

SYSTEM DYNAMIC MODELING OF MONEY MARKET PROCESSES

The IS – LM aggregate demand model aims to show what determines national income for a given price level. We can consider this model as an indication that causes a change in income in the short run, when the price level is fixed, or as a reason for the shift in the aggregate demand curve. These two interpretations of the model are equivalent. When the price level is fixed in the short term, shifts in the aggregate demand curve lead to changes in the equilibrium level of national income.

The IS – LM model has two parts, the IS curve and the LM curve. IS means "investment" and "savings", and the IS curve reflects what is happening in the market for goods and services. LM means "liquidity" and "money", and the LM curve represents what happens to the supply and demand for money. The interest rate affects both investment and the demand for money, so it is the variable that connects the two halves of the IS-LM model.

The model shows how the interaction between commodity and money markets determines the position and slope of the aggregate demand curve and, consequently, the level of national income in the short run.

Let's consider the continuous model, allow various adjustments in the money market and the commodity market, none of which is instantaneous. We assume that the commodity market is adapting more slowly than the money market. Creating this continuous model, we determine these adjustment factors in terms of the two adjustment equations. In the commodity market, we assume that revenue increases over time if there is excess demand, and decreases if there is excess supply. More precisely

$$\dot{Y}(t) = \alpha (E(t) - Y(t)), \alpha > 0$$

where

$$E(t) = C(t) + I(t) + G.$$

Let the interest rate in the money market rise if there is excess demand in that market, and fall if there is excess supply. More precisely

$$\dot{r}(t) = \beta (Md - Ms), \beta > \alpha > 0.$$

So, we have such a complete model

$$\begin{aligned} C(t) &= a + bYd(t) & \dot{Y}(t) &= \alpha(E(t) - Y(t)), \alpha > 0 \\ Yd(t) &= Y(t) - Tx(t) & Md(t) &= M_0 + kY(t) - ur(t) \\ Tx(t) &= Tx_0 + txY(t) & Ms(t) &= M \\ I(t) &= I_0 - hr(t) & \dot{r}(t) &= \beta(Md(t) - Ms(t)), \beta > 0. \\ E(t) &= C(t) + I(t) + G \end{aligned}$$

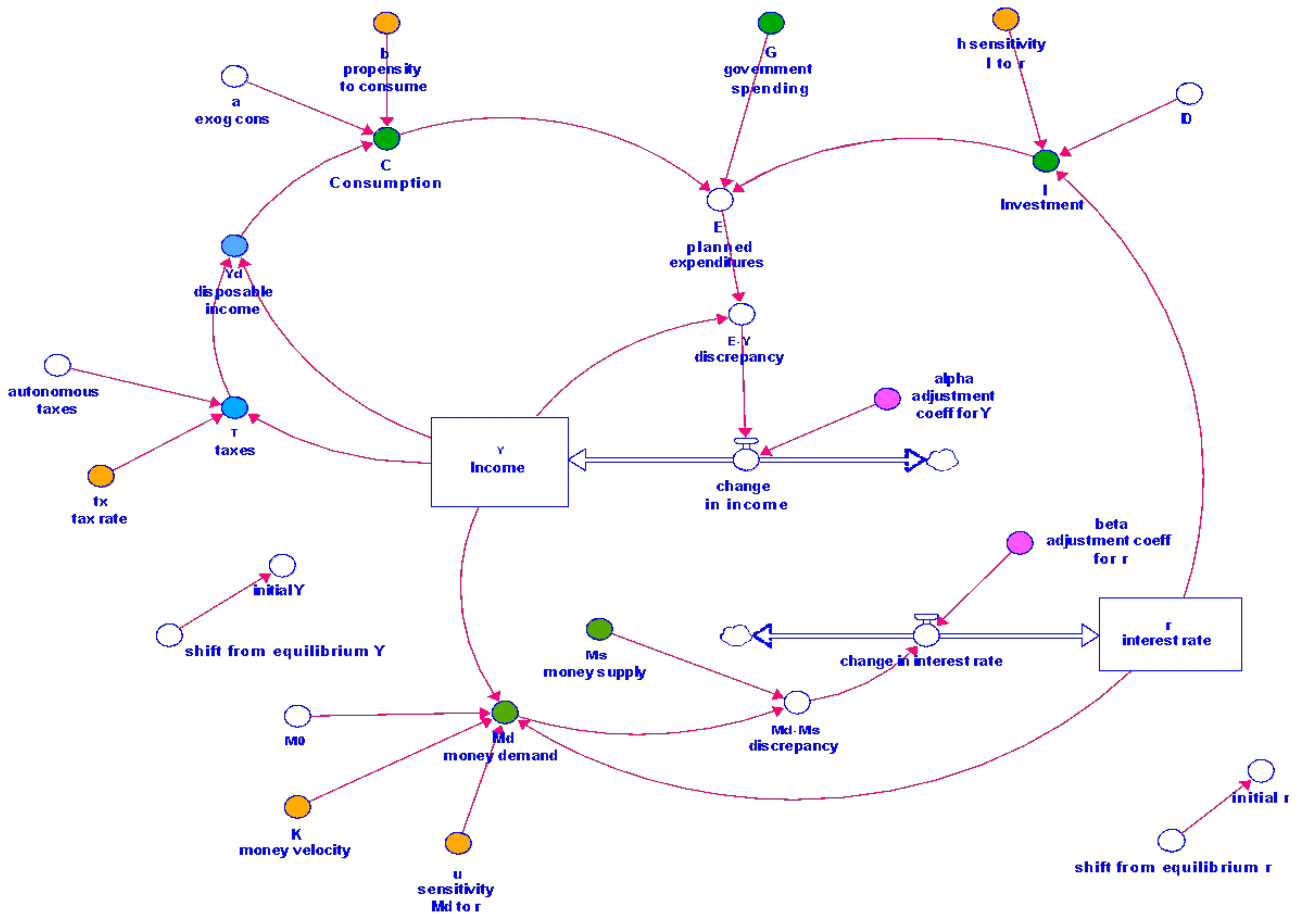


Figure 1. System Dynamic IS-LM Model

We now show that we can establish this model in the (Y, r) - phase space and show that the IS and LM curves are no more than isoclines. More importantly, we can consider the four quadrants and the vector forces in them. The results are obtained by alternately substituting all the ratios in each of the correction equations. So they will look like

$$IS: \dot{Y}(t) = \alpha (a - bTx_0 + I_0 + G) - \alpha (1 - b(1-tx)) Y(t) - \alpha hr(t)$$

$$LM: \dot{r}(t) = \beta (M_0 - M) + \beta kY(t) - \beta ur(t) .$$

From these equations it immediately follows that the IS curve is an isocline $\dot{Y}=0$, and the LM curve is an isocline $\dot{r}=0$. At this point, we will assume that $(1-b(1-tx))>0$ or $b(1-tx)<1$. This shows that the IS curve has a negative slope. We assume that k and u are positive, so the LM curve has a positive slope. Now let's turn to the four quadrants and consider the vector forces. Let's consider the commodity market first. If $\dot{Y}(t)>0$, then $Y(t)$ increases. So it will be when

$$\alpha(a-bTx_0+I_0+G) - \alpha(1-b(1-tx))Y(t) - \alpha hr(t) > 0$$

$$r(t) < (a-bTx_0+I_0+G)/h - (1-b(1-tx))Y(t)/h$$

Now let's turn to the money market. If $r(t) > 0$, then $r(t)$ increases and

$$\beta(M_0 - M) + \beta k Y(t) - \beta u r(t) > 0$$

$$r(t) < (M_0 - M)/u + k Y(t)/u.$$

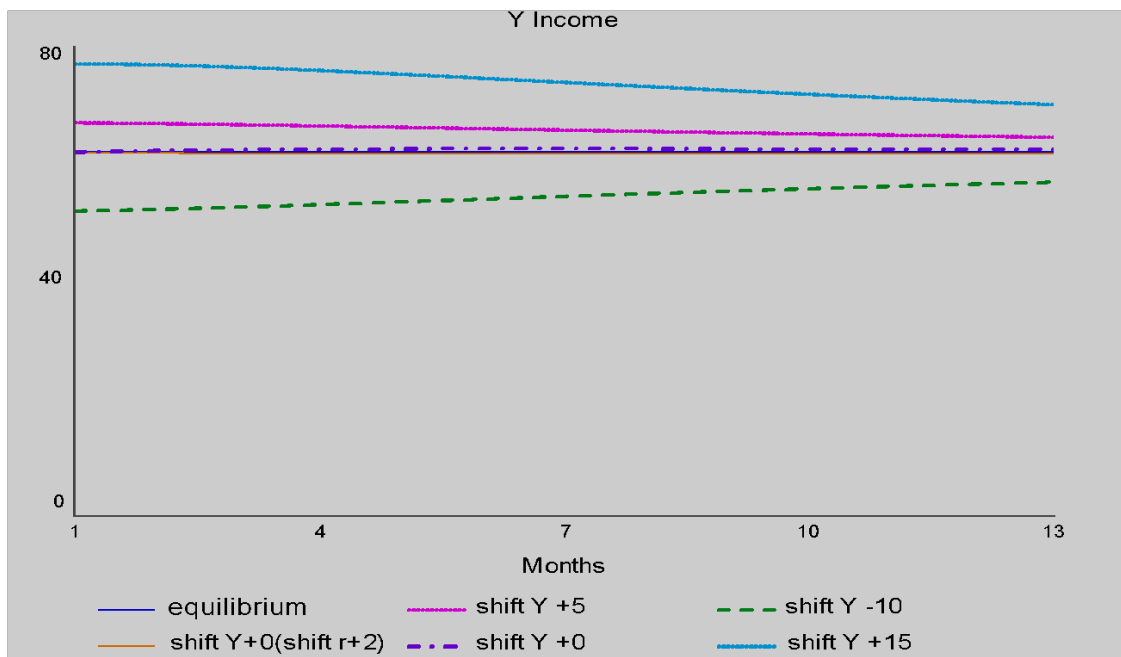


Figure 2. Dynamics of income

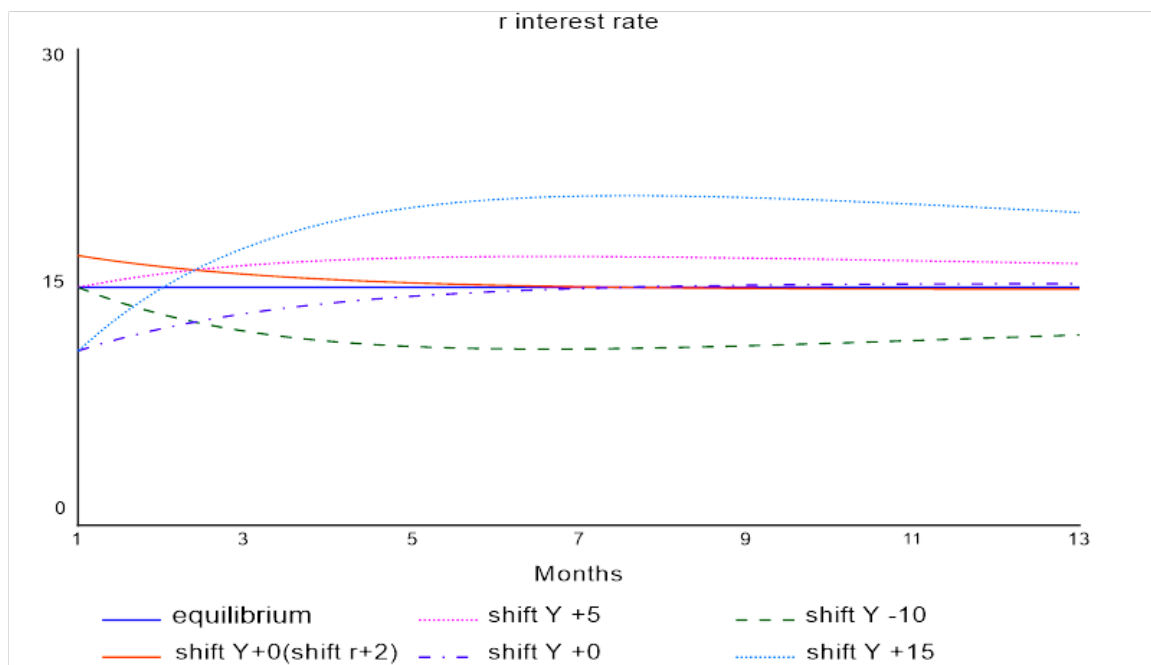


Figure 3. Dynamics of interest rate

Thus, we see that below the LM curve there is pressure to raise interest rates, while above the LM curve there is pressure to reduce interest rates. These forces are shown by the up and down curves along and above the LM curve.

The dynamics are more clearly illustrated if we consider some changes, as can be seen in the graph. Assuming an instantaneous adjustment in the money market, the economy follows a trajectory that lies along the LM curve. We have a counterclockwise movement (Fig. 4).

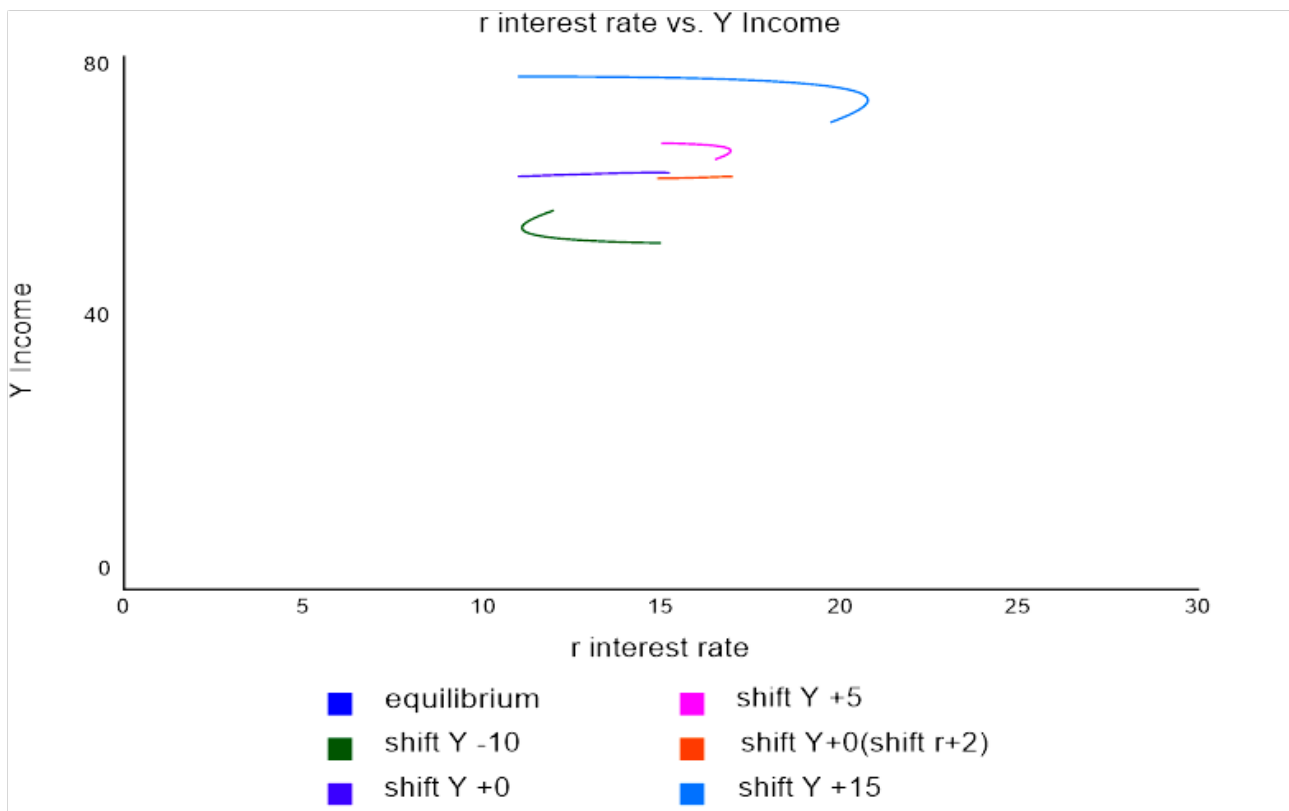


Figure 4. Scatter diagram of income and interest rate dynamics

References

1. Shone, Ronald. (2003). *An Introduction to Economic Dynamics*. Cambridge: Cambridge University Press, pp. 91-101.
2. Mankiw, N. Gregory. (2016). *Macroeconomics*. 9th ed. New York: Harvard University, Worth Publishers. P. 548.
3. Лук'яненко, І., Віт, Д. (2017). Системний аналіз формування державної політики в умовах макроекономічної дестабілізації.
4. Лук'яненко, І., Віт, Д., Оліскевич, М. (2020). Фінансова політика в умовах тінізації та дисбалансів на ринку праці: методологія та інструментарій.