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A GRAPH REPRESENTATION OF A BASIC MACROECONOMIC SCHEME: THE IS-LM MODEL

by Valentino Piana (1998-2001)

Contents

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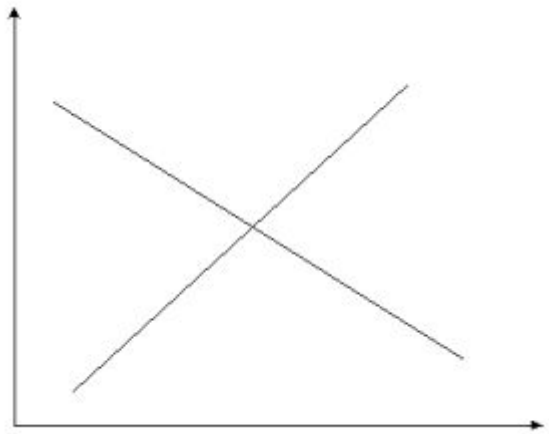
1. Introduction to our graph representation

In this essay, we re-state the common IS-LM model in a neat graphical representation, which offers a few advantages over the traditional representation, which exploits the Cartesian space and analytical geometry.



We rather use some very basic elements of **graph theory** (nodes and arrows)

This allows us to offer a representation of the variables and the linkages between them in a **more compact and straightforward way**, especially well-suited for **students** and people interested in a first but systematic view on **how the economy works**.

To **a creative economist**, this representation offers the immediate possibility of **adding further variables** and outlining **new or different linkages** between variables.

This graph representation was developped by the author during the academic years 1996-97 and 1997-98 when he taught Macroeconomics at the **Cracow University of Economics (Poland)**.

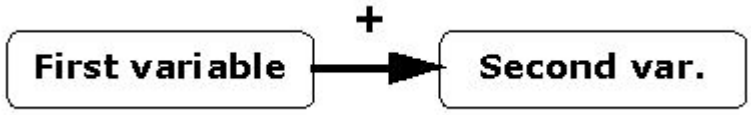
To author's knowledge, this graph version of IS-LM is **an innovative tool for research and teaching purposes**, but if you have published or seen a published paper on a similar subject please let the Economics Web Institute know.

At the same time, we hope you shall appreciate this graph method and **develop you own models**, basing on the easily modifiable version of the scheme, whose download is available here for free.

2. The rules

Variables, as consumption or exports, are put in **rectangular frames**. To reader's friendliness, variables are in full names, **not** abbreviations or **math symbols**.

Links between variables are expressed through **oriented arrows**, with **changes** in the first variable having an impact on the second.



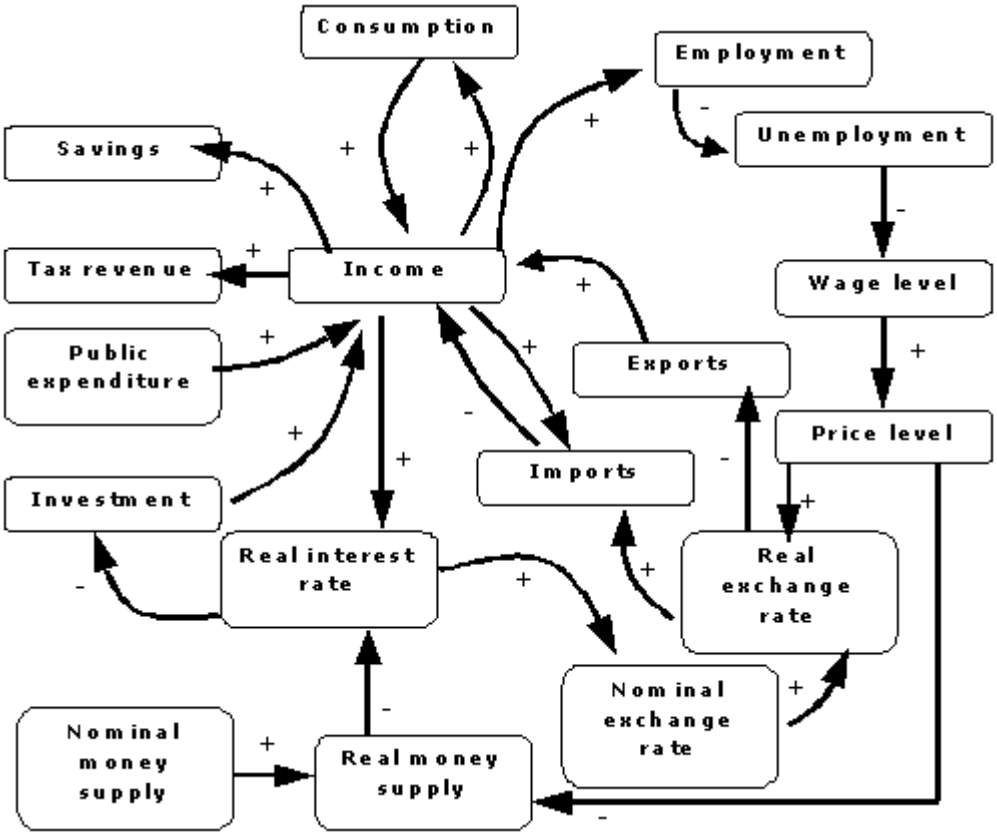
A sign "+" means that the change in the first variable provokes a change **in the same direction** for the second ("an increase give rise to an increment", "higher ... give rise to higher ...").

By contrast, **a sign "-"** shows that the change in the second variable will be **in the opposite direction** ("a fall in the employment will increase unemployment").

A **long chain** is easy to develop:

An increase of the first variable will eventually provokes a fall of the third, after producing a rise in the second.

3. The scheme



Arrows express an influence of the first variable on the second one.	**A sign "+"** means that the change in the first variable provokes a change **in the same direction** for the second ("an increase give rise to an increment").	By contrast, **a sign "-"** shows that the change in the second variable will be **in the opposite direction** ("a fall in ... will increase ...").
For a justification of the signs, just click here.		
For two examples of interpretation of the scheme, see here.		
If you would like to modify this graph, e.g. for changing the names of the variables in accordance with your preferite textbook or for adding new variables / relationships, just download the MS Word file from here.		

If you can't see the entire scheme on the screen, you may try to customize your browser, for example hiding the MS Explorer buttons (Menu: View; Line: Toolbars; Option: Standard Buttons - unchecked) or Netscape buttons (Menu: View; Line: Show; Option: Navigation Bar - unchecked).

4. Reading the scheme: two examples

To read the graph, you simply **start from a variable**, imposing **a change** in a specified direction (**increase or fall**). Then, following the arrows, you see the dynamics of the variables immediately involved, depending on the sign you see: a plus sign means a change in the same direction (**increase or fall**, respectively), whereas a minus sign has the opposite meaning (**fall or increase**, respectively).

The impact will usually spread over time, since real processes need time to take place - with the possible exception of financial and monetary movements.

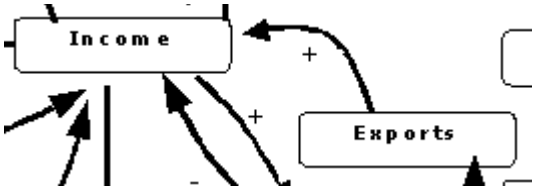
Similarly, the strength of the reaction in the second variable depends on its responsiveness (elasticity) to the first one. The relationships have variable strength; thus the reader can single out **what should be particularly responsive in order a certain final effect to take place**.

A *caveat*: All changes in variable levels will take place in the expected direction provided that the other variables around are not changing at the same time ("other things equal" clause). If this does not hold, specific hypotheses on surrounding dynamics should be introduced.

Furthermore, the changes in the second-wave variables will exert subsequent pressure on third-wave variables, until all variables in the graph have been considered.

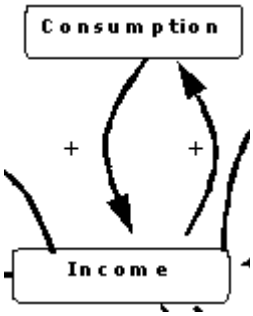
The longer the chain, the weaker the effects and the longer the time delay since original source.

4.1. Export-led growth

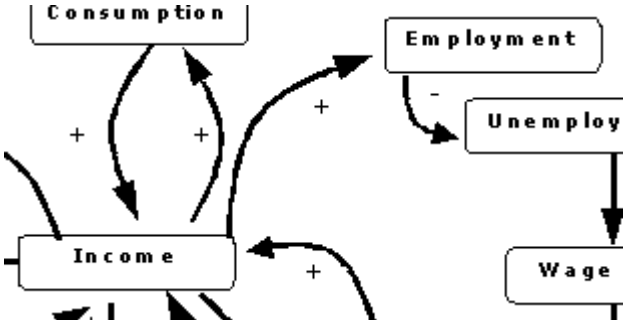


Other things equal, an increase of export will trigger an increase of income.

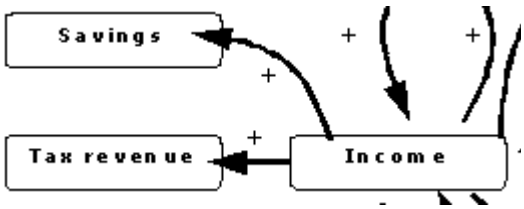
The increase in income gives rise to 6 main phenomena:



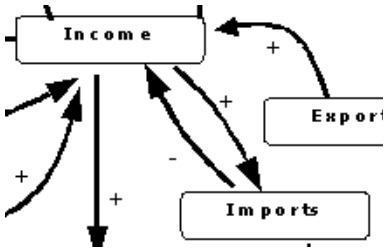
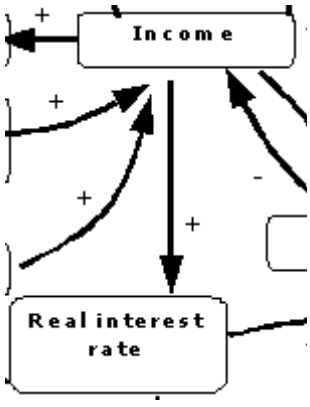
1. an increase of consumption, since households are richer. Consumption growth, in turn, implies a further increase of income (Keynesian multiplier);



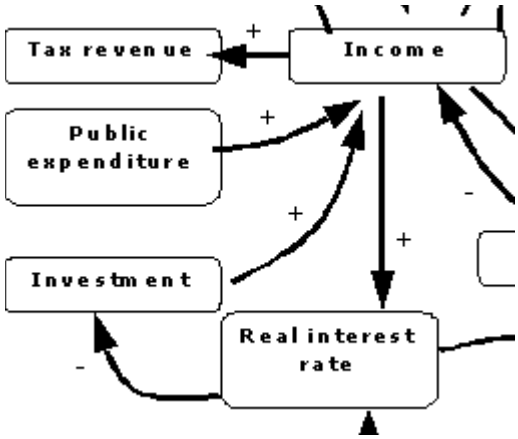
2. an increase of employment, since more production requires more labour;



3. the growing income helps the households, by increasing their savings;

	4. the growing income helps the State, by widening the tax base, thus the tax revenue. At normal levels of public expenditure, this means a reduced deficit or even a surplus for the State budget;
	5. it increases imports;
	6. it also produces an increase of the real interest rate, given a fixed real money supply, which in turn depends on a deliberate choice of the central bank not to increase the nominal money supply (not to print money, not to allow more credit from banks to the economy).

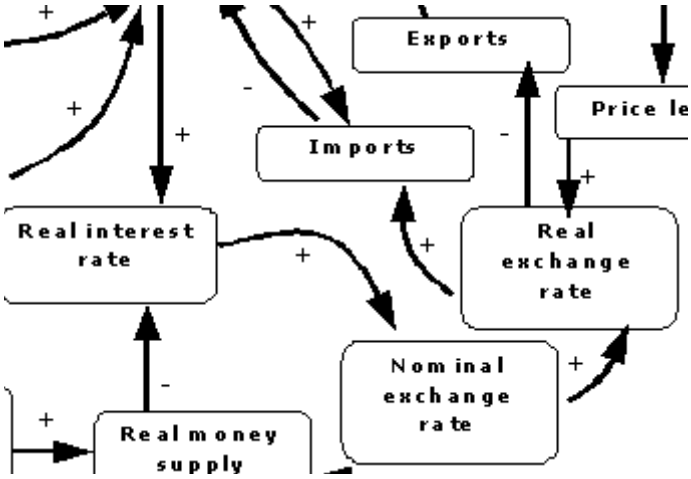
The rise of real interest rate is a turning point.



The rise of real interest rate depresses investment, which in turn brakes the income growth.

The initial export push on income is thus supported by consumption and restrained by investment.

The state and the households are main beneficiaries, together with exporters, while firms (especially producers of capital investment goods) are the losers.

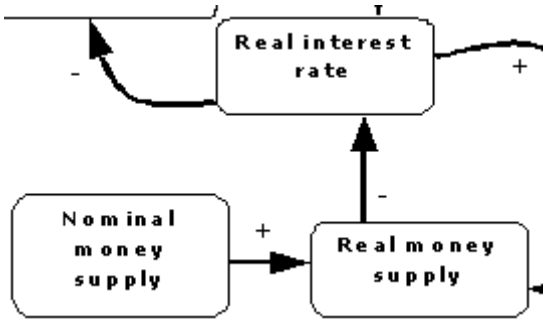


The increase in the real interest rate has the further effect of increasing the nominal exchange rate, by attracting foreign capital. Thus the real exchange rate rise as well. With stronger domestic currency, not only imports will further rise but also the exports will be restrained.

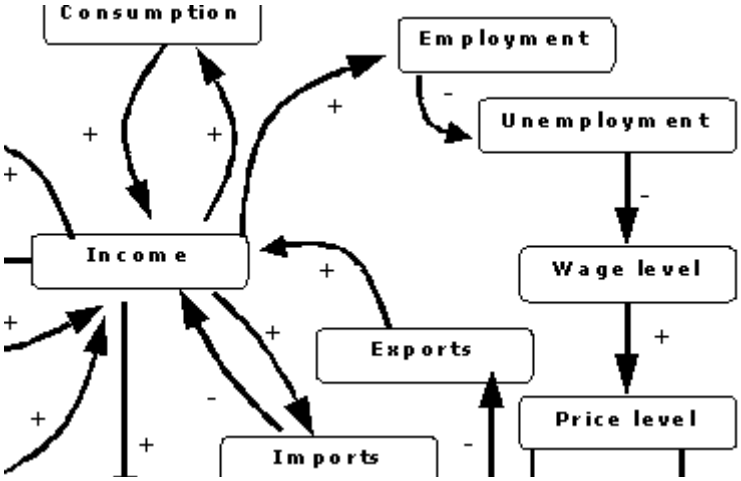
A second negative loop is then emerged: a rise in exports will eventually be absorbed by an increase of real exchange rate.

All this depend on the policy of the central bank, which did not increase the nominal money supply, leaving room for interest rate to rise, depressing both investment and exports.

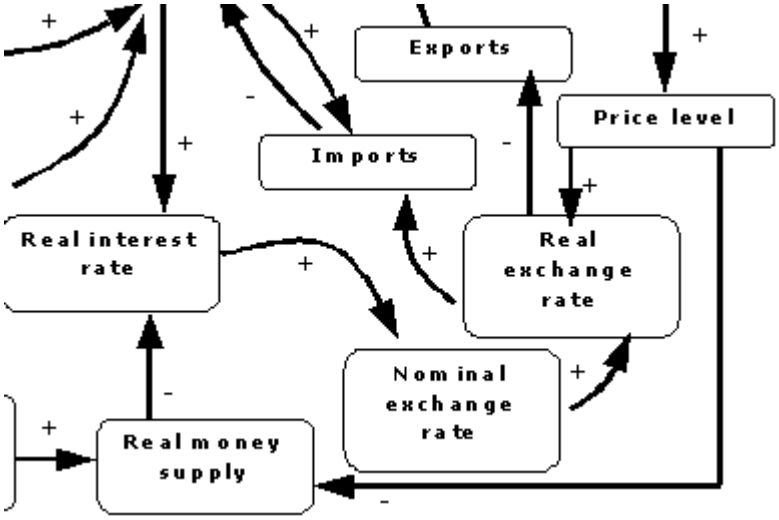
Export-led growth is unsustainable and short living, unless the central bank accompanies the GDP growth with an expansionary monetary policy (larger money supply), so to leave the interest rate at the previous level.



If the central bank acts and keep the interest rate under control, everybody is happy: investment stay at the same level so as the exchange rate, leaving room for export to continue their growth.



Prolonged GDP growth boost employment, as we said, and this reduces unemployment. To the extent wages are dependent on unemployment, they will rise as well, increasing the cost of production. This will exert a pressure on firms to rise prices. Inflation becomes a real risk.



The increase of price level reduces the real money supply: by definition the latter is nominal money supply divided by price level. Unless the central bank further increases the nominal money supply, the real interest rate will rise, with all its unpleasant consequences on export and investment.

Thus, expansionary monetary policy risks to provoke inflation and a further need for money supply expansion.

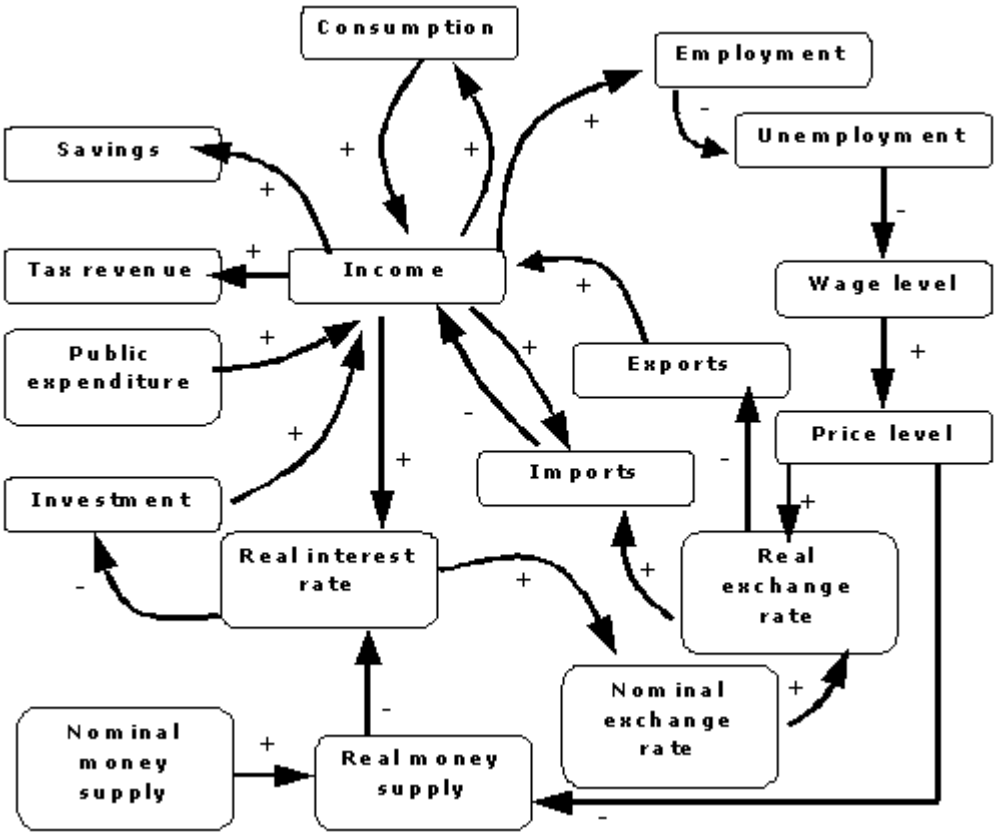
[See previous graph]

Unfortunately, the price level increase is already braking exports by strengthening the real exchange rate, given a stable world price level. In other words, inflation is damaging exports by increasing the price of domestic goods in foreign terms, even in the event of a fixed nominal exchange rate or an expansion of money supply that keep the real interest rate stable.

If price level is extremely responsive to unemployment, then the task of the central bank is very difficult, since the export-led growth is in danger from different points of attack.

In synthesis, an export-led growth is possible but it requires a careful policy of control in side effects that can menace to erode the basis of the same spurring element: exports.

Crucial is the responsiveness of the variables to changes in the other values. If investment is not really influenced by the interest rate (either exports by the exchange rate), the export-led growth is clearly easier to manage.



Looking again at the graph, the export-led growth will be stronger and more sustainable:
i) the larger the share of exports on GDP;
ii) the stronger the Keynesian multiplier;
iii) the less the interest rate reacts to income;
iv) the less the exchange rate reacts to the interest rate;
v) the less investment reacts to the interest rate;
vi) the less exports are responsive to exchange rate;
vii) the less are wages are responsive to unemployment;
viii) the less

	prices are responsive to wages; ix) the less imports are responsive to income.

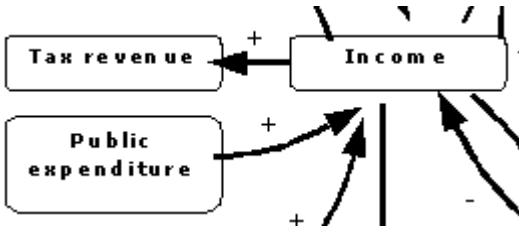
We started our story from an increase of exports. But what could have provoked it?
A first answer would be a growing foreign GDP with the widening foreign imports it implies. Another would be the opening of new markets for domestic goods abroad, due to marketing efforts of exporters.

Furthermore, it is possible that the export dynamics is the target of conscious economic policies.
To the extent export-led growth is strong, a careful fiscal policy promoting export may be a cute move, since tax revenue will rise throughout the growth.

Alternatevely, a pre-emptive expansionary policy by the central bank could provoke an export increase through international price competitiveness of the country, improved by a devaluation, prompted by the fall of interest rate, due in turn to the increase in nominal (and real) money supply decided by the central bank.

In short, an export-led growth can be triggered by external and internal reasons, accompanied and braked by internal conditions.

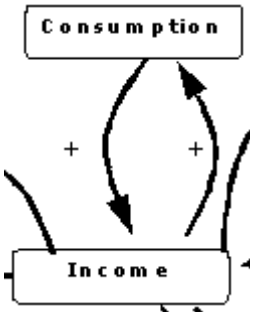
We invite the reader to try a similar description and interpretation of a fiscal expansionary policy, relying on an increase in public expenditure. Which will be the immediate and far-reaching consequences?

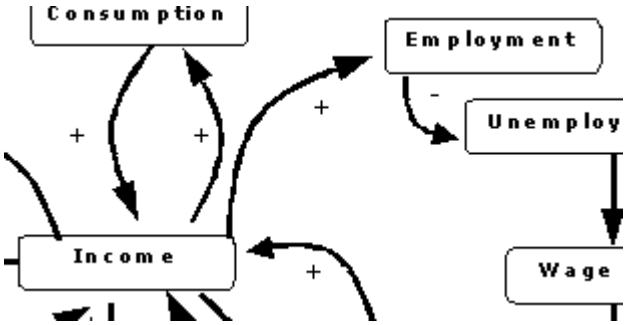


GDP is the sum of public expenditure, consumption, investment and net exports; thus any fall in any of these variables will have a negative impact on it. Accordingly, a cut in public expenditure, however decided and other things equal, has a direct impact on GDP, reducing it, with a movement in the same direction (sign "+" in our graph). The fall in income (GDP) may be

due to a decrease in production of goods and services previously bought by the public sector and/or due to a direct reduction in the number of civil servants.

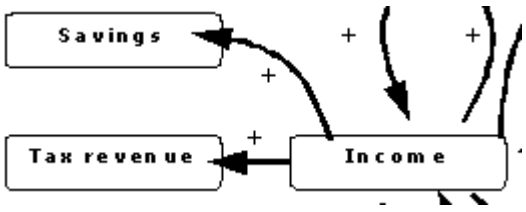
At any rate, a fiscal cut reduces income of households. This, in turn, reduces their consumption, because they have less to spend. The reduction in consumption has the further effect of reducing income, triggering a vicious circle, so strong in the '30s of the last century that it was "discovered" and conceptualised by authors of that age (Kahn and Keynes). Since then, this vicious (or virtuous - if it works the other way round!) circle is known as the Keynesian multiplier.





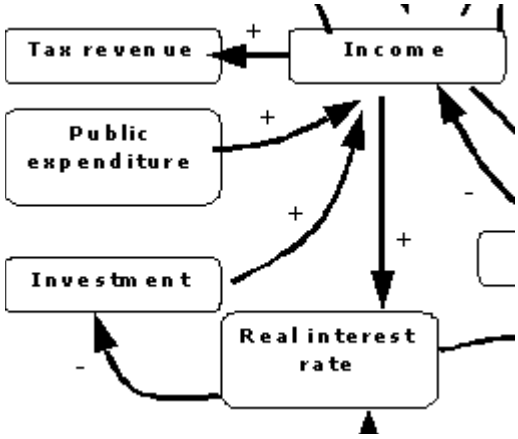
The on-going fall in income reduces employment as well, since less labour is required for productive aims.

Household savings will go in the same direction as income, so that they will fall.



Even more importantly from the point of view of the decision-makers, they should know that the tax revenue will shrink, since the tax base (income, value added...) goes in this direction. If for example the public expenditure cut was justified by the necessity of reducing the public deficit (tax revenue less public expenditure), it is clear that the parallel fall in tax revenue makes this objective much farther.

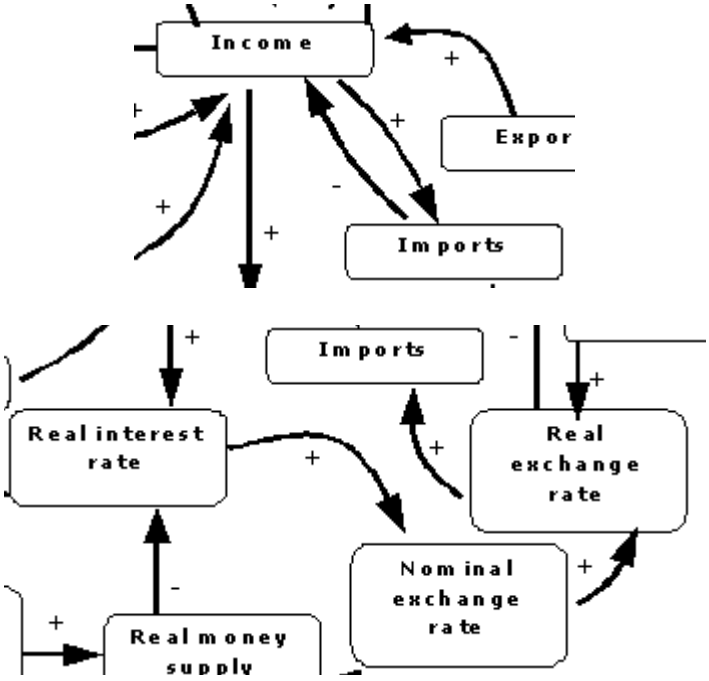
All the changes we saw after a cut in public expenditure are usually considered as negative. But in the economy, at each negative side often correspond a positive element somewhere else.



In fact, the fall in income reduces the real interest rate, through a reduction of money demand for transactions.
The fall in real interest rate should increase investment, braking or even inverting the income reduction.

By the same token, the reduction in the real interest rate implies a fall in the nominal exchange rate, to the extent the latter is free to float and move.

The devaluation in both nominal and real exchange rate will improve the international price competitiveness of the economy, fostering exports and depressing imports.

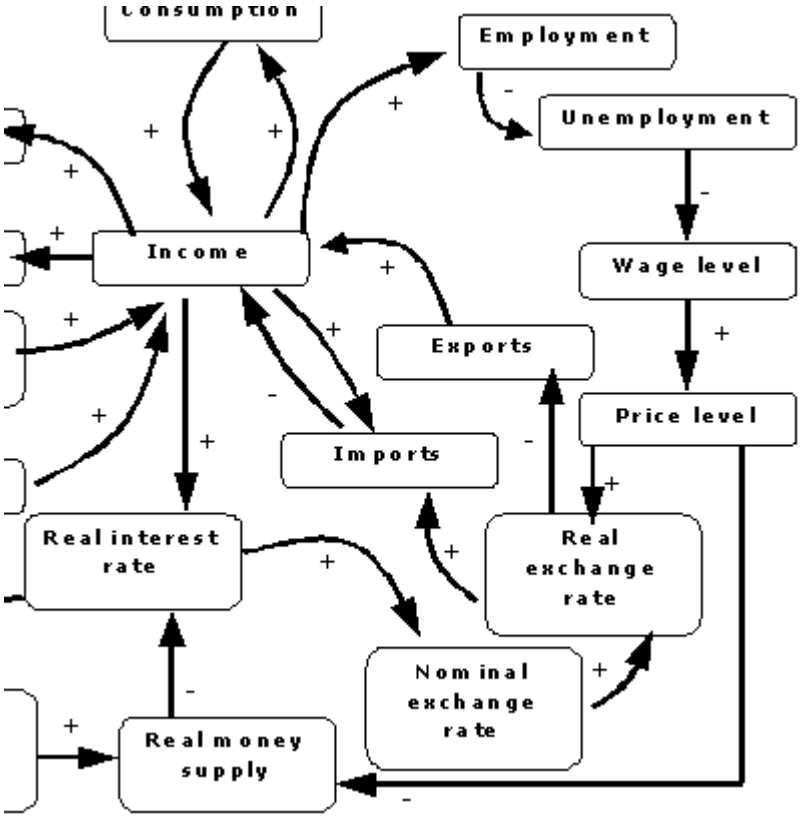


Imports can play an extremely important role in inverting the business cycle.

They immediately fall as soon as income goes down. They further fall due to devaluation. This is conducive to a boost of domestic production which outperform general income dynamics, exactly because of substitution of imports (and new positive dynamics of exports).

If investment and net export dynamics are sufficiently strong, the initial fall in income will be reverted, the Keynesian multiplier will begin to work in the growth

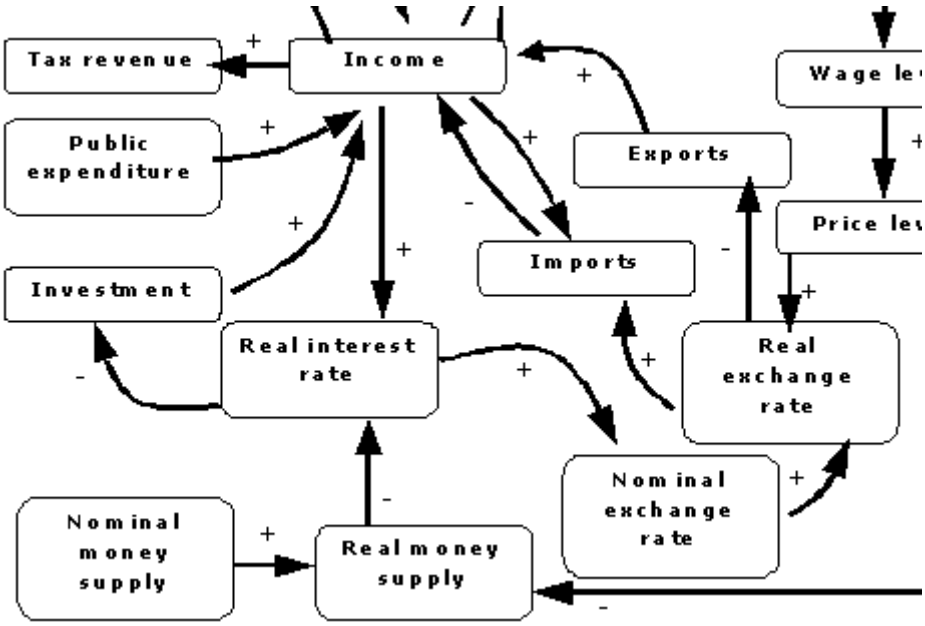
direction and the public expenditure cut will be fully compensated (in a macroeconomic perspective).



To a similar scenario can contribute also a fall in the absolute price level: to the extent the on-going reduction in employment and the symmetric increase in unemployment will reduce the absolute level of wages, the firms may decide to reduce prices. This would increase the real money supply and further reduce the real interest rate, as well as improve the international price competitiveness with a fall in real exchange rate.

In this complex dynamics, it is pretty clear who are the losers: the households saw reduced their income, shrinked employment, and lower wages. In particular, families relying on public expenditure would be in the front line.

Another relatively clear thing is the possibly marginal role of the central bank. In all we saw, we could simply imagine that the nominal money supply was unchanged, with no work for the central banker.



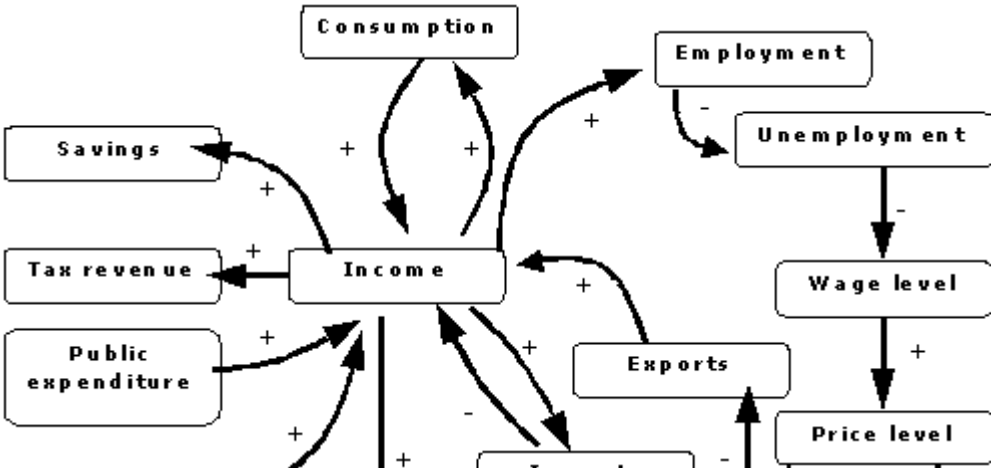
Only if he decides so, the central bank can influence the cycle. If the public expenditure cut is immediately connected with an increase of the money supply, the consequent fall in the interest rate will anticipate the positive effects on investment and net export we previously saw as linked to a GDP painful fall.

In this way, the cut is immediately compensated and the Keynesian multiplier needn't to be activated in the depressive direction, as well as there will be no negative impact on the total level of employment. Since the tax base will be nearly unchanged, the State deficit will neatly improve.

If by contrast the central bank decides to reduce the money supply, the increase in the interest rate will be sudden and extremely strong.

Investment and net export will shrink and the GDP, receiving depressive pressure from every side, will severely contract.

[See previous graph]



Mass unemployment will be the dominant feature of the system. Deflation is the consequence, but the fall of price is hardly capable to invert the trend. Notwithstanding the initial expenditure cut, the state deficit will worsen because of the induced chain of events.

The recovery isn't guaranteed until a policy change is imposed.

5.The advantages of this representation

This graph representation has two groups of the advantages:

1. **practical** advantages for **students** and **practioners**;
2. **theoretical advantages** for economists and business cycle analysts.

In the first group, one can underline that this representation is quite **compact**, reducing three or four diagrams to unity in one page. Once accustomed with conventions, the reader can **easy navigate the graph**.

Our experience shows that students, in long reasoning and causal chains, tend to lose their direction and to describe the final effects on a variable just guessing out whether it will grow or falls. By contrats, thanks to this graph, the sequence will be understood with no mistakes or guesses.

Depending on the depth of knowledge, the verbal suggestion required in reading the scheme can range from a simple statement directly arising from the graph up to elaborated weighted argumentation on sources, justifications and effects of complex dynamics.

The **lack of mathematical difficulties** is particularly suitable to keep reader's **attention** high on economics, **not on formal geometric devices**.

In a theoretical perspective, the graph representation is:

a. **compatible** with **equilibrium** theory;
b. **open to non-linear dynamics**;
c. **suitable for disequilibrium** processes with endless fluctuations.

The **notion of general economic equilibrium is unnecessary** for interpreting the graph.

Similarly, the graph representation is:

a. **compatible** with **linear** relationships between variables;
b. **open to non-linear relationships** (e.g. quadratic);
c. **suitable for non-parametric processes**.

Moreover, the graph allows an easy introduction of **new variables** (e.g. oil price for influencing the price level).

Similarly, it is easy to introduce **new links** as well as **new directions of influence**.

Please note that the model is particularly suitable to analyse situations with **more than one shock at a time**. This also means that is possible to **start** not from a motionless steady state but **from an autonomously evolving system** where a certain policy action is taken, to evaluate its potential effectiveness.

Last but not least, this representation can be developped as a **scheme for computer simulations** that generate time series to compare with real world ones.

Appendix 1.

Justification for signs in relationships

The IS-LM model relies on **positive and negative relationships** between macroeconomic variables. In order to describe the subsequent changes provoked by an initial shock, you just read the graph representation, following the arrows. You formally do not need to know the reason why two variables go in the same or in the opposite direction. **The formal model and its graph representation works without justifications**.

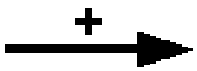
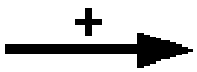
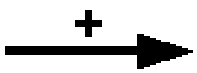
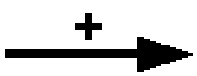
Still, to economically understand what is happening, it is useful to know the justifications, also in order to judge the strength and the speed of the relationship.

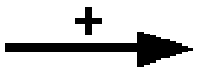
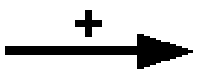
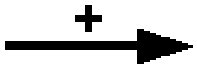
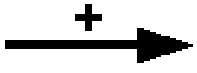
Here we present a **standard and simplified** (sometimes **simplistic**) **justification** for those relationships that are considered within the IS-LM model.

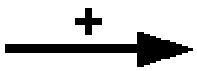
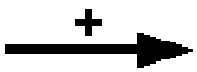
Sign "plus" on the arrow: a movement in a direction in the first variable provokes a movement in the same direction in the second one.

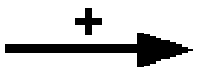
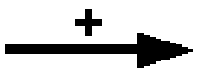
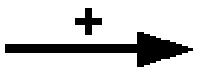
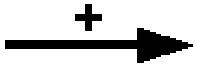
Sign "minus" on the arrow: a movement in the first variable provokes a movement in the **opposite** direction in the second one.

All comments take the **starting point** of **an increase** in the **first variable**. If you starts from the opposite point of view (a fall), the same considerations will bring you to opposite conclusions.

	Income		**Consumption**	
	Higher income means that people are richer, thus they will additionally spend a part of this new income.			
	Consumption		**Income**	
	Income (GDP) is equal to the sum of consumption, investment, public expenditure and net export (exports less imports, also known as "trade balance"). Any increase in one in its components, the others being equal, will raise GDP by the same amount.			
	Income		**Savings**	
	Higher income means that people are richer, thus they additionally save the part of this new income that has not been spent in consumption. In IS-LM model, the households can use their income only for consumption or savings by definition. Income = Consumption + Savings.			
	Income		**Tax revenue**	
	Higher income means **wider tax base** for direct tax on people's income. At the same tax rates, this improves the tax revenue.			
	Public expenditure		**Income**	

	investment, public expenditure and net export (exports less imports, also known as "trade balance"). Any increase in one in its components, the others being equal, will raise GDP by the same amount.			
	Investment		**Income**	
	Income (GDP) is equal to the sum of consumption, investment, public expenditure and net export (exports less imports, also known as "trade balance"). Any increase in one in its components, the others being equal, will raise GDP by the same amount.			
	Income		**Real interest rate**	
	The increase of income brings together an **increase in volume of transactions**. Money, the means of payments settlement, is more and more demanded. But if the supply of money (to which the demand must be equal) is unchanged, something should counteract the growth in demand: the interest rate should rise, in order to "tame" demand for money. In fact, in a simplified world where people can choose only between money and bonds, an increase of the interest rate on bonds will make them more attractive, reducing the demand for money.			
	Income		**Imports**	
	Higher income means more purchasing power for foreign goods. People are richer and demand more foreign consumption goods.			
	Exports		**Income**	

	Income (GDP) is equal to the sum of consumption, investment, public expenditure and net export (exports less imports, also known as "trade balance"). Any increase in one in its components, the others being equal, will raise GDP by the same amount.			
	Income		**Employment**	
	The higher the production, the higher the number of people required for productive processes.			
	Employment		**Unemployment**	
	The more people find a job, the fewer the jobless.			
	Unemployment		**Wages**	
	If unemployment increases, the workers will accept lower wages, both in individual negotiations and in collective bargains.			
	Wages		**Price level**	
	The higher the wages, the higher the cost for firms to produce. Firms will increase their prices, hence the general price level.			
	Price level		**Real exchange rate**	

	exchange rate, an increase in domestic price level will make more expensive for foreigners to buy our goods.			
	Real exchange rate		**Imports**	
	A higher real exchange rate means that domestic goods are more and more expensive. Thus domestic buyers will more and more prefer foreign "cheaper" goods. The same is true both whether the increase in real exchange rate is due to an increase of domestic general price level or to the nominal exchange rate.			
	Nominal money supply		**Real money supply**	
	Real money supply is computed as the nominal one divided by the price level. Thus, any increase of nominal supply will increase the real one, given a certain level of prices.			
	Real interest rate		**Nominal exchange rate**	
	In a free-floating system, the exchange rate will be determined by demand and supply of domestic currency. An increase in real interest rate makes domestic bonds more attractive for foreigners (since they are more profitable than before). Accordingly, there will be an **inflow of foreign capital** directed to domestic bonds. This means an increased demand for domestic currency, which will increase its "price": the nominal exchange rate.			
	Nominal exchange rate		**Real exchange rate**	

	Real exchange rate is computed as the nominal one divided by the price level. Thus, any increase of nominal exchange rate will increase the real one, given a certain level of prices.			
	Imports		**Income**	
	The larger the imports, the less the domestic production finds a buyer, other things equal.			
	Price level		**Real money supply**	
	Real money supply is computed as the nominal one divided by the price level. Thus, any increase of prices will reduce the real money supply, given a certain level of nominal one.			
	Real money supply		**Real interest rate**	
	An increase in supply always reduce the price, if demand stay at the same level. Employing this quite general rule, an increase of real money supply reduces the "price" of money, i.e. the real interest rate.			
	Real interest rate		**Investment**	
	Firms decide their investments looking at perspective profits and discounting their future values to present one. Higher interest rate means a lower present value of future profits. Moreover, the higher interest increases the cost of capital. Thus, **lower profitability and higher costs** depress investment.			

	Real exchange rate	**-** 	**Exports**	
	A higher real exchange rate means that domestic goods are more and more expensive. Thus foreign buyers will more and more renounce to domestic goods.			

Appendix 2. Introduction for absolute beginners

1. Understanding the economy as a whole

Our lives are extremely dependent on how well the economic system works and distributes its fruits to the member of the society. In an international perspective, the world economy is a complex structure linking nations and peoples in an ever-changing environment. **How the economy works** is a decisive question for understanding nations' physiology and pathology, first essential step to diagnosis and sanation.

Economic **newspapers**, official bodies' **announcements**, **academic reflections** describe processes, suggest interpretations, support policies and remedies. There you can find a burgeoning source of ideas in order **to develop your own point of view**.

Questions may be:

• how can growth be triggered when everything goes wrong?

• what will be the effects of rising prices?

• how will booming exports impact the households?

Well, in the newspapers you find a lot of suggested answers. But it is helpful to develop **a coherent and tested framework** to keep all relations together and as well as to learn the lessons from the past and from other nations' experience.

In this vein, economist have developed many schemes of the **physiology of the national and international economy**. One of the most basic schemes is the IS-LM model.

2. Introduction to a basic macroeconomic framework: the IS-LM model

The IS-LM model **gather the most important variables** of the economy and **link them in a straightforward way**. Among others, the model comprehends:

- household consumption;
- public expenditure;
- tax revenue;
- imports from abroad;
- exports to the international markets;
- the gross national product (GNP), basic measure of economic level of a nation;
- inflation;
- the interest rates banks requires for giving a loan to firms and households.

If you extensively read economic newspapers, you shall find a lot of common ideas.

Those variables are **defined within the model** and formally treated in **formulas** and **relationships**. Our version of the model, however, does not use math formulas, just intuitive ideas of "growth" and "fall" in variables values.

Basically, **the model relate the variables to each other**, to enquire what changes will be induces by an initial shock in one or more variables.

The use of the model allows you to **see the far-reaching consequences** of events and policies, basing on the relations proposed by the model. This gives you a hint for **forecasting possible developments** of economic climate. Conversely, a critical comparison with the real situation of your country in past and current values of variables will help you to judge the realism of the same model and its suggestions.

JEL Classification of this essay: E12, A20, A22