Department of Economics, Rice University
International Finance (Econ 421)
Yossi Yakhin

Handout #1: National Income and Product Accounts

1. Introduction

The main objective of the course is to acquire theoretical tools that will allow us to analyze the effect of different events on macroeconomic variables in the context of open economies. However, before we start thinking about the economic relationship between different variables, we first want to make sure we understand what these variables mean and describe some accounting relationships between them.[1]

This handout reviews some of the concepts and accounting identities of the National Income and Product Accounts (NIPA) and puts them in the context of a simple demand and supply model. Towards the end of the handout we will emphasize the difference between closed and open economies. You should already be familiar with much of the material in this handout from previous macroeconomics classes.

2. Output and Income

The NIPA system records the contribution of main economic variables to national income and output in a given period of time. Countries' aggregate production and income are of special interest since they summarize in one number the economic activity of all agents in the economy.[2]

Output and income are closely related but are not necessarily the same. The main difference is that output, or total production, is measured in market prices (the prices that consumers pay), while national income is measured in prices of production factors. These

[1] By economic relationship we mean a relationship that is driven by "human behavior"; they are based on economic theory and therefore may or may not hold in reality. For example, along typical demand curves quantities fall when prices increase. This relationship can be derived from a simple consumer problem that maximizes utility subject to a budget constraint. On the other hand, accounting relationships always hold. They hold by the power of their definition. For example, profits of a firm are given by its revenues minus expenditure.

[2] We will use the terms aggregate production (or product, for short) and output interchangeably.

measurements may lead to different results due to the existence of indirect taxes (sales tax).[3] The following example illustrates the difference between output and income.

Example 1: Sales Tax and The difference Between Output and Income

Consider an economy that produces one good – corn. The marginal cost of production is given by:

$$MC = 0.8X^s$$

where MC is the marginal cost in dollars, and X is the quantity of corn in bushels. Assuming that labor is the only factor of production, then the marginal cost represents payments to workers.[4] Aggregate demand in the economy is given by:

$$P = 100 - 1.2X^d$$

where P is the price consumers pay. With no taxes we find equilibrium by equating demand and supply:

$$MC = P\ ,\ X^d = X^s \qquad \Rightarrow \qquad X = 50\ ,\ P = 40$$

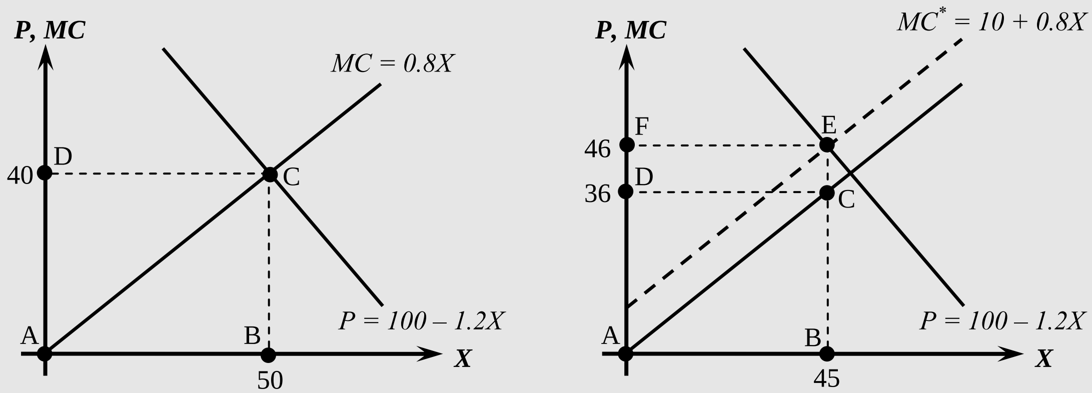
Panel A in Figure 1 illustrates this graphically. From the solution it is easy to see that total product, or output, is 50 bushels of corn, which in monetary terms equals $2000. How about income? In this example there are two types of income: labor income and profits of the producers. Salaries are the production cost in this case and are measured by the area under the supply curve. Therefore, labor income is $1000. Profits are represented by the area between the marginal cost curve and equilibrium price, which also equals $1000. Hence, in this example total income is $2000, and it equals total output.

[3] Transfers from abroad may also lead to a difference between output and national income.

[4] Suppose that the wage rate per employee is constant regardless of the quantity produced. Can you explain under what conditions the marginal cost increases with X?

Figure 1: Output vs Income

(A) No Sales Tax (B) Sales Tax = $10 per Unit



Output = ABCD = $2000
Labor Cost = ABC = $1000
Profits = ACD = $1000
Income = ABCD = $2000
Tax Payments = $0

Output = ABEF = $2070
Labor Cost = ABC = $810
Profits = ACD = $810
Income = ABCD = $1620
Tax Payments = DCEF = $450

Now suppose that the government has a sales tax of $10 per bushel of corn. Effectively, taxes change the marginal cost faced by producers. In addition to the production cost they now have to pay the government $10 for each bushel they sell. Therefore, the effective marginal cost is:

$$MC^{*} = 10 + 0.8X^{s}$$

This is illustrated in Panel B of Figure 1. Given demand, equilibrium now results in:

$$MC^{*} = P\ ,\ X^{d} = X^{s} \quad \Rightarrow \quad X = 45\ ,\ P = 46$$

Notice that there are now two relevant prices: consumer price and a producer price. Consumer price is the price consumers pay, $46 in this case, and producer price is the price producers receive, $36. The difference is the sales tax, $10. With sales tax output falls to 45 bushels, which worth $2070 (output is always measured in consumer prices). Labor cost is the area under the *original* marginal cost curve. It is now equal to $810. Profits are given by the area between the original marginal cost curve and the producer price, and they equal $810. Income, in this example, is therefore $1620, which is lower than output.[5] The difference is the tax revenue of the government.

Two comments are in order. First, in our analysis we chose to shift supply and hold the demand curve fixed; however, we can reach the exact same conclusions by holding supply fixed and reducing demand by the tax rate. Second, notice that after introducing sales tax production fell from 50 to 45; however, in monetary terms it has increased from $2000 to $2070. This illustrates the difference between *real* and *nominal* output (which you probably discussed in previous macroeconomics classes). We really care about real output, i.e. to measure the economy by how many products it produces. However, we measure economic activity in monetary terms since in reality the economy produces many products and we cannot just add the quantity of each of them (adding apples to oranges).

There are several measures of output and income. Here we will describe some of the definitions and explain the differences between them.

2.1. Measures of Product (Output)

GDP – Gross Domestic Product

One of the most important measures of economic activity is **gross domestic product** (**GDP**). GDP measures the value of all goods and services produced within the borders of a country in a given period of time.

GNP – Gross National Product

Another measure of output is **gross national product** (**GNP**). GNP measures the value of all goods and services produced by the residents of a country in a given period of time. Note that GNP measures output by factors' nationality, while GDP measures output by factors' location. The difference between GNP and GDP is **net foreign payments** (**NFP**), which is the value of goods and services produced by the residents of the home country

[5] A sale subsidy would result in income that is greater than output.

abroad minus the value of foreign production in the home country. We can therefore summarize the relationship between GNP and GDP by:

$$GNP = GDP + NFP$$

NFP includes labor income, profits, and interest payments. The interest payment a country receives from (or pays to) the rest of the world is the return on foreign financial assets. These assets are important, especially for small open economies, since they allow a country to smooth its consumption over time. A country may wish to borrow from the rest of the world in bad times and repay in good times. We will discuss the role of foreign assets in more detail later in the course.

NNP – Net National Product

During production, machinery suffers wear and tear. That is, while the economy produces new goods and services its capital stock loses value. The wear and tear of capital is called **depreciation**. GNP does not take this loss into account. Subtracting depreciation from GNP results in **net national product** (**NNP**), that is:

$$NNP = GNP - Depreciation$$

For capital owners, depreciation is a cost that reduces their income. Therefore, netting out depreciation from GNP results in a measure of output that is closer to income.

2.2. Measures of Income

NI – National Income

National income (**NI**) is the sum of incomes received by all agents in the country. NI can be calculated either by aggregating the income of agents in the economy, or by converting NNP from purchase prices to factor prices. As our earlier example demonstrates, this can be achieved by subtracting **indirect taxes** from NNP.

The country may also have additional income from foreigners through **unilateral transfers**. This income is not captured in NNP since it does not come from production. Therefore, we have to add such transfers to NNP. We can now write NI as:

NI = NNP – Indirect Business Taxes + Unilateral Transfers

PI – Personal Income

Personal income (**PI**) is the income of households and non-corporate businesses. In order to calculate PI we need to adjust NI, which includes the income of all agents, to reflect the income of households and non-corporate businesses.

Three adjustments are required. First, corporations may retain some of their profits. These profits are part of NI and are not transferred to households through dividends. Therefore we have to subtract **retained profits** from NI.

Second, the government transfers to and receives payments from households through, for example, the Social Security system. These transfers are not associated with any productive activity and therefore do not affect NI; they do, however, affect the income of households. Therefore, we have to add **net transfers** (transfers minus payments) to NI when we calculate PI.

Finally, NI includes interest income of *all agents* in the economy. PI, however, includes only the interest income of households and non-corporate businesses. We therefore need to subtract from NI the interest income of other agents (corporations and government). We do that by subtracting **net interest** and add back **personal interest income**:

PI = NI – Retained Profits + Net Transfers – Net Interest
+ Personal Interest Income

Y^d – Disposable Income

Disposable income, often denoted by $\boldsymbol{Y^d}$, is the income available for households for consumption and saving. To calculate Y^d we need to subtract personal tax and non-tax payments from PI:

$$\boldsymbol{Y^d = PI - Personal\ Tax\ and\ Non\text{-}Tax\ Payments}$$

Personal taxes include taxes on income, realized capital gains, and on personal property. Non-tax payments include donations, fees, and fines.

2.3. Notation and Some Simplifying Assumptions

The definitions NIPA uses can get very cumbersome.[6] The reason is that the real world is complicated, and if we want to get accurate measures of output and income we have to face these complications and adjust our definitions accordingly.

When we write models, however, there is no need to take every little detail into account. In fact, we use models because the real world is too complicated. We hope that by focusing only on the details we perceive as important our theoretical models will have something meaningful to say about the real world.

In what follows, we present notation and make assumptions that will greatly simplify our presentation hereafter.

GDP and GNP

We will denote GDP by Q and GNP by Y, and assume that production factors are employed only within the borders of their country. Therefore NFP consists only of net interest payments from/to the rest of the world.

Let r denote the real interest rate and B^* denote the net foreign asset position of the home country; that is, B^* is the amount the rest of the world owes the home country.[7] Notice that today's interest income is determined by the asset holdings in the previous

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[6] You can find the exact definitions made by the Bureau of Economic Analysis (BEA) at: http://www.bea.gov/bea/an/nipaguid.pdf.

[7] If B^* is negative the country is in debt to the rest of the world.

period. Therefore, we will add the subscript -1 to B^* (resulting in B^*_{-1}) to denote the net foreign asset position in the *previous period*. With this notation, interest payments are given by rB^*_{-1}, and GNP is related to GDP through:

$$\boldsymbol{Y = Q + rB^*_{-1}}$$

GNP, NNP, NI, and PI

We will assume that:

$$\boldsymbol{Y = NNP = NI = PI}$$

That is, there is no depreciation, indirect taxes, or unilateral transfers, and we abstract from all the details that differentiate national income from personal income.

Disposable Income, Y^d

We will assume that the only taxes, *T*, are on households and there are no non-tax payments. Disposable income is therefore given by:

$$\boldsymbol{Y^d = Y - T}$$

Example 2: National Accounts and the labor market

Consider the corn economy again, and suppose that there are no taxes of any kind. Labor demand in the economy is given by:

$$W = P \times MPL = 60 - 0.8L^d$$

where *W* is the wage rate per hour, and *L* is labor inputs measured by hours worked. Also, *P* denotes the price of corn and *MPL* is the marginal product of labor. You should be familiar with the equality $W = P \times MPL$ from previous economics classes.[8]

Labor supply is given by:

$$W = 0.4L^s$$

Equilibrium in the labor market gives:

$$L = 50\ ,\ W = 20$$

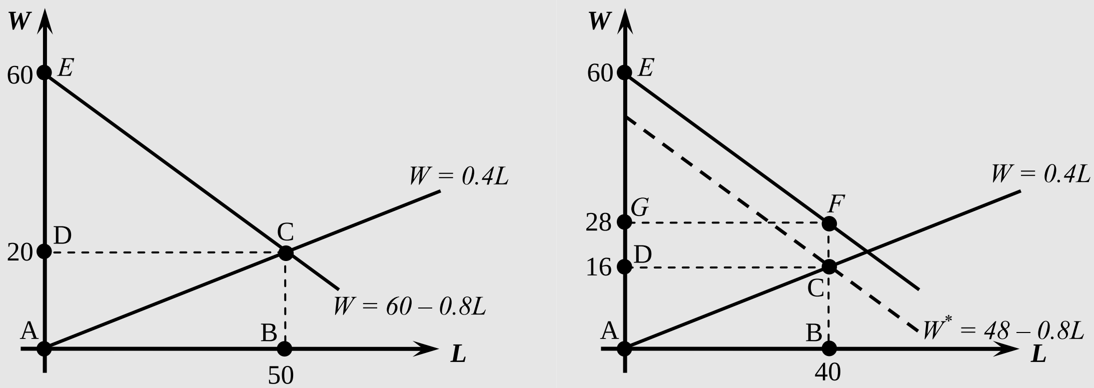
Panel A in Figure 2 illustrates the equilibrium graphically.

[8] If we include indirect taxes, can you determine which price *P* represents (i.e. consumer price or producer price)?

Figure 2: National Accounts and The Labor Market

(A) No Taxes

(B) Labor Income Tax = $12 per Hour



Labor Income = ABCD = $1000
Profits = CDE = $1000
National Income = ABCE = $2000
Disposable Income = ABCE = $2000
Tax Payments = $0

Labor Income (gross) = ABFG = $1120
Profits = EFG = $640
National Income = ABFE = $1760
Disposable Income = ABCD + EFG = $1280
Tax Payments = CDGF = $480

We are interested in identifying labor income, profits, and national income. Labor income is simply the product of W and L, and therefore it equals $1000. In this case it is easier to first identify national income and only then find profits. Since there is no sales tax, national income is the same as output. Notice that labor demand is given by $P \times MPL$, which measures the **value** of labor's marginal product. To find total product we simply need to add all the marginal values. Therefore, output (and hence national income in this case) is found by calculating the area under the labor demand curve, which is given by the area of ABCE in Panel A of Figure 2 and equals $2000. Profits are the difference between national income and labor income, area CDE in the diagram, and are equal to $1000.

Now assume that there is a $12 labor income tax on every hour of work. Effectively, households are now faced with a labor demand curve that is lower by $12. This is because employers are still willing to pay the exact same salaries as before for any level of L, but households' actual payment is $12 lower. The effective labor demand is now given by:

$$W^* = 48 - 0.8L^d$$

This is illustrated in Panel B of Figure 2 by shifting labor demand downward.[9] We now have

$$L = 40\ ,\ W^{*} = 28$$

Similarly to the case of sales tax there is now a difference between the wage employers pay ($28) and the wage employees receive ($16), the difference reflects the tax rate.

Notice that output is measured by the area under the **original** demand curve as it reflects the value of products sold to consumers, area ABFE in the figure. National Income still equals output since there is no sales tax, and hence is also represented by ABFE which equals $1760. National Income is composed of gross labor income, area ABFG – $1120, and profits, area EFG – $640. Finally, disposable income equals National Income minus labor income tax. Taxes are given by area CDGF and equal $480, therefore disposable income is $1760 – $480 = $1280.

4. National Income Accounting in Closed and Open Economies

4.1. Output and Its Uses

By definition, goods and services can be put to one of three (and only three) uses:

- **Consumption** (***C***) **–** Consumption is goods and services purchased by the private sector to fulfill current wants.
- **Investment** (***I***) **–** Investment is any change in buildings, equipment, and inventories. The change in buildings and equipment is called **fixed investment**. This type of investment increases the stock of capital in the economy, and therefore increases its future productive capacity. Both the private and public sectors can invest; however, ***I*** includes only private investment.
- **Government Purchases** (***G***) **–** Goods and services purchased by the public sector.

The sum of these uses, $C + I + G$, is called **domestic absorption**.

9 Alternatively we can shift labor supply upward by $12 and get the exact same conclusions.

Closed Economies

Closed economies, by definition, do not trade with the rest of the world ($IM = EX = 0$) and do not hold foreign assets ($B^* = 0$). Therefore, they can only use their own output for consumption, investment, and government purchases. That is:

$$\boldsymbol{Q = C + I + G}$$

This equation is the resource constraint for closed economies. Notice that since closed economies do not hold foreign assets, that is $B^*=0$, it follows that $Y = Q$, and hence $Y = C + I + G$.

Open Economies

Open economies trade with other countries. As a result each of the three uses may include foreign components. Similarly, domestically produced products may be used by foreigners. Therefore, in order to obtain the equality between output and uses we must adjust for international trade. We do that by subtracting imports (IM) and adding exports (EX):

$$\boldsymbol{Q = C + I + G + EX - IM}$$

This equation is the resource constraint for open economies. By subtracting imports we remove the foreign component from domestic uses, while by adding exports we account for the use foreigners make of domestically produced output. We often refer to the difference between exports and imports, $EX - IM$, as **net export** (***NX***) or the **trade balance** (***TB***). That is:

$$\boldsymbol{NX = TB = EX - IM}$$

4.2. Saving and Investment

Saving and investment have a common property; they both allow agents to shift resources over time. Therefore, it is not surprising to find a tight relationship between them. This relationship is a direct implication of the resource constraint. However, before we describe the relationship between saving and investment, we first have to explain what we mean by saving.

Saving

For any agent, saving is the difference between its income and consumption. In the economy we have three agents; firms, households, and government.

- **Firms:** firms' savings are defined as the after-tax retained profits. However, the assumption that $Y = PI$ implies that all corporate profits are distributed through dividends. Therefore, by assumption, firms do not save.
- **Households:** Households' savings are the difference between their disposable income, Y^d, and their consumption, C. We denote these savings by S_p (for private savings):

$$\boldsymbol{S_p = Y^d - C}$$

- **Government:** Government savings are the difference between the government's income and consumption. Government's income is its tax revenues, T, and its consumption is G. We denote government's savings by S_g:

$$\boldsymbol{S_g = T - G}$$

Total savings in the economy, S, are therefore given by:

$$\boldsymbol{S = S_p + S_g}$$

Closed Economies

We now derive the relationship between saving and investment in closed economies. The definitions of private and public savings imply:

$$S = S_p + S_g = Y^d - C + T - G$$

Substitute for $Y^d = Y - T$ and notice that in closed economies $Y = Q$ (since B^*=0) we get:

$$S = Q - C - G$$

From the resource constraint for closed economies we get $Q - C - G = I$, therefore:

$$\boldsymbol{S = I}$$

That is, in closed economies national saving must equal investment.[10]

As an example think of a closed economy with no government that produces only corn. The income of all agents is generated by corn production (labor income and firms'

[10] This derivation made use of many of our simplifying assumptions. It should be noted, however that the equality between saving and investment is an accounting identity and is independent of these assumption.

profits); therefore, total income in the economy is equal to the value of corn produced. When households save they consume less corn than the value of their income, as a result firms' inventories increase since they do not sell all the corn they produced. This increase in inventories is counted as investment. Therefore, any quantity that is not consumed must be invested. Notice that in this example investment is imposed on the firms by low demand. Nevertheless, the equality between saving and investment holds.

Now consider the opposite case when firms decide to invest, i.e. put aside some corn seeds for production next year. Since firms do not sell all of their output, households consume less than their income. The difference between income and consumption is saving, which by construction is the same quantity firms invest.

Notice that the equality between saving and investment is an identity; that is, it always holds even if the quantity households *want* to save does not match the quantity firms *want* to invest. It is only in equilibrium that these wants equate.

Open Economies

From the definitions of private and public savings we have:

$$S = S_p + S_g = Y^d - C + T - G$$

Substitute for $Y^d = Y - T$ and using $Y = Q + rB^*_{-1}$ we get:

$$S = Q + rB^*_{-1} - C - G$$

From the resource constraint for open economies $Q - C - G = I + EX - IM$, therefore:

$$\boldsymbol{S - I = EX - IM + rB^*_{-1}}$$

The right hand side, $EX - IM + rB^*_{-1}$, is called the **current account** (**CA**). The current account summarizes the external balance of the economy. It measures the value home residents receive from abroad through net exports and the return on foreign assets.[11]

The relationship between saving and investment can now be written as:

$$\boldsymbol{S - I = CA}$$

[11] Strictly speaking the CA also includes unilateral current transfers and NFP other than interest payments. However, under our assumptions these additional terms are zero. We will discuss the current account in more detail in the next two handouts.

Evidently, saving need not equal investment in open economies. The reason is that agents can now save and invest through the external sector. In our corn-producing economy, for example, when domestic demand is low due to high saving rate, firms can export the excess production rather than increase their inventories. Similarly, if there is excess domestic demand due to large investments, households can import corn to satisfy their demand rather than save.

5. Appendix: Derivation of Demand and Supply

Our analysis in this handout made use of demand and supply in both goods and labor markets. We took these curves as given, and did not discuss their origin. This appendix provides the missing link. You should already be familiar with this material from previous intermediate micro classes.

Firms supply output and demand labor; therefore, the corresponding curves are derived from firms' optimal behavior. Consumers, on the other hand, demand goods and supply labor; therefore, the corresponding curves are derived from consumers' optimal behavior. Below we provide a numerical example that illustrates this.

5.1. Firms

Consider a profits maximizing firm that has access to the following production technology:

$$X = \sqrt{L}$$

Where X is output and L is labor. Let P_X denote the price of X, and W the wage rate. The firm chooses L to maximize profits:

$$P_X \sqrt{L} - WL$$

First order condition:

$$\frac{1}{2}\frac{P_X}{\sqrt{L}} - W = 0$$

Which gives:

$$W = \frac{1}{2}\frac{P_X}{\sqrt{L}}$$

This is the (inverse) **labor demand** curve since it tells us how much labor the firm wants to employ for each level of wage. Notice also that $f'(L) = \frac{1}{2\sqrt{L}}$, therefore more generally, labor demand is given by the value of marginal product:

$$W = P_X f'(L)$$

We now turn to derive the marginal cost curve, which defines output's supply. To that end we will first derive total cost and then differentiate it with respect to *X*. Since labor is the only factor of production, total cost is given by *WL*. However, we need to express the cost in terms of *X*, not *L*. Substituting for labor using the production function we have:

$$TC(X) = WX^2$$

Differentiating with respect to *X* gives the marginal cost:

$$MC(X) = 2WX$$

Under profit maximization we have[12]:

$$P_X = MC(X)$$

Therefore the **supply curve** is given by:

$$P_X = 2WX$$

Notice that after using technology ($X = \sqrt{L}$) this is the exact same equation as labor demand. This is hardly surprising since both equations characterize profit maximization of the firms. The only difference is that labor demand represents this condition in the labor market, while the supply curve represents it in the goods market.

5.2. Consumers

Consumers demand goods for consumption and supply labor. Suppose that the representative consumer derives utility from *X* and dis-utility from *L*. Preferences are given by:

$$U(X, L) = \ln(X - 0.5L^2)$$

The consumer uses its labor income to purchase *X*. The budget constraint is therefore:

$$P_X X = WL$$

[12] Make sure you know how to derive this relationship.

Our objective is to derive demand for X and supply of L. We do that by solving the consumer problem and expressing both X and L as a function of prices, P_X and W.

The Lagrangian:

$$\text{Lagrangian} = \ln(X - 0.5L^2) + \lambda(WL - P_X X)$$

First order conditions:

$$X: \qquad \frac{1}{X - 0.5L^2} = \lambda P_X$$

$$L: \qquad \frac{L}{X - 0.5L^2} = \lambda W$$

Combine the two conditions to get:

$$L = \frac{W}{P_X}$$

Which defines **labor supply**. Substitute L into the budget constraint and get the **demand curve for X**:

$$X = \left(\frac{W}{P_X}\right)^2$$