Use Newton's mechanics to describe macroeconomics

By Wanchung Hu
Department of Economics
College of social sciences
National Taiwan University

Abstract

There is an analogy between physics and economics. Here, I will use Newton's mechanics to describe and deduct the principle of macroeconomics. Economics force is defined as F=dMV/dt=dPG/dt. The link between inflation rate, interest rate, growth rate, and money acceleration rate will also be defined. Principles of least action will be applied to the economics principle. Thus, we have new potent tools to analyze economics activities.

Text

The classical money equation is:

$$\mathrm{MV} = \mathrm{PQ}$$

This equation links money supply and total national product. There is an interesting analogy between physics and economics. By using this equation, I can define economics force in the period t. Let:

$$\mathrm{F} = \frac{\mathrm{dMV}}{\mathrm{dt}}$$

Thus,

$$\mathrm{F} = \frac{\mathrm{dPQ}}{\mathrm{dt}}$$

From my recent article about macroeconomics, the PQ is the national GDP. And, the growth rate of GDP is:

$$\gamma = \frac{\mathrm{dPQ}}{\mathrm{PQdt}} = \frac{\mathrm{dMV}}{\mathrm{MVdt}} = \frac{\mathrm{F}}{\mathrm{MV}} = \frac{\mathrm{F}}{\mathrm{PQ}}$$

The economic force contributes to the change of an economic entity. By the above Fischer equation, we can also get:

$$\frac{\mathrm{dMV}}{\mathrm{dt}} = \frac{\mathrm{dPQ}}{\mathrm{dt}}$$

Thus,

$$\mathrm{M} \times \frac{\mathrm{dV}}{\mathrm{dt}} + \mathrm{V} \times \frac{\mathrm{dM}}{\mathrm{dt}} = \mathrm{P} \times \frac{\mathrm{dQ}}{\mathrm{dt}} + \mathrm{Q} \times \frac{\mathrm{dP}}{\mathrm{dt}}$$

We give the definition of money acceleration as dV/dt. And, we divide the left side by MV and divide the right side by PQ. Then, we get:

$$\frac{dM}{M * dt} + \frac{dV}{V * dt} = \frac{dP}{P * dt} + \frac{dQ}{Q * dt}$$

Then, we will get:

$$r + l = \pi + g$$

We have the definitions: r is money growth rate, l is liquidity rate(money acceleration divided by money velocity), π is inflation rate, and g is good growth rate. Since the right side is also the net GDP growth rate, we can get GDP growth rate is interest rate plus liquidity rate. From here, we can also see the money growth rate is actually the national nominal interest rate.

$$r - \pi = g - l$$

Thus, the real interest rate is good growth rate minis liquidity rate. From here, we can also apply to exchange rate decision theory. The decision of currency exchange rate can be dependent on interest rate difference and inflation rate difference between two countries. That is also the difference of g-l(good growth rate minus liquidity rate) between two nations.

In addition, the good growth rate is equal to:

$$r + l - \pi = g$$

Thus, we can see the relation of good growth rate to interest rate, liquidity rate, and inflation rate.

$$r = g + \pi - l$$

We can see that the decision of interest rate relies on good growth rate(+), inflation rate(+), and liquidity rate(-).

We can now understand Phillip relation by the first equation(r+l=π+g). Since GDP growth rate is the right side, it will depend on two factors: inflation rate and good growth rate. GDP growth rate will affect employment rate. Thus, the employment rate is decided by inflation rate and good growth rate. The more inflation is, the more employment is. This is the reason of Phillip relation. But, during static inflation, there is severe negative good growth rate. Thus, the net GDP rate will be low or even negative. Thus, the original Philip relation may not be applied.

We can also define the money distance as r=v*dt. We will let money distance as the real distance. We can use Tinbergen's gravity model to look at trade between two economics entities:

$$U = \frac{GMVmv}{r} = \frac{GPQpq}{r}$$

Thus, the trade is in direct proportional to the GDPs of the two nations and is inverse proportional to the distance of the two nations. The trade force between the two nations is:

$$\mathrm{F} = \frac{\mathrm{GMVmv}}{\mathrm{r}^2} = \frac{\mathrm{GPQpq}}{\mathrm{r}^2}$$

Since r=v*dt, the above equation can be transformed into:

$$\mathrm{F} = \frac{\mathrm{GPQpq}}{\mathrm{r}^2} = \frac{\mathrm{GMm}}{\mathrm{dt}^2}$$

Thus, the trade between the two nations will be affected by their money supplies. I will also define the kinetic energy of economics(trade).

$$\mathrm{Ek} = \mathrm{F} * \mathrm{r} = \frac{\mathrm{dMV}}{\mathrm{dt}} * \mathrm{r} = \frac{1}{2}\mathrm{MV}^2 = \mathrm{L}$$

Finally, I will use principle of least action to describe the economic saving principle. The principle of least action is:

$$\mathrm{S} = \int \mathrm{Ldt} = \int \mathrm{F} * \mathrm{r}\,\mathrm{dt} = \mathrm{F} * \mathrm{r} * \mathrm{t}$$

Thus, the least principle of action is the combination (multiply) of least force, least distance, and least time. I call this economics saving principle since we need to save force(effort), time, and traveling distance for any economics activities.