Course: Economics I (macroeconomics)

Study text

4th Chapter

Aggregate Expenditure and Product

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4 Aggregate expenditure and product

In this chapter we will introduce the factors, that influence the development of macroeconomic product, and the circumstances that lead to its change to a new equilibrium position, thus leading to fluctuations in the actual product. The main reason there will be changes in aggregate demand. The Keynesian multiplier model will be introduced, firt in the 2-sectoral economy, then in the 3- and 4-sectoral economy.

4.1 Aggregate planned expenditure and product

Planned aggregate expenditures are divided into household spending (C), private investment spending (I), government purchases (G) and net exports (NX). The usual markings PAE comes from the initial words of *Planned Aggregate Expenditures*, but we have already known the acronym AD - aggregate demand. In writing as follows:

$AD = PAE = C + I + G + NX$

There are two forms of aggregate expenditures:

- **autonomous expenditure** – independent on product,
- **induced expenditure** – dependent on product (induced by the product).

Each model is based on its assumptions (conditions) under which its conclusions are valid. It is important to realize that changes in these conditions affect formulated conclusions.

Keynesian multiplier model is based on the following **assumptions:**

- *there is a sufficient amount of unused inputs* in the economy (idle capital and labor). This situation is called „output gap", where the real output of the economy is lower than potential;

- *companies are able to meet the growing demand* for domestic production, either current production, or of its existing stockpile. There is no restriction on the supply side and the level of production is determined by demand side;

- *we abstract* for certain simplifications of gross savings of enterprises, it is from that part of the incomes that takes the form unpaid profits and incomes needed to pay depreciation of fixed capital.

- *nominal wage rates and price level are fixed.* This assumption allows to unify the development of the nominal and real product;

- *central bank controls the money supply and interest rates are constant.*

Thus the economy is in the output gap and plagued by relatively high unemployment rate.

First assume 2-sectoral economy including only households and firms.

The term product is referred to gross domestic product. What are the equilibrium conditions at the aggregate production? In order to achieve macroeconomic equilibrium the sum of planned expenditure must equal the quantity of production. This relationship can be written as the first identity: **AD = Y**.

Macroeconomic equilibrium AD = Y is demonstrated in Fig. 4.1. The straight line with a slope of 45 degrees divides the quadrant into two equal parts and for each point on this line, the distance is equal along taxes. This line is called the line of squares. Planned expenditures are equal to the output.

Fig. 4.1 Macroeconomic equilibrium (AD = Y)
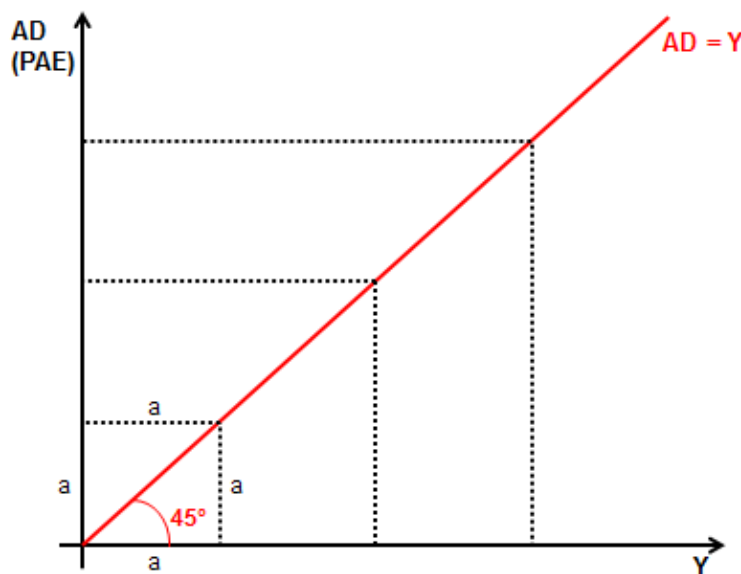
4.2 Model of multiplier in the 2-sectoral economy

The simplest model of the multiplier (expenditure model) is based on the hypothetical existence of only two sectors - households and firms. We abstract from other economic operators. It follows the basic premise that the total planned expenditures consist only of household consumption expenditure (C) and private investment spending (I).

AD = C + I

Thus, we can write that income (Y) equals disposable income (YD).

Y = YD

Now we focus on the explanation of individual components in terms of macroeconomic equilibrium in 2-sectoral economy. We will focus more closely on consumer spending and household saving.

Disposable income have to be define. It is income households are able to manipulate with. We start from the Keynesian concept of formation of consumer spending and saving. Household spending is dependent on the household disposable income.

There are two parts of consumer spending:

- **autonomous consumption expenditures (Ca).** This component is independent on disposable income. As examples we can mention purchase of necessary food, medicine, housing expenses, various fees etc.

- **Induced consumer spending (mpc.YD).** This component includes expenses dependent on disposable income. Increasing disposable income rises household spending. We assume that each additional unit of disposable income households receive, is spent on consumption. The ratio is called **marginal propensity to consume** (mpc).

That relationship can be written as follows:

$$mpc = \frac{\Delta C}{\Delta YD}$$

Mpc can take values from 0 to 1 and is the same for different items that make up disposable income (wages, social benefits, etc.). Marginal propensity to consume indicates how consumer spending is changed when increasing disposable income (by one unit). If consumer spends, for example CZK 0.80 and he/she saves CZK 0.20 from one additional unit of disposable income, the marginal propensity to consume is 0.8.

Consumption function is defined as the sum of autonomous (Ca) and induced consumption (mpc.YD):
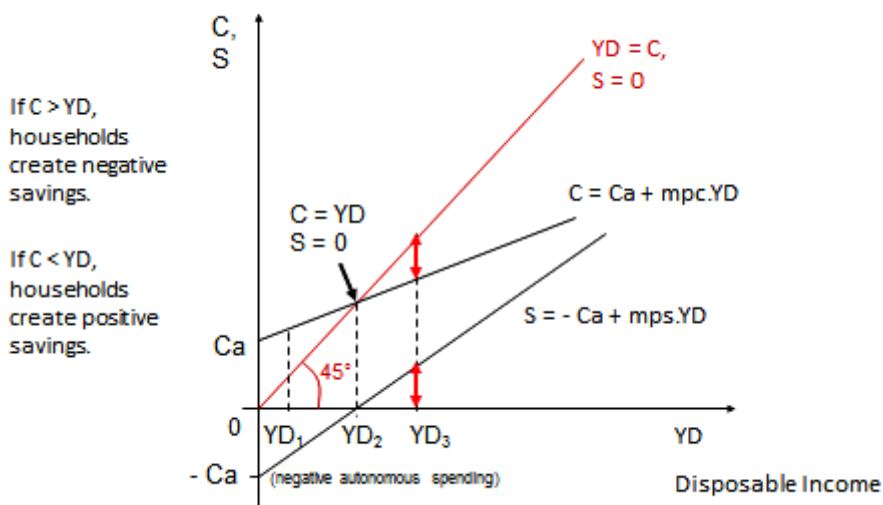
C = Ca + mpc.YD

Average propensity to consume (apc) is defined as:

$$apc = \frac{C}{YD}$$

Due to the fact that Ca > 0, *apc* is decreasing when rising YD.

Keynesian consumption function defines the relationship between the size of consumer expenditure and the level of disposable income. Graphically, both functions are presented in Fig. 4.2.

Fig. 4.2 Keynesian spending and savings function

In Fig. 4.2 the line of 45 degrees represents a set of points, where consumer spending equals disposable income and households creat no savings (S = 0).

Consumption function is defined by a growing linear function. Its slope is determined by the marginal propensity to consume (*mpc*). Households are able to create saving only in case of their disposable income is greater than consumption expenditure.

Savings function is also linea and can be derived from equation YD = C + S where S is expressed:

S = YD – C
$S = YD – Ca – mpc.YD$
$S = – Ca + YD – mpc.YD$
$S = – Ca + (1 – mpc).YD$

The sum of the marginal propensity to consume and the marginal propensity to save equals to one (mpc + mps = 1), hence *(1 - mpc)* equals *mps*.

S = – Ca + mps.YD

where (- Ca) = autonomous consumption in its negative value,
mps = marginal propensity to save, $\Delta S/\Delta YD$,
YD = disposable income.

Mps takes values from 0 to 1. If we know the value of the variable *mpc*, for example. *mpc = 0.8*, we know automatically that *mps = 0.2*. There is a derivation of *mpc + mps = 1:*

C + S = YD, assuming mpc and mps are greater than zero, then:
$\Delta C + \Delta S = \Delta YD$ *(devided by ΔYD):*
$\Delta C/\Delta YD + \Delta S/\Delta YD = \Delta YD/\Delta Y$
mpc + mps = 1.

According to J. M. Keynes savings is made up from a certain level of household disposable income.
Slope of the savings function corresponds to a marginal propensity to save (mps).

In addition, we introduce *average propensity to save* (aps) by writing:

$$aps = \frac{S}{YD}$$

As we have already mentioned, we assume the following distribution of disposable income: consumer spending and savings. Also the sum of the average values of aps and apc equals to one:

apc + aps = 1

Keynesian spending and savings function can move or change their slope. It depends on:

- ***interest rates changes***; rising interest rates motivate to save money;

- ***household wealth and its changes***;

- non-economic factors, such as ***optimistic or pessimistic expectations*** about future development in the economy;

- ***government intervention*** – social benefits, change in taxes etc.;

- ***population growth***.

Investment spending

Investment expenditures consist of expenditures for the purchase of fixed capital formation and increase in stocks. These expenditures are independent or autonomous.

$I = I_a$

We will not consider the possible relationship between income growth and the need for additional capital goods.

Fig. 4.3 illustrates the investment function. Assume investment spending is not dependent on real output. It is dependent on interest rate and investment profitability.

Fig. 4.3 Autonomous investment expenditure
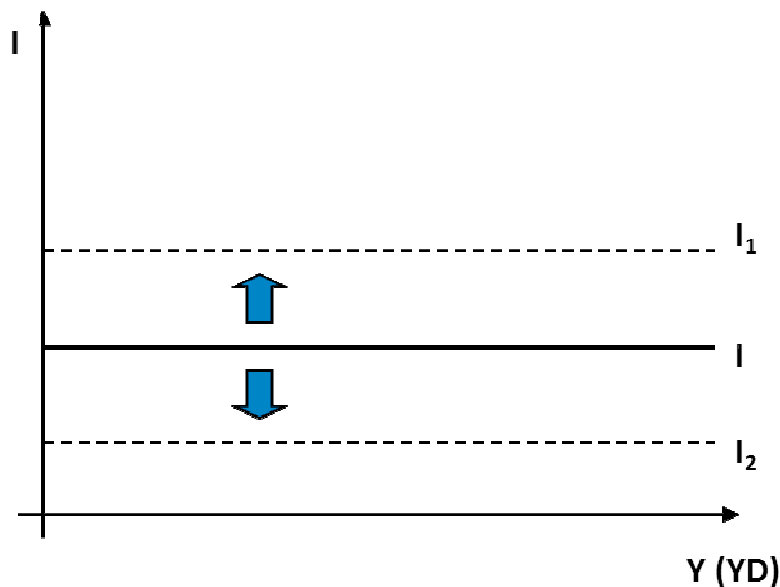
Different capital goods have different expected rate of return (r) - the share of the expected annual net income and the price capital goods. Generally the rule is that projects with high profitability carry a higher degree of risk. Therefore, investors do not take account only the profitability of the project, but also its riskiness. In principle, the profitability is compared with the interest.

Complex models use concept of present value (PV - Present Value) of expected future returns. The formula is the following:

$$PV = \frac{N_1}{(1+i)} + \frac{N_2}{(1+i)^2} + \frac{N_3}{(1+i)^3} + \ldots + \frac{N_n}{(1+i)^n}$$

where N_1 to N_n are expected incomes in a given time period, *i* is interest rate.

Investment demand will include only those projects whose net present value (*NPV)*, it is the PV after deducting the cost of the investment project, is greater than zero.

Investment demand may affect other factors (beside the interest rate):

- *level of taxation of profits* from the planned investment projects, taxes reduce net income and then the demand for investment;

- *business confidence and optimism* - especially confidence in the stability and validity of statutory provisions and standards. In case of positive economic development of the country, investment spening is expected to rise. Conversely, unstable social, legal and political environment is a barrier to the development of investment activities;

- *population growth*, it usually leads to the growth of all needs of the population and the growth of aggregate demand.

Equilibrium product and simple spending multiplier

Beside the AS/AD model, we can use the Keynesian multiplier model to show equilibrium output.

The beginnings of the multiplier model can be found in the Keynesian theory. The theory of the multiplier was developed in detail wihtin the Neokeynesianism in the US and its practical use culminated mainly in the 50s and 60s of the 20th century.

First, we will deal with multiplier model in the bisectoral economy and we will derive the simple spending multiplier.

Aggregate planned expenditures (AD) represent sum of consumption and investment spending:

$AD = Y$

Aggregate planned expenditures may vary from the actual expenditure incurred. The actual investment expenditures may vary from the planned investments. Firms may experience unexpected drawdown in inventories or unexpected surplus. The equilibrium output determines the situation when unplanned investment equals zero (IU = 0).

Macroeconomic equilibrium is shown in Fig. 4.4. Upper graph illustrates the macroeconomic equilibrium (point E) in the model of multiplier. AD line is derived from spending function increased by the investment spending. At the point E

production supplied is equal to the amount of planned expenditures – or aggregate demand: AS (Y) = AD.

Fig. 4.4 Determination of macroeconomic equilibrium in bisectoral economy using multiplier model (top graph) and using the functions of savings and investments (lower graph)
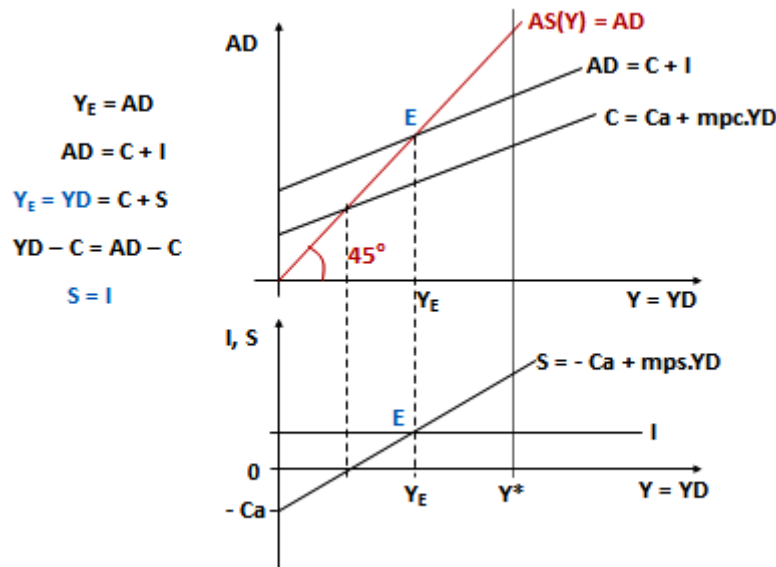
The bottom graph illustrates the investment and savings function. In case of equilibrium situation AD = Y, the savings equals planned investment expenditures (S = I). Within the Keynesian model, the economy is below the level of potential output.

Savings (S) is referred to leakage, because this is a part of the income that escapes in the sense that it does not become a household expenditure.

Equilibrium product conditions can be summarized in the following identities:

1. $Y = AD$,
2. $IU = Y - AD = 0$,
3. aggregate non-consumption expenditures = aggregate leakages, $I = S$.

The concept of the multiplier stems from the fact that when the level of spending (e.g. investment) is increased of any amount, so the change (increase) in equilibrium output is higher (multiplied). That is why initial impulse will cause a string of other expenditures, because of induced consumption spending.

Consider the following example. The company decides to buy production equipment of 100 monetary units. This will result in an increase in planned investment of 100 (ΔI = 100), the manufacturer of the equipment receives 100 units. Increase in income will be greater than 100. How does this work? Collected 100 units are divided into profit to managers, wages, and payments to subcontractors etc. Assuming propensity to

consume 0.8, then 80 units will be spent and 20 units saved. 80 spend units will occurs as incomes again. This sum will be back in households while 64 units are spent and 16 units saved. This process (multiplication) runs until exhaustion.

Macroeconomic equilibrium condition Y = AD can be split:

$Y = AD$
$Y = Ca + mpc.Y + I$
$A = Ca + I$
$Y = A + mpc.Y$
A = autonomous expenditures (independent on product)

Assume positive change in autonomous spending: $\Delta A > 0$. We are interested in how an increase in autonomous expenditures affects the product:

$\Delta Y = \Delta A + mpc. \Delta Y$
$\Delta Y - mpc. \Delta Y = \Delta A$
$\Delta Y(1 - mpc) = \Delta A$

$$\Delta Y = \Delta A. \frac{1}{1 - mpc}$$

The fraction $\dfrac{1}{1 - mpc}$ is denoted as α and we call it **a simple spending multiplier** (multiplier of autonomous expenditures).

The level of investment or autonomous consumption can vary. In case of the change in investment we talk about **simple investment multiplier**.

Change in investment (ΔI):

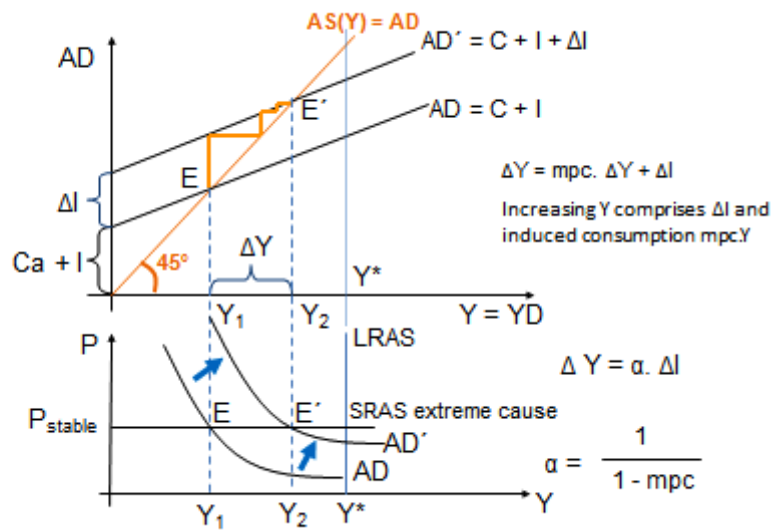$\Delta Y = \alpha. \Delta I$
$\alpha = \dfrac{1}{1 - mpc}$

Change in autonomous consumption (ΔCa):

$\Delta Y = \alpha. \Delta Ca$
$\alpha = \dfrac{1}{1 - mpc}$

A simple spending multiplier says **how many times the output will increase when autonomous expenditure rise by one unit.**

Fig. 4.5 Multiplier effect while increasing investments in the 2-sectoral economy

The effect of increased investment spending is demonstrated in Fig. 5.4. The top graph shows the multiplier effect in the model of multiplier. Increased investment stimulates product. The initial impulse (increasing investment) leads to subsequent growth of induced consumption. Eventually induced consumption converges to zero as disposable income is perched on consumption and savings and the savings is leakage.

Consider the initial positive change in investment ΔI = 100 units and mpc = 0.8. In the first round, we can calculate the change in product: ΔY = 0,8.100 = 80; in the second round ΔY = 0,82.100 = 64; and in the third round ΔY = 0,83.100 = 51.2 of monetary units. Additional changes in product lead to zero due to the formation of savings - the marginal propensity to save is 0.2 and that means that there is always 20 % of additional disposable income saved. The total effect of increased investment is $\Delta Y = \dfrac{1}{1-mpc} \cdot \Delta I$.

Fig. 4.5 shows multiplier effect in the model AS/AD. Because the Keynesian theory assumes fixed price level, the SRAS curve is displayed as a horizontal line (referred to as an extreme case). Increasing AD causes the positive change in output.

The multiplier is dependent, not only on the positive changes in investment, but also on the value of the *marginal propensity to consume*. The higher the marginal propensity to consume is, the higher the value of the multiplier.

The size of the multiplier effect is logically influenced by marginal propensity to save. A simple spending multiplier can be expressed also in the form of:

$$\alpha = \frac{1}{mps}$$

It is the reciprocal value of the **marginal leakage rate of income**: *MLR*. The higher the value of the marginal propensity to save is, the lower the multiplier effect, because savings is leakage from the flow of household expenditures.

4.3 Model of multiplier in the 3-sectoral (closed) economy

Aggregate demand in the 3-sectoral economy is made up of the following components:

AD = C + I + G

Three sectoral model of the economy includes these additional variables:

- **government spending** (G),

- **government transfer payments** (TR). We will consider only transfer payments to households (excluding grants and subsidies to companies).

- **total tax** *(TA_T),* where we also classify mandatory payments for health, social insurance and other payments that reduce the level of disposable income. Total taxes are divided into two groups:

  a) **income taxes** *(t.Y)*, they vary with change in income. We understand income tax from wages, profits, etc.,
  b) **autonomous taxes** *(TA)* **,** i.e. independent on the output, e.g. real estate transfer tax, inheritance tax, gift tax or wealth tax.

We can derive the following:

$TA_T = t.Y + TA$

The rate *t* is the *marginal tax rate* and indicates the share of total tax change to change in output (income):

$t = \Delta TA_T / \Delta Y$

Average rate of income tax, i.e. the share of total taxes to total income is expressed as:

$TA_T / Y = (TA/Y) + t$

If TA > 0, the average tax rate decreases when increasing income.

The three sectoral model of the economy there is no longer valid the equality of income and disposable income. In this model we use:

YD = Y − t.Y − TA + TR

Aggregate demand consists of:

AD = Ca + mpc(Y − t.Y − TA + TR) + I + G

Ca = autonomous consumption,

mpc = marginal propensity to consume,

Y = income (product) of the economy,

t = rate of income tax (e.g. if the rate of income tax is 25 %, then t = 0.25)

TA = autonomous taxes,

TR = transfer payments,

I = planned investment,

G = government expenditure on purchase of goods and services.

Autonomous expenditures include autonomous tax (TA), transfer payments (TR), investment (I) and government spending on purchases of goods and services (G).

Equilibrium output in terms of the 3-sectoral economy

The principle of equilibrium production has been already mentioned. At equilibrium level o output Y = AD is valid (IU = 0).

Macroeconomic equilibrium in the three sectoral model of the economy:

$Y = Ca + mpc(Y − t.Y − TA + TR) + I + G$

Autonomous expenditure consists of:

$A = Ca + mpc.TR − mpc.TA + I + G$

Now if there is a change in autonomous spending, we can derive the change in output:

$Y = A + mpc.Y − mpc.t.Y$

Change in Y (ΔY) when ΔA:

$ΔY = ΔA + mpc. ΔY − mpc. t. ΔY$

And after adjustment:

$$\Delta Y = \Delta A. \frac{1}{1-mpc(1-t)}$$

The fraction $\frac{1}{1-mpc(1-t)}$ is referred to as **a multiplier of autonomous expenditure in the 3-sectoral economy** (or as a multiplier of autonomous expenditure involving the tax rate).

Expenses are incurred for the purchase of C, I and G, income is used for consumption, savings, and is taxed. Subtract from the taxes paid by government transfers, we get the variable net taxes.

$$C + I + G = C + S + (TA_T - TR)$$

After deducting consumption (C) from both sides of the equation, we get:

$$I + G = S + (TA_T - TR)$$

Where $S + (TA_T - TR)$ represent leakages from the economy in the 3-sectoral model. It is a part of income that is not spent on the purchase of consumer goods.

The equilibrium condition is the following expression:

$$I + G = S + NT$$

The following Fig. 4.7 shows the multiplier effect of an increase in government expenditure on purchase of goods and services (G) in the model of the multiplier (top graph) and the model of AS/AD (bottom graph). The principle is the same as in the 2-sectoral economy.

Fig. 4.6 Multiplier effect of increased government spending in the 3-sectoral economy
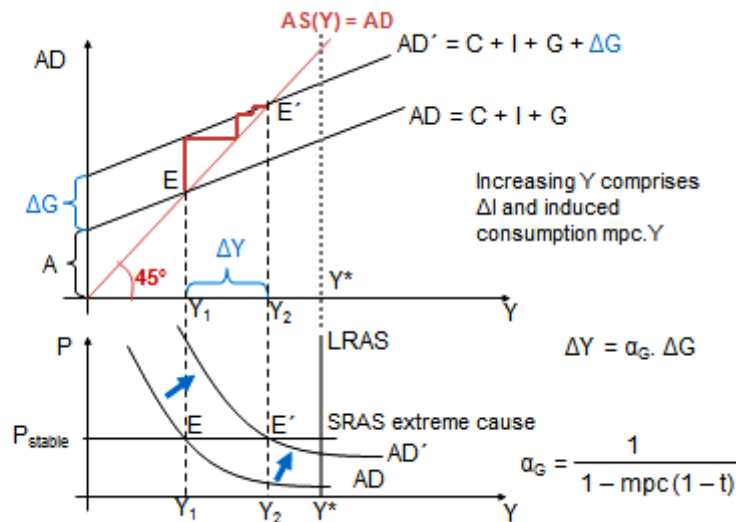
Marginal propensity to consume (*mpc*) and the rate of income tax *(t)* determine the slope of aggregate demand (the higher the *mpc* and the lower *t* is, the steeper the AD). The slope of the line AD is given by *mpc(1 - t)*.

The point E is the point where the planned expenditures (aggregate demand) equal to the real product (Y_1).

Assume ***increased military spending***. Military expenditures are part of government spending G that is the final component of aggregate demand. The increase in the real output will be:

$$\Delta Y = \Delta G. \frac{1}{1 - mpc(1-t)}$$

The lower graph in Fig. 4.6 shows the multiplier effect in the AS/AD model. Again assuming a horizontal SRAS.

All variables: Ca, I, G, TR, TA and t can vary in this model.

Change in autonomous consumption, investment and government spending.

The increase (or a decrease) of these variables will lead to a multiple increase (decrease) of equilibrium product.

   Change in autonomous consumption (ΔCa):

$$\Delta Y = \Delta Ca. \frac{1}{1 - mpc(1-t)}$$

$$\frac{1}{1 - mpc(1-t)} = \alpha_{Ca}$$

α_{Ca} … multiplier of autonomous consumption in the 3-sectoral economy

Change in investment (ΔI):

$$\Delta Y = \Delta I. \ \frac{1}{1 - mpc(1-t)}$$

$$\frac{1}{1 - mpc(1-t)} = \alpha_I$$

α_I ... investment multiplier in the 3-sectoral economy

The change of government expenditure on purchase of goods and services (G):

$$\Delta Y = \Delta G. \ \frac{1}{1 - mpc(1-t)}$$

$$\frac{1}{1 - mpc(1-t)} = \alpha_G$$

α_G … multiplier of government spending in the 3-sectoral economy

The change in transfer payments. For example, increasing unemployment benefits will lead in the very first round to increasing purchases of goods and services, but not the in fully amount of this change, only the part that will not be saved.

Change in transfer payments (ΔTR):

$$\Delta Y = \Delta TR. \ \frac{mpc}{1 - mpc(1-t)}$$

$$\frac{mpc}{1 - mpc(1-t)} = \alpha_{TR}$$

α_{TR} … multiplier of transfer payments in the 3-sectoral economy

Changing autonomous taxes. It has similar effect as an increase in transfer payments, but with a negative sign:

Change in autonomous taxes (ΔTA):

$$\Delta Y = \Delta TA. \frac{-mpc}{1-mpc(1-t)}$$

$$\frac{-mpc}{1-mpc(1-t)} = \alpha_{TA}$$

α_{TA} ... *multiplier of autonomous taxes in 3-sectoral economy*

In the case $\Delta TA > 0$, change i output is negative, and the multiplier has a negative sign. Conversely, if the $\Delta TA < 0$, change in output is positive.

Change in tax rates. An increase (decrease) in tax burden will, ceteris paribus, cause a decrease (increase) in the output.

Change in tax rate (Δt):

$$\Delta Y = \frac{-1}{1-mpc(1-t_1)}.mpc. \Delta t. \ Y_0$$

$\Delta t = t_1 - t_0$

t_1...*new tax rate,*

t_0...*previous tax rate,*

Y_0...*previous level of output.*

4.4 Model of multiplier in the 4-sectoral (open) economy

The total planned spending is expanded by **net exports**, i.e. the difference between exports and imports.

Export (exports) will be considered as an *autonomous variable* (independent on the size of the domestic income).

Import (import), however, has different characteristics. Import includes autonomous *(Ma)* and induced import *(mpm.Y).* The *mpm* (or *mpi*) - marginal propensity to import can be calculated as:

$mpm = \Delta M/\Delta Y$

Import function has the following expression:

$M = Ma + mpm.Y$

We will assume that the propensity to import mpm is fixed for any level of income and can take values in the interval from 0 and 1.

The function of net export can be written as:

NX = X – Ma – mpm.Y

Whereby the expression (*X* - *Ma*) can be substituted by autonomous NXa:

NX = NXa – mpm.Y

Fig. 4.7 displays the Keynesian export and import function. Export is drawn as a horizontal line. Import and net export functions are dependent on national income and are expressed as linear functions.

Fig. 4.7 Keynesian functions of export, import and net export
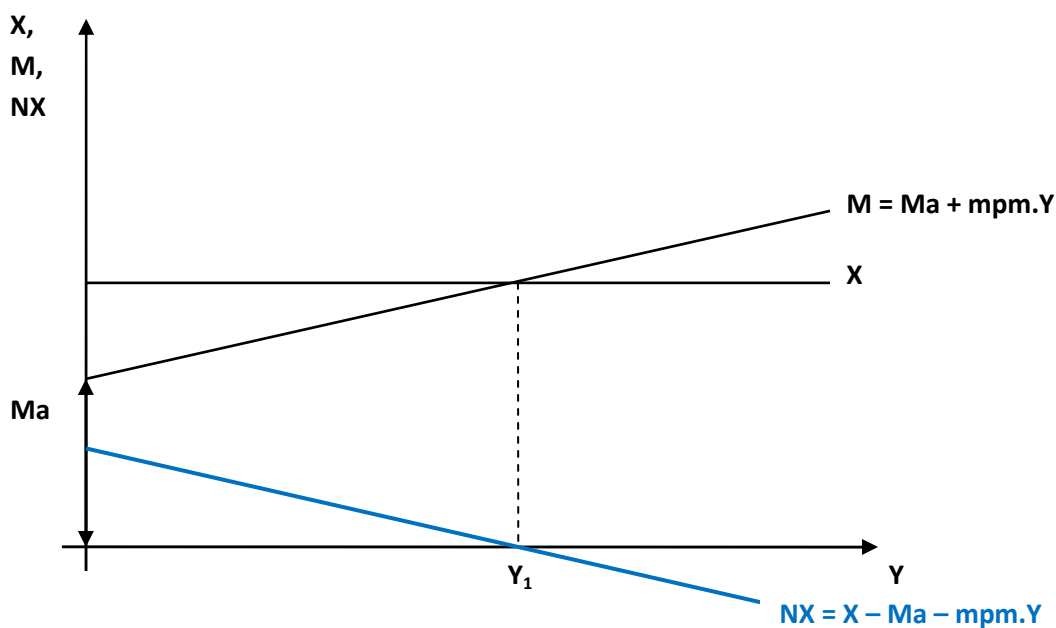
All functions to export, import, and net exports here have the shape of a straight line. The slopes of import and net export function are given by the marginal propensity to import (mpm). The function of net exports (NX) indicates that the growth of national income causes increasing value of the NX-induced import and thus the NX function is decreasing.

There are main causes of shifting NX:

- *a decline in foreign demand and income* due to cyclical phase of recession abroad will lead to a decline in X. Conversely a phase of economic growth in the domestic economy will result in the growth of M (but in this case it is only a shift along the curve);

- *exchange rate appreciation* leads to higher prices of exported goods and a decline in X, while imports will be cheaper and foreign goods more affordable, and therefore M grows;

- *if the price changes*, their rapid growth in the domestic economy will lead to a decline in the growth of M and X;

- deliberate *government action* in the form of protectionist or export promotion measures, as well as the agreement states (member states) to impose an embargo - ban on imports of raw materials from the country and possibly the imposition of further sanctions against that country;

- *the behavior of consumers* in the form of changes in their preferences. Preference may also be affected by non-economic factors, such as political influences, e.g. a boycott of purchasing a good.

Shifting of NX function is demonstrated in Fig. 4.8.

Fig. 4.8 Shifts of net export (NT) function
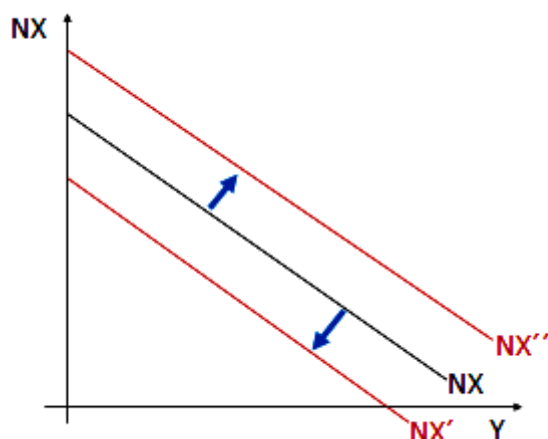
Model of multiplier in an open economy

As regards the determination of equilibrium conditions, the model is actually based on openness of the economy. Total planned expenditures include 4 components:

$$AD = C + I + G + NX$$

$$AD = A + mpc.(1 - t).Y - mpm.Y$$

$$A = Ca - mpc.TA + mpc.TR + I + G + NX_a$$

Conditions of equilibrium output in an open economy:

$$Y\ (AS) = AD$$

IU = 0.

Total planned non-consumable expenditure (injections) and total leakages are equal:

I + G + X = S + NT + M

We can derive an multiplier (also called the multiplier with foreign trade) in an open economy.

*Y = A + mpc(1 – t).Y – mpm.Y*

Change in Y when change in A:

ΔY = ΔA + mpc(1 – t). ΔY – mpm. ΔY

$$\Delta Y = \Delta A \cdot \frac{1}{1 - mpc(1-t) + mpm}$$

The fraction $\dfrac{1}{1 - mpc(1-t) + mpm}$ is called **the multiplier in an open economy**, respectively, autonomous expenditure multiplier in an open economy. The multiplier indicates how many times the output will change if autonomous spending changes by one unit.

The following Fig. 4.9 shows the multiplier effect of an increase in investment expenditures in an open economy. Principle of multiplier does not change, but its value is lower due to additional losses - payments for imports. Aggregate demand consists of all 4 components and its slope is given by [*mpc(1 - t) - mpm*]. The top graph shows the multiplier effect. The initial impulse in the form of an increase in investment is accompanied by a further increase in the product in the form of induced consumption. The total effect is expressed as: ΔY = ΔI. $\dfrac{1}{1 - mpc(1-t) + mpm}$. The bottom graph shows the shift of AD rightward in the AS/AD model. The new point of macroeconomic equilibrium E´ is closer to potential product Y*.

Fig. 4.9 Multiplier effect of increased investment (autonomous expenditures) in an open economy

$$\alpha_i = \frac{1}{1 - mpc\,(1 - t) + mpm}$$
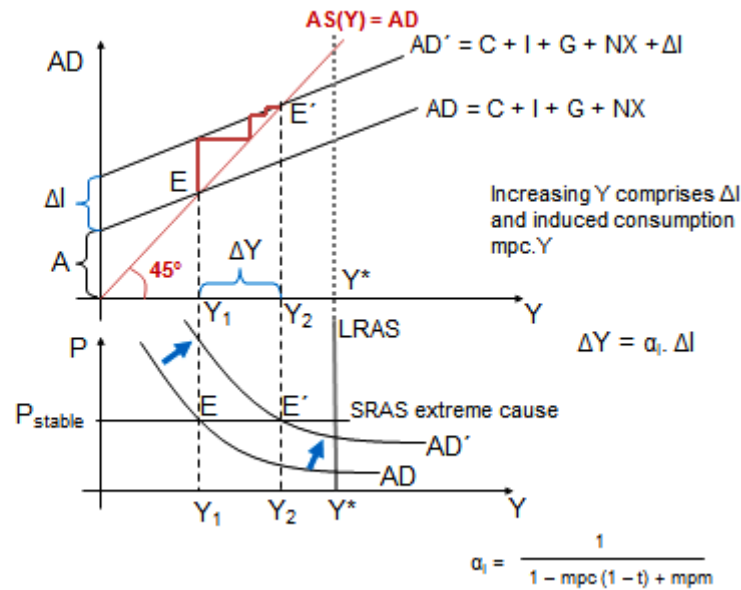
The multiplier in an open economy can be applied not only within the national economy, but also at local and municipal level in the form of *regional multipliers*.

Assuming $NX = NX_a - mpm.Y$, the increase in autonomous spending (for example an increase in government spending) will affect the net export:

$$\Delta NX = \frac{-mpm}{1 - mpc(1-t) + mpm} \cdot \Delta G$$

$(\Delta NX_a = 0)$

The fraction $\dfrac{-mpm}{1 - mpc(1-t) + mpm}$ is known as the multiplier of net export.

Finally, we can compare the leakage rate of national income (*MLR*) in 2-, 3- and 4-sectoral economy:

- **2-sectoral:**

  $mps.\Delta Y$

  $$\alpha = \frac{1}{mps} = \frac{1}{1 - mpc}$$

  $MLR = mps$

- **3-sectoral:**

mps(ΔY − t.ΔY)+ t.ΔY

$$\alpha = \frac{1}{mps(1-t)+t} = \frac{1}{1-mpc(1-t)}$$

MLR = mps(1 − t) + t

- **4-sectoral:**

mps(ΔY − t.ΔY) + t.ΔY + mpm.ΔY

$$\alpha = \frac{1}{mps(1-t)+t+mpm} = \frac{1}{1-mpc(1-t)+mpm}$$

MLR = mps(1 − t) + t + mpm

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