The Digital Economist

Lecture 4 -- The Real Economy and Aggregate Demand

The concept of aggregate demand is used to understand and measure the ability, and willingness, of individuals and institutions to purchase goods and services.

Say's law stated that "Supply creates its own Demand" in which the income earned producing a certain quantity of goods and services should be sufficient to purchase and identical quantity of those same products. However in a complex economy with sticky prices and wages, financial sectors in various stages of development, political institutions that fail to promote certainty and optimism, and strong international linkages and dependencies -- this law may not always hold. The ability to spend on the output of an economy may not be identical to the ability to produce that output.

AGGREGATE DEMAND

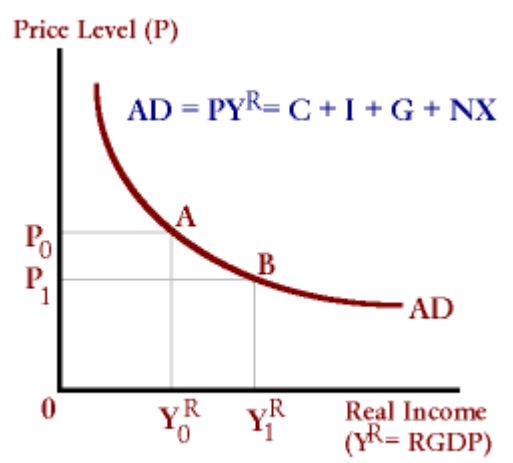
Aggregate demand is a measure the ability to spend *or* the level of expenditure necessary to command varying quantities of goods and services at different price levels. This concept is a measure of purchasing power such that when prices increase with a given level of nominal income, fewer goods or services can be purchased.

In understanding the behavior of aggregate demand we must take a close look at its individual components:

AD: Nominal Income = $P_t Y^R_t = (C_t + I_t + G_t + NX_t)$

Figure 1, Aggregate Demand

note:
AD = $\{Y^R_t, P_t \varepsilon \mathbf{R}^2 \mid Y^R_t = NGDP_t / P_t\}$



For a given level of nominal expenditure, an inverse relationship exists between the price level 'P' and Real Income 'Y^R'. Aggregate demand represents this inverse

relationship between the price level and a given level of purchasing power in an economy.

Any factor that affects consumption, investment, government, or export-import decisions will translate in to a change in nominal expenditure and, at an existing price level, a change in purchasing power. These factors may include changes in interest rates, exchange rates, wealth, taxes, public spending, expectations, or monetary policy targets.

Consumption Expenditure

Of the four components of aggregate demand, consumption expenditure C is the largest contributing to between 60% and 70% of total expenditure. For this reason, we often start our analysis with this particular component. This category of expenditure includes private spending on durable goods (*automobiles, electronic goods, appliances, ...*), non-durable goods (*food, clothing, books and magazines,...*), and services (*housing, health-care, education, entertainment,...*).

Special attention must be given to the service component of consumption expenditure for several reasons. First, services represent the largest component representing at least 50 percent of this type of spending. Second, services include housing services measured directly by rents being paid from tenant to landlord, in the case of rental housing, or indirectly as imputed rent that an individual would pay to himself in the case of owner occupied housing. In the latter case the homeowner acts as both tenant and landlord with no actual payment changing hands but imputed expenditure being included in the services category to reflect the value of the housing services received from the owner-occupied home. Third, services, unlike durable and some non-durable goods, are difficult to accumulate as inventory. Thus any changes in the demand for services (*due to changing preferences or the general level of economic activity*) must be immediately matched with changes in production. This is not always an easy task in any economy.

Consumption expenditure decisions are strongly influenced by household disposable (after-tax) income, household wealth, savings needs and plans, confidence in the future direction of the economy, and interest rates (in the case of durable-goods purchases).

Investment Expenditure

Investment expenditure I represents a smaller share of the total but tends to be the most volatile component leading to the cyclical behavior of aggregate demand. This category of expenditure includes fixed nonresidential investment (*factories, machines, transport equipment*), fixed residential investment (*new houses and apartments*), and business inventories. Often the volatility in investment results from fluctuation in inventory levels due to changing expectation about business conditions.

Fixed residential and nonresidential investment refers to the creation of income-producing assets. Assets that will generate net-benefits (*benefits - costs from housing services*) in the case of owner-occupied housing or generate profits as part of the production process. These net-benefits and profits depend on the expected revenue or

gross benefits generated by the asset as well as the costs of acquiring, maintaining and replacing these assets.

Demand for the production of the asset will directly affect the revenue generated. Strong demand based on preferences, optimism, purchasing power, or demographics will lead to the desire for more investment expenditure.

Acquisition costs include both the purchase price of the asset and the borrowing costs involved both which are highly sensitive to changes in interest rates. Higher interest rates lead to higher borrowing costs and thus lower net-benefits or profits such that the level of aggregate investment expenditure may be reduced. Maintenance and replacement costs depend on the useful life of an asset and its rate of depreciation. Assets that wear out very quickly or become obsolete in a short period of time have higher costs with the same effect as rising interest rates. Because of the sensitivity of investment decisions to changing interest rates, this category of expenditure is easily affected by monetary policies and activity in the financial sector of an economy.

Government Expenditure
Government expenditure G is a reflection of the fiscal needs and policies of the public sector in a given economy. This type of expenditure might be in reaction to the demand for public goods and services by private households and businesses through voting or other types of political activity. In addition, government expenditure could be used as a deliberate policy tool to increase nominal incomes in the hope of stimulating aggregate demand.

Net Export Expenditure
Finally, Net export expenditure NX reflects the international linkages based directly on service and merchandise flows across borders in addition indirectly reflecting capital flows into and out of a particular country. Merchandise flows are sensitive to domestic income levels and preferences for foreign-made goods. In addition these flows are influenced by exchange rates which determine the domestic price of goods and services produced abroad. Capital flows depend on interest rate (*yield*) differentials among nations as well as exchange rates which affect the domestic price of a foreign asset both at the time of purchase of that asset and at the time of sale.

As we will see in the following sections, specific spending components may be defined by broad functional relationships:

C_t = f{income (Y_t), wealth (W), taxes (T) , interest rates (r) , and prices (P_t)}

I_t = f{interest rates (r), capital productivity and longevity, and income (Y_t)}

G_t = f{fiscal policies, budgetary needs and borrowing constraints}

NX_t = Exports - Imports = f{exchange rates(e.r.), interest rates (domestic& foreign), income (domestic & foreign)}

In addition interest rates and exchange rates are affected by activity in the financial sector of the economy. This activity may include changes in monetary policy as administered by central banking authorities and changes in expectations of future economic activity, inflation, and credit risk.

SAVINGS AND INVESTMENT

A key variable missing from the above discussion is **savings**. Savings represents the source of funds within financial markets and behind those funds actual resources of the real economy. Domestic Investment Expenditure represents the use of those funds. It is important to keep in mind that these funds being transferred from lender to borrower represent scarce resources. These resources are made available via the saver foregoing current consumption allowing these resources to be used for the creation, accumulation, and replacement of capital -- capital that will allow labor to be more productive in the future.

Measures of Savings begins with the Income Identity:

$$\mathbf{Y} = C + I + G + NX$$

and rearranging terms:

$$\mathbf{Y} - C - G - NX = I_{[-]}(r)$$

where the left-hand-side of the equation represent the source of funds and the right-hand-side, the use of funds. Additionally, we note that Investment decisions are (negatively) related to the real rate of interest '**r**' (*see lecture 6*).

By subtracting and adding-in taxes 'T' which represents the transfer of resources from the private sector to the public sector we have:

$$[\mathbf{Y} - T - C] + [T - G] + [-NX] = \mathbf{I(r)}$$

Each term in brackets now represents a separate type of savings defined as follows:

$S_{Private} = [\mathbf{Y} - T - C]$ ... Private savings,

$S_{Public} = [T - G]$ ... Public Savings and,

$S_{foreign} = [-NX]$ ... Foreign Savings

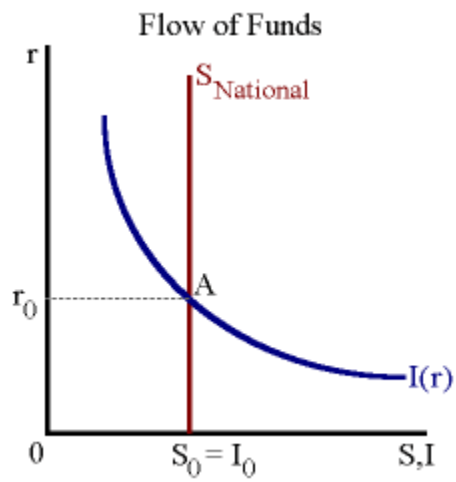
Note that NX represents the Current Account Balance within the balance of payments. Thus, its negative, [-NX] represents the Capital Account Balance (*see the Balance of Payments in lecture 2*) that, when positive in value, represents foreign lending to the domestic economy.

Adding these three terms together we have:

$$S_{National} = S_{pvt} + S_{pub} + S_{foreign}$$

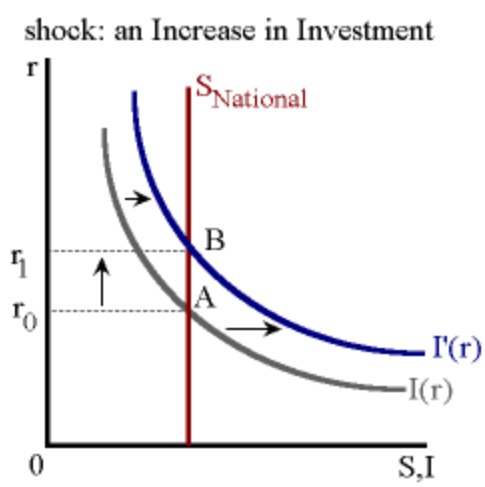
This level of savings is shown by the vertical line in the diagram below. The real rate of interest will adjust in competitive financial markets to bring National Savings into equality with Domestic Investment as shown by $\mathbf{r_0}$.

Figure 2, Savings and Investment



Various shocks can affect the flow of funds and thus the rate of interest. For example, an increase in investment expenditure perhaps due to an increase in the productivity of capital or due to growth in the real economy will shift the Investment schedule to the right.

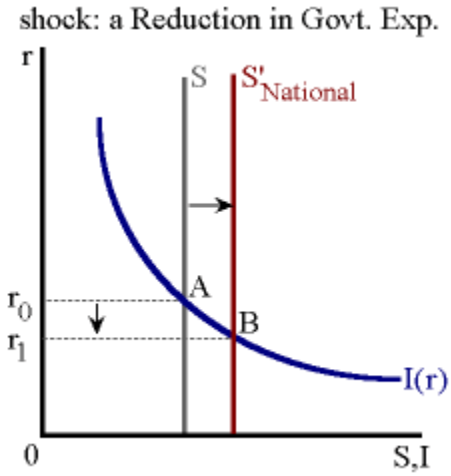
Figure 3, An Investment Shock



Fiscal policy shocks can also affect the flow of funds and real interest rates. For example, suppose that Government Expenditure G decreases. Holding taxes constant, this will lead

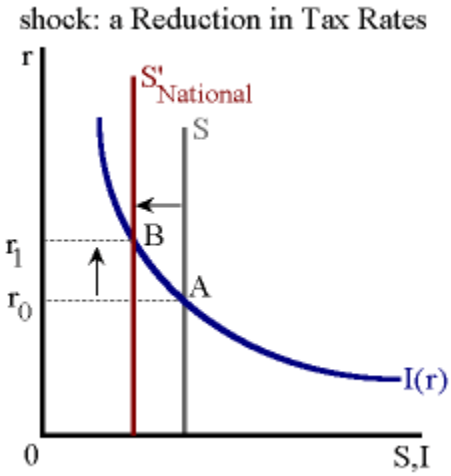
to an increase in Public Savings and National Savings. The savings function will shift to the right creating an excess supply of funds thus causing the real rate of interest to fall

Figure 4a, A Fiscal Shock



Changes to the tax rate is a bit more complicated. Changes in taxes affect both consumption expenditure and thus Private Savings as well as Public Savings directly. However, working through the Marginal Propensity to Consume, an increase in the tax rate reduces Consumption Expenditure / Private Savings by less than the increase in Public Savings.

Figure 4b, A Fiscal Shocks



A Numerical Example

Suppose that we have the following equations:

$C = 0.80(Y - T)$	... consumption expenditure, MPC = 0.80
$T = 0.20(Y)$	... Tax Revenue, tax rate = 20%
$G = 2{,}000$	... Government Exp. (billions)
$NX = -500$	... Current Acct. Balance (deficit)
$I = 2{,}600 - 100(r)$	... Investment Exp.
$\mathbf{Y} = 10{,}000$	... Real GDP (Output in billions) held constant.

Solving (given **Y** = 10,000), we find that:

$T = 2{,}000$

$C = 0.80(10{,}000 - 2{,}000) = 6{,}400$

and

$S_{pvt} = Y - T - C = 1{,}600$,

$S_{pub} = T - G = 0$ and,

$S_{foreign} = [-NX] = 500$

thus,

$S_{National} = 1{,}600 + 0 + 500 = 2{,}100$

setting

$S_{National} = I(r)$

we have:

$2{,}100 = 2{,}600 - 100(r)$

and

r0 = 5% and Investment expenditure = 2,100.

* * *

Now, if the tax rate were to be reduced to 10% (t' = 0.10):

$T' = 1{,}000$

$C' = 0.80(10{,}000 - 1{,}000) = 7{,}200$ and

$\Delta C = +800$

$S'_{pvt} = Y - T - C = 1{,}800$ and

$\Delta S_{pvt} = +200$

$S'_{pub} = T - G = -1{,}000$ and

$\Delta S_{pub} = -1{,}000$

$S_{foreign} = [-NX] = 500$ as before.

Thus,

$S'_{National} = 1{,}800 - 1{,}000 + 500 = 1{,}300$ and
$\Delta S_{National} = -800$

setting $S'_{National} = I(r)$ we have:

$1{,}300 = 2{,}600 - 100(r)$ or

r1 = 13% and Investment expenditure = 1,300.

Reducing the tax rate from 20% to 10% has led to an increase in the real interest rate from 5% to 13%. With this interest rate increase, private Investment Expenditure will be reduced (from 2,100 to 1,300).

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Worksheet #2: Savings and Investment

1. Potential Output **'Y*'** for a given economy is $10,000 [i.e., $10 trillion]. Given the following equations:

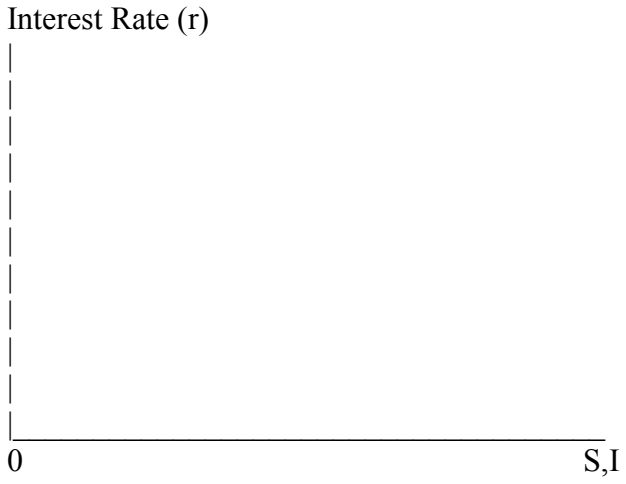
C = 0.80(**Y*** - T)	-- Consumption Expenditure
T = 0.10**Y***	-- Taxes [*tax rate* = 10%]
G = $2,000	-- Government Expenditure
I = $1,500 – 100(r)	-- Domestic Investment Expenditure [r = *market interest rate*]
NX = 0	-- Exports = Imports

a. Calculate the following:

- Private Savings,
- Public Savings, and
- National Savings.

b. At what market interest rate will Domestic Investment be equal to National Savings?

Graph the results of parts 'a-c' in the diagram below:



c. Describe how an increase in the tax rate from 10% to 15% will affect Private, Public and National Savings and the market rate of interest.

Worksheet #2, page 2

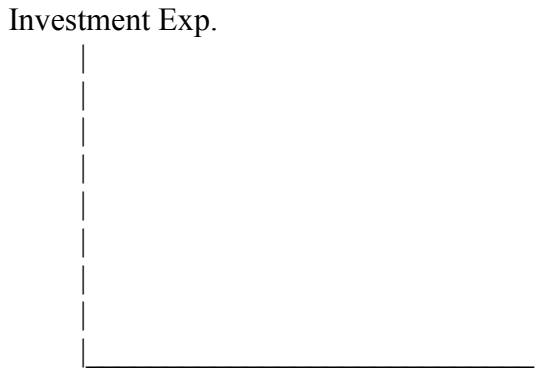
2. Given the following:

Y* = $10,000	--	Potential Output (held constant)
C = b(**Y*** - T)	--	Consumption Expenditure [b = Marginal Propensity to Consume]
T = 0.10**Y***	--	Tax Revenue [Tax rate = 10%]
S_{public} = T – G = $0	--	Public Savings [G = T *always*!]
$S_{private}$ = Y*-T – C	--	Private Savings
$S_{national} = S_{public} + S_{private}$		
NX = $0	--	Net Export Expenditure [always in balance]
$I_{domestic}$ = 1000 – 100(r)		Investment Expenditure [r = interest rate]
$I_{domestic} = S_{national}$	--	Assume that the interest rate adjusts such that Domestic Investment Expenditure is always equal to National Savings.

Complete the following table:

MPC	Potential Output	=	Consumption Expenditure	+	Government Expenditure	+	Investment Expenditure	National Savings	Interest Rate
0.50	$10,000		_____		_____		_____	_____	____
0.55	$10,000		_____		_____		_____	_____	____
0.60	$10,000		_____		_____		_____	_____	____
0.65	$10,000		_____		_____		_____	_____	____
0.70	$10,000		_____		_____		_____	_____	____
0.75	$10,000		_____		_____		_____	_____	____
0.80	$10,000		_____		_____		_____	_____	____
0.85	$10,000		_____		_____		_____	_____	____
0.90	$10,000		_____		_____		_____	_____	____
0.95	$10,000		_____		_____		_____	_____	____
1.00	$10,000		_____		_____		_____	_____	____

and Graph the relationship between *Consumption Expenditure* and *Investment Expenditure* in the diagram to the right:



AGGREGATE EXPENDITURE AND INCOME DETERMINATION

Given our understanding of National Income Accounting, one method of calculating nominal GDP (Y^N) was through the expenditure approach such that:

$$NGDP = \sum P_i Q_i = \mathbf{Y}^{Nominal}$$

or

$$\mathbf{Y}^{Nominal} = C + I + G + NX$$

where the variables on the right-hand side represent the four expenditure categories that make up GDP. What is important is that certain expenditure decisions are proportional to the level of income (*discussed more fully in lecture 5*) such that as aggregate income increases, expenditure increases by some fraction of this income change. We can think in terms of this expression representing an equilibrium condition (Y_e) such that for one unique level of income, expenditure is exactly equal to that level of income:

$$\mathbf{Y_e} : \text{Aggregate Income} = \text{Aggregate Expenditure}$$

We will begin with consumption expenditure 'C' defined as being proportional to disposable income (gross income less taxes paid) with the proportional relationship being defined by the marginal propensity to consume '**b**':

$$C = C_o + \mathbf{b}(Y-T), \qquad 0 < b < 1$$

Tax revenue 'T' is defined to be some fraction of income via the tax rate 't':

$$T = tY, \qquad 0 < t < 1$$

For algebraic simplicity we will define the other expenditure categories; investment 'I', government 'G', and net exports 'NX' as being autonomous with respect to income (i.e., spending decisions remain independent of the level of national income). We will combine these values with autonomous consumption 'C_o' and summarize this via a single variable '$\mathbf{A_o}$' known as **autonomous expenditure**:

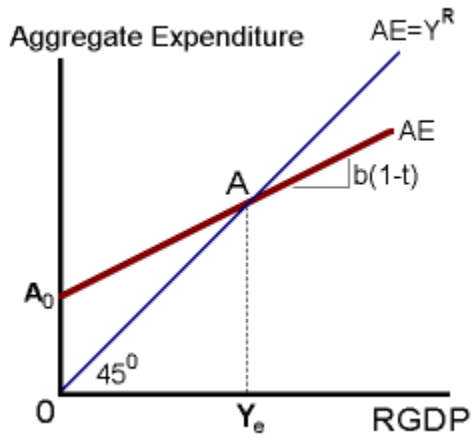
$$\mathbf{A_o} = C_o + I_o + G_o + NX_o$$

Thus, the expenditure equation can be written as:

$$AE = \mathbf{A_o} + \mathbf{b}(1 - t)\mathbf{Y}$$

as shown in the diagram below:

Figure 5, Aggregate Expenditure



and in equilibrium:

$$\mathbf{Y_e} : \mathbf{Y} = \mathbf{A_o} + \mathbf{b}(1 - t)\mathbf{Y}$$

Solving for 'Y_e', the equilibrium value of income, we have

$$\mathbf{Y_e} = \alpha'[\mathbf{A_o}],$$

where $\boldsymbol{\alpha'} = [1 - b(1 - t)]^{-1}$ and represents, what is commonly known as, the **simple spending multiplier**.

See: The Digital Economist: http://www.digitaleconomist.com/ae_4020.html#1
To experiment with changes to the parameters of the expenditure model.

The Multiplier Process

Any time new spending is introduced into the economy (*or if spending is removed*), it will cause GDP (*and other measures of national income*) to change by some multiple of that spending shock. This takes place through the multiplier process in aggregate spending largely via changes in consumption expenditure. For example, suppose that the marginal propensity to spend (changes in spending induced by changes in income) is equal to 0.50

$$\textit{Expenditure} = \mathbf{A_o} + 0.75(\mathbf{Y} - 0.333\mathbf{Y})$$

$$= \mathbf{A_o} + 0.50\mathbf{Y}$$

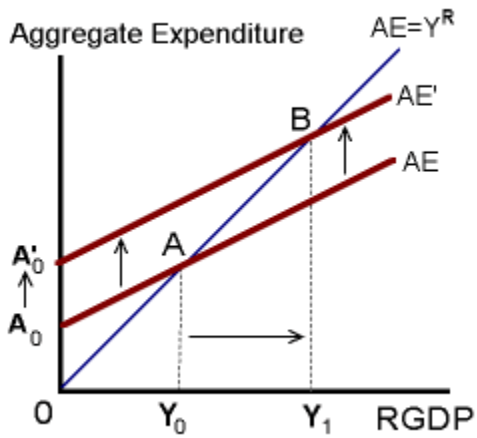
Given our equilibrium condition: **Y** = AE (*Aggregate Expenditure*)

$$\mathbf{Y} = \mathbf{A_o} + 0.50\mathbf{Y}$$

Since [1-b(1-t)] < 1, the spending multiplier α' will be greater than one such that:

$$\mathbf{Y_e} = 2.0[\mathbf{A_o}] \text{ and } \Delta\mathbf{Y_e} = 2.0[\Delta\mathbf{A_o}]$$

Figure 6, An Autonomous Shock and the Multiplier



An initial change in autonomous spending (*for example, a shock in the form of an increase in government spending equal to $20*) is received as income by some person or business in the aggregate economy. This spending translates into an increase in income for that person who, for a given propensity to spend, will increase his expenditure by $10 . This $10 in additional spending is received by someone else as income who spends 50% of that amount.

iteration	**ΔIncome**	**ΔExpenditure**
0	Δ $\mathbf{A_o}$= $20 (billion)	10
1	10	5
2	5	2.5
3	2.5	1.25
4	1.25	0.625
5	0.625	0.313
6	0.313	0.157
7	0.157	0.079
8	0.079	0.040
:	:	:
n	0.001	-

Total Change in Income: $40 (billion)

See: The Digital Economist: http://www.digitaleconomist.com/s_mult.html
to practice with the effects of changing parameter values on the spending multiplier.

The spending flows through the aggregate economy such that when we total up all of the increases in income we find that aggregate income has increased by $40 billion -- 2.0 times the initial spending shock. This is known as the multiplier process.
If we extend the model to include: 1) the relationship between *investment expenditure* and the **real interest rate** as seen in the flow of funds model (*and discussed more fully in lecture 6*):

$$I = f_{[-]}(r)$$

and, 2) the relationship between **Import Expenditure** and National Income:

$$IM = f_{[+]}(Y)$$

This second relationship highlights the notion that changes in domestic income has a positive effect on Import expenditure. As income rises, individuals spend a fraction of this increase on domestically produced goods and, in addition, foreign goods.

We can build the expenditure equation as follows:

$C = C_o + \mathbf{b}(Y - T)$ -- **b** = *the Marginal Propensity to Consume*
$T = \mathbf{t}(Y)$ -- **t** = *the Tax Rate*
$I = I_o - \mathbf{h}(r)$ -- **h** = *the Interest Sensitivity of Investment*
$G = G_o$
$NX = EX_o - IM$
$IM = \mathbf{m}(Y)$ -- **m** = the Marginal Propensity to Import
$AE = C + I + G + NX$
$= \mathbf{A_o} + [\mathbf{b}(1 - \mathbf{t}) - \mathbf{m}]Y - \mathbf{h}(r)$ *with* $\mathbf{A_o} = C_o + I_o + G_o + EX_o$

In equilibrium:

Y_e: $\mathbf{Y} = AE$

$\mathbf{Y_e} = \alpha'[\mathbf{A_o} - \mathbf{h}(r)]$ *where* $\alpha' = [1 - \mathbf{b}(1 - \mathbf{t}) + \mathbf{m}]^{-1}$

The addition of the **Marginal Propensity to Import** (*the fraction of each additional dollar of income devoted to import spending*) has modified the derivation of the multiplier with the provision that: $[1 - \mathbf{b}(1 - \mathbf{t}) + \mathbf{m}] < 1.0$.

The addition of the **Interest Sensitivity of Investment** (*a measure of how investment expenditure responds to changes in the real rate of interest*) allows for modeling the effects of changes in the real rate of interest 'r' on the equilibrium level of income:

$\mathbf{\Delta Y_e} = \alpha'[-h(\mathbf{\Delta r})]$ such that as $r \uparrow$, $Y_e \downarrow$.

Be sure that you understand the following concepts and terms:

- Aggregate Demand
- Nominal Income (GDP)
- Real GDP
- Purchasing Power
- Consumption Expenditure
- Investment Expenditure
- Government Expenditure
- Net Export Expenditure
- Marginal Propensity to Consume
- Private Savings
- Public Savings
- Foreign Savings
- Current Account Balance
- Capital Account Balance
- National Savings
- Real Rate of Interest
- Flow of Funds
- Aggregate Expenditure
- Autonomous Expenditure
- Marginal Propensity to Spend
- The Multiplier

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Worksheet #3: The Algebra of Demand-Side Equilibrium

1. Given the following equations:

$C_t = 0.75(Y_t - T)$	*Consumption Expenditure*
$I_t = 200$	*Investment Expenditure*
$G_t = 250$	*Government Expenditure*
$NX_t = 50$	*Net-Export Expenditure*
$T = 0.20Y_t$	
$Y_t = C_t + I_t + G_t + NX_t$	*Equilibrium Condition*

a. Determine the following:

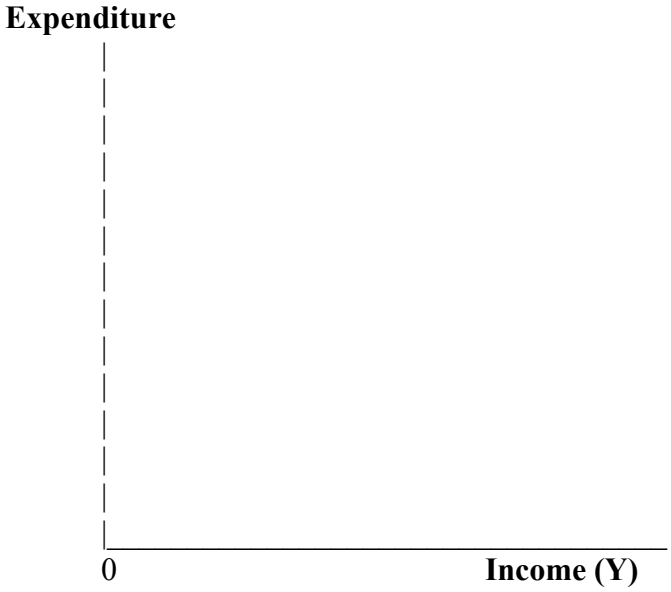
i. the Marginal Propensity to Consume:_____

ii. the (Income) tax rate:_____

iii. the level of Autonomous Expenditure A_o:_____

iv. the Spending multiplier: {1/[1-b(1-t)]}:_____

b. find the level of equilibrium income and graph this relationship in the diagram below:



c. Given this equilibrium level of income, calculate the level of tax revenue collected:_____ Is the government running a surplus or deficit:?_____

d. Calculate the level of savings:_____ and investment expenditure:_____ at the equilibrium level of income. Is there a funds (savings-investment) surplus or deficit?_____ How are these surplus or deficit funds being used?_____

Worksheet #3, page 2

2. Suppose that Income is fixed at **$1000**. Using the equations of page 2, substituting in the following investment equation:

$$I = 200 - 100(r),$$

calculate the corresponding value of the real interest rate, investment expenditure, savings, and the budget deficit.

How will a $50 ($\Delta G = 50$) increase in government spending impact the real interest rate?

How does this shock affect: savings, investment expenditure, and the budget surplus/deficit.