices; i.e., including indirect taxes. We can also express GNP at factor cost,[3] by subtracting T from both sides of 1.7.

Often, especially when we are analyzing developing countries, we prefer to use Gross *Domestic* Product (GDP) rather than Gross *National* Product (GNP). The former is thought to be a better indicator of what is actually produced in an economy. To go from GNP to GDP we subtract $L_E, K_{E,}$ and T_E from both sides of 1.7:

$$GDP^{mp} = C + I + G + NX - L_E + K_E + T_E \tag{1.8}$$

What would be an actual example of an item that belongs in L_E or $K_{E,}$? Why would the discrepancy between GNP and GDP likely be larger for a developing country?

Finally note that the definition of value added in production for good j is the value of output minus the value of purchased inputs:

$$VA_j^{mp} = X_j - \left(\sum_{i=1}^{n} A_{ij} + M_j \right). \tag{1.9}$$

It thus follows from expression (1.2) that the sum of value added across j is just GNP; i.e., $GNP^{mp} = \Sigma_j VA_j^{mp}$ The important implication of this is that it means we can measure GNP either from the product side or the income side. Both give the same result.

[3] This was very important for analyzing Soviet-type economies where indirect taxes were used heavily, and which were not set according to value. If most indirect taxes are related to value then GNP at market prices will give a pretty accurate picture of what goes on.

It is important to remember that the National Income Accounts are a measure of flows of transactions per period. Income is a flow variable. Many important variables of interest are stocks. They are ignored in the National Income Accounts, but we will have to take them into account. The National Income Accounts give a picture of transactions over a period, much like a profit and loss statement. But a savvy investor wishes to see the firm's balance sheet. The same holds true for an economy. Knowledge of current spending may be insufficient to fully guide decisions. It may be important to look at measures of national wealth (debt) or international asset positions, as well as what is happening with the money stock.

1.2. Some Useful Identities

The NIA are just a series of identities. But identities can often be illuminating. Consider the following two identities:

$$Y \equiv C + I + G + X$$

$$Y \equiv C + S + T + M$$

The first identity says that final output is either consumed, invested purchased by the government or exported. The second says that individuals may use their income to either consume, save, pay taxes or purchase imports. If you combine the identities and cancel out the C's you get the following interesting result:

$$(S - I) + (T - G) = X - M$$

Why is this interesting? What important idea is conveyed by it?

1.3. Index Numbers

Economic data is often expressed in units of value (GDP, consumption, etc.). Value is the product of price and quantity. This introduces a complication because both prices and quantities change over time. To control for this we use price and quantity indexes. But there are inherent ambiguities with index numbers.

Let p_0q_0 and p_1q_1 be two bundles actually consumed in years 0 and 1. This is the actual data we have (these could be sums). We are interested in the growth in real output (we could do the same for the price level), so we have two potential measures:

$$L^Q = \frac{p_0q_1}{p_0q_0} \tag{1.10}$$

and

$$P^Q = \frac{p_1 q_1}{p_1 q_0} \tag{1.11}$$

which are base-year weighted and current year weighted indexes, respectively.

Our interest is in a quantitative measure of the change in utility associated with the two baskets purchased. That is, we would like to know how much extra it costs to have utility change from u_0 to u_1. Define the expenditure function $e(p_r, u_t) = \min\{p_r q_t | u \geq u_t\}$, where r refers to prices in the reference year. Then an ideal, or true, measure of the change in output would be

$$\frac{e(p_r, u_1)}{e(p_r, u_0)} \tag{1.12}$$

i.e., the ratio of two expenditure functions. This would give the minimum amount necessary to achieve the actual change in utility between the two periods. There are two obvious candidates as true measures:

$$L^{Q*} = \frac{e(p_0, u_1)}{e(p_0, u_0)} \tag{1.13}$$

and

$$P^{Q*} = \frac{e(p_1, u_1)}{e(p_1, u_0)} \tag{1.14}$$

These are idea indexes. We want to know how they compare with what we actually work with.

Start with the Paasche indexes. Clearly $e(p_1, u_1) = p_1 q_1$ by virtue of utility maximization. But $e(p_1, u_0) \leq p_1 q_0$, because in year 0 agents did not face year 1 prices. Had they, substitution might have resulted in the same utility achieved at a lower price. Therefore, we have:

Proposition 1.1. $P^{Q*} \geq P^Q$. *The current-year output index understates the true current-year index.*

$$P^{Q*} = \frac{e(p_1, u_1)}{e(p_1, u_0)} \geq \frac{p_1 q_1}{p_1 q_0} = P^Q \tag{1.15}$$

Similar reasoning yields $L^{Q*} \leq L^Q$, that is, the Laspeyres index overstates the true change:

$$L^{Q*} = \frac{e(p_0, u_1)}{e(p_0, u_0)} \leq \frac{p_0 q_0}{p_1 q_1} = L^Q \tag{1.16}$$

Again, this is due to the fact that actual indexes ignore substitution. Faced with base year prices we would have consumed differently this year.

One may be tempted to conclude that:

$$P^Q \leq \text{truth} \leq L^Q$$

This is generally *not* true, however. The reason is that we do not know if L^{Q*} is greater or less than P^{Q*}. Indeed, it is possible for $P^Q > L^Q$; hence, in general it is meaningless to talk about *the* price or quantity index, though we do this in theory all the time.

Remark 1. *An exception, where the Laspeyres and Paasche indexes are the same, is when preferences are homothetic. In that case, the expenditure function is proportional to utility; e.g.,* $e(u, p) = ub(p)$ *for some function* $b(p)$*. Then,*

$$P^{Q*} = \frac{e(p_1, u_1)}{e(p_1, u_0)} = \frac{u_1 b(p_1)}{u_0 b(p_1)} = \frac{u_1}{u_0}$$

and

$$L^{Q*} = \frac{e(p_0, u_1)}{e(p_0, u_0)} = \frac{u_1 b(p_0)}{u_0 b(p_0)} = \frac{u_1}{u_0}$$

Of course, the problem is that preferences are typically not homothetic.

1.3.1. What Can We Say?

The general theoretical conclusions we can make are not profound. We do know that if $P^Q \geq 1$, if follows that $p_1 q_1 \geq p_0 q_0$. Since agents purchased q_1 when they could have purchased q_0, it follows that $q_1 \succ q_0$. Hence, we must be at least as well off as before; in other words, welfare has not fallen in this case.

Similarly, if $L^Q \leq 1$, it follows that $p_0 q_1 \leq p_0 q_0$. This implies that we are certainly worse off than before (if the strict inequality holds). Again, this follows because agents preferred q_0 at initial period prices.

The conclusion is that there is no single "best" index. Even the Fisher ideal index $(P^Q L^Q)^{\frac{1}{2}}$ is not "true." Rather we have a family of indexes associated with different conceptual experiments. One must properly identify the experiment. Since economies change over time, using base-year or current-year weights will provide different results.[4]

[4] The same holds for comparisons across space. Consider comparative measures of US and Soviet defense spending employing US prices and Soviet prices. These give very different results. Why? Can you figure out which set of prices made a larger gap between the two?

1.3.2. How Good is the Approximation?

It is easy to show that a Laspeyres index (also a Paasche) is a first-order approximation to the truth.

Consider $e(p_0, u_1)$, i.e., real income in year 1 at year 0 prices. We can write this as:

$$e(p_0, u_1) = p_0 q_1 + (e(p_0, u_1) - p_0 q_1) \tag{1.17}$$
$$= \text{"}L\text{"} + S \tag{1.18}$$

where "L" is the Laspeyres-type measure, and S is the surplus. Notice that in this case, S is negative, since there may be a cheaper way to achieve u_1 at p_0 prices. Further note that "L" is easily computable from available data. That is why it is popular. S is not, however, observable, since it depends on the utility function. But clearly $S \leq 0$. So "L" overstates real income. But by how much?