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A Geometrical Imaging of the Real Gap Between Economies of China and the United States

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GDP of China is about 10 trillion dollars and GDP of the United States is about 18 trillion dollars. Suppose that we know for the coming years, economy of the US will experience a real growth rate equal to %3 and economy of China will experience a real growth as of %6. Now, the question is how long does it take for economy of China to catch the economy of the United States. The early impression is that the desired time is the answer of the equation $10\times1.06^X = 18\times1.03^X$. The correct answer however is quite different. GDP is not a simple number and the gap between two countries can not be addressed simply through their sizes. It is rather a geometrical object. Countries pass different paths in the space of production. The gaps between GDP of different countries depend on the path that each country passes through and local metric. To address distance between economies of China and of the US we need to know their utility preferences and the path that China passes to reach the US size. The true gap then can be found if we calculate local metric along this path. It resembles impressions about measurements in the General Theory of Relativity. Path dependency of measurements is an old known fact in economy. It is widely discussed in the Index Number Theory. Our aim is to stick to the geometrical view presented in the General Relativity to provide a fast impression about the matter for physicists. We show that different elements in the general relativity have their own counterparts in economics. We claim that national agencies who provide aggregate data resemble falling observers into a curved space time. It is while the World Bank or international organizations are outside observers.

I. INTRODUCTION

Suppose that you want to extrapolate the time that it needs for economy of China to become as big as the economy of the United States. The current size of economy of China is about 10 trillion dollars and the current size of economy of the US is 18 trillion dollars. Now, suppose that we are sure that economy of China in coming years will experience a real growth as of %6 and economy of the US experiences a %3 rate. Then, the question is how many years does it take for economy of China to catch economy of the US. Our impression is that we can simply find the answer through solving the equation

$$\begin{aligned} 10\times1.06^X &= 18\times1.03^X \\ \Rightarrow X &= \frac{ln(18/10)}{ln(1.06/1.03)} \approx 20\ years. \end{aligned} \tag{1}$$

This answer is however untrue. GDP is not a simple number. We aggregate a set of productions through their prices

$$GDP = \Sigma_a P_a Y_a, \tag{2}$$

in which a ranges for any form of final goods or services provided in a country, Y_a is the quantity of each good and P_a is price. Though the output of the aggregation is a single number but this number is an outcome of interacting sectors and can have different meanings in different situations. The point is that prices as meters to make this aggregation are outcomes of level of capital and productivity in each sector and interaction of sectors. All of these factors are dynamic over time and as a result prices are subjective to heterogeneous dynamic over time. So, we have a dynamic meter to make aggregation.

Heterogeneous dynamics of prices makes it impossible to define a proper measure for GDP growth rate. Despite our impression, growth rate is influenced by the pattern of growth. Let's make this point clearer. Suppose that we have two countries with exactly initial and final conditions at the beginning and the end of a period. Then suppose that despite their initial and final conditions their pattern of growth is different over the period. Though their growth rate are different over time we however expect that the average of the real growth to be the same over the whole period. This expectation however is violated in our measurements for the growth rate. This is an old known fact in economy. In our paper we provide a toy model in which three countries have exactly the same initial and final conditions over a period. In spite of the same initial and final conditions average rate of growth for each country over the whole period is quite different. While national agency of a country reports a real growth as of 2.1%, national agencies of the other countries report a 3% and 3.5% growth rate for the same expansion. This is a surprising fact. For the same size of expansion for the whole period, the governing party of a country should be proud while the governing party of

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