Technological Progress and the Future of Kuznets Curve's

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Abstract

We use OECD members' data to ascertain that new-born technological inventions increase the degree of inequality but that this declines as the technology disperses into the overall economy (e.g., Galor and Tsiddon, 1997; Weil, 2005). Therefore, we show explicitly that Kuznets curve does not converge to a single inverted U-curve but fluctuates through technological progress as a sine curve.

JEL Classification Codes: E37, I3, O31.

Keywords: Kuznets curve, Income inequality, Cubic hypothesis, Technological progress

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1 Introduction

This study considers the fluctuation in the degree of income inequality after the Kuznets curve hypothesized that the relationship between income inequality and income level would follow a single inverted U-shaped curve. It is known that the level of inequality is generally extended at the beginning phrase of economic growth, but that it gradually declines as economic growth matures. If the hypothesis of the Kuznets curve is correct, after one cycle of an inverted U, the degree of inequality should be permanently converged and stable with economic growth.

The literature demonstrates that since the 1970's the Gini index in the United States has started to increase again (e.g., Weinberg, 1996; Jones and Weinberg, 2000; DeNavas-Walt and Cleveland, 2002). Observing that Gini indexes in several developed countries have started to increase again after completing a single inverted U-pattern, Amos (1988) with the U.S. Gini index and Tachibanaki (2005) with the Japan Gini index, proposed another hypothesis. This was the cubic hypothesis of income inequality. The crucial idea of the cubic hypothesis is that there is an increasing trend in income inequality found in a mature postindustrial society. Weil (2005) suggested three reasons to explain such a phenomenon; (i) Technological advances, (ii) Increase in international trade, (iii) Superstar dynamics.

What happens to the Gini index after Kuznets curve does not converge to a single inverted U-shaped pattern and starts to increase again following the cubic hypothesis? It would be necessary to converge to a specific number as "A" in Figure 1 or decrease again as "B" in Figure 1 since the Gini index is measured between 0 and 1. Moreover if it decreases again after the peak of another cycle, a study on income and inequality would extend to a biquadratic hypothesis. What happens thereafter if a Gini index does not converge but moves somewhere? It would be related then to a multidimensional hypothesis.

Contrarily to many reports, including that of Kuznets (1955) that focused on the relationship between the Gini index and income (economic growth phase or time), we relate the Gini index to technological progress, which Weil (2005) regarded as a source for increasing the Gini index. Here we want to estimate the future of Kuznets curve's, considering how the Gini index changes with technological progress. Galor and Tsiddon (1997) proposed using overlapping generation (OLG) model that the degree of inequality increases with new-born technology (i.e., invention periods); however, as it disperses to the overall economy (i.e., periods of technological innovations) the inequality decreases. Weil (2005) also mentioned that if a new technological revolution increases the degree of inequality and then that new technology is dissipated to the economy, the level of inequality that has been increased would be turn back to its initial level before the new technology arrived.

Therefore, assuming that technological progress takes place repetitively throughout long term

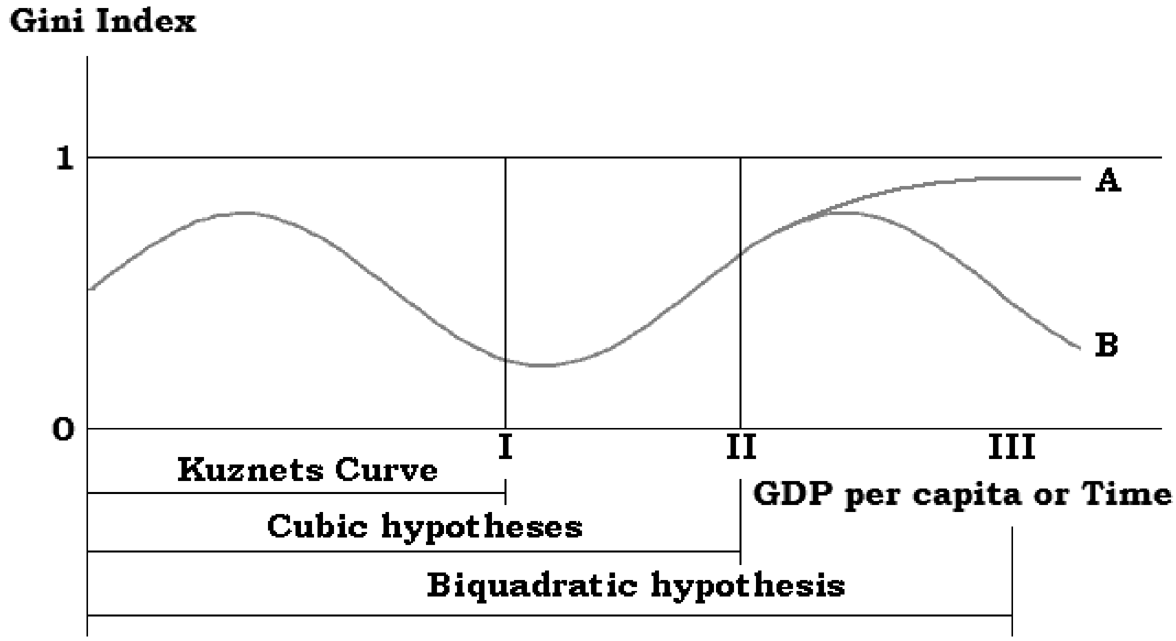

Figure 1: Biquadratic hypothesis

economic growth such as the Kondratiev wave[1], we can drive a conceptual graph of the future of Kuznets curve' as in Figure 2.

In this paper, using OECD member's data, we aim to confirm the above as Galor and Tsiddon (1997) and Weil (2005) mentioned, which is the comovemnt between technological progess and income inequality. Gaolr and Tsiddon (1997) and Weil (2005) refer to how inequality changes with the process of inventions and innovations. However they do not mention the future of the Kuznets curve in the long term[2].

Our study is the first to confirm these using data. As a consequence, we affirm that for most OECD members the Gini index temporarily increases and decreases, taking an inverted U-shaped, during the process of technological invention and diffused innovation. We reconfirm the above relationship between the Gini index and technological progress. With all of the results derived from the OECD members' data, we forecast the future shapes of Kuznet curve as follows. Since the Gini index goes through the inverted U-shaped pattern during the processing of each new born technology and its diffusion, the Kuznets curve does not converge to a single inverted U-shaped curve, but it can repeat the inverted U-shaped curve several times, depending on how many times new technologies emerged.

This paper is organized as follows. In section 2, we describe the relationship between the rate

[1] Gaolr and Tsiddon (1997, footnote 21 (p.376)) implied that technological progress could be generated endogenously.

[2] This paper, we believe, is the first to consider the future of the Kuznets curve with technological progess.

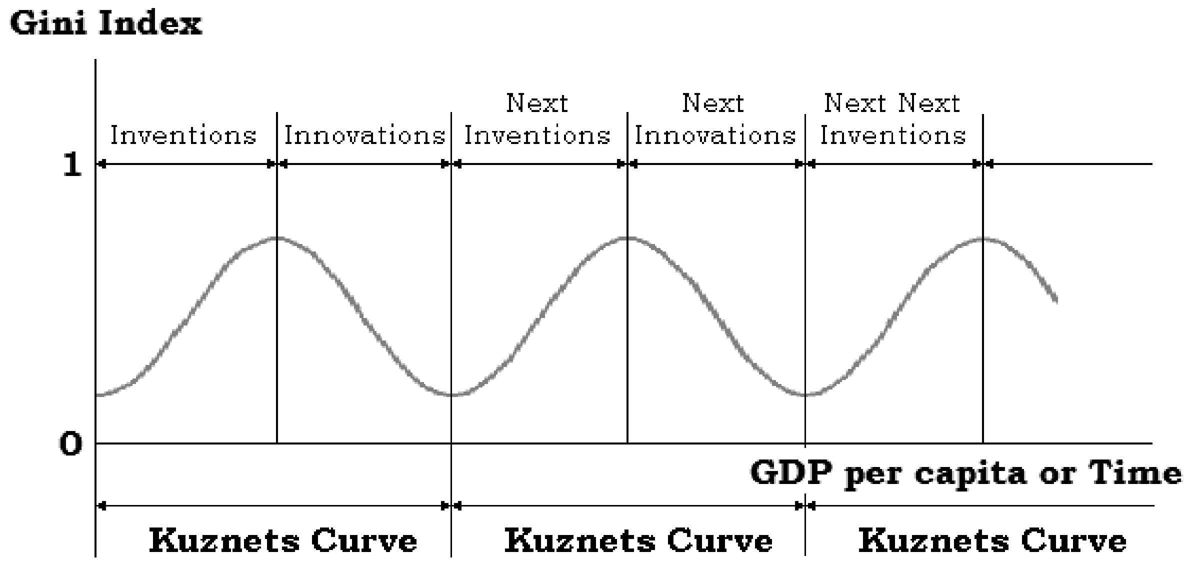

Figure 2: Conceptual graph

of change of technological progress and the Gini index based on OECD members' data. We then propose a conclusion in Section 3, discussing the implications and developing ideas for the future of this research.

2 Technological progress and the Gini index

To investigate how income inequality changes under the process of new born technology and its diffusion, we first employ OECD members' data to establish the relationship between the two rates of change related to technological progress and the degree of income inequality. These two rates of change are derived from TFP (Total Factor Productivity) and Gini index data, respectively. There might be doubts about whether TFP is the best satisfactory measure of invention. We believe TFP is a good proxy for it. The rate of change of technological progress in time t is calculated by TFP such as (TFP(t)-TFP(t-1))/TFP(t-1), and the rate of the Gini index change in time t is obtained by Gini index such as (Gini(t)-Gini(t-1))/Gini(t-1). TFP data can be obtained from Miketa 2004 at the International Institute for Applied Systems Analysis (IIASA) homepage (http://www.iiasa.ac.at/). The TFP data for 73 countries are calculated by the author [3]. Gini index data is from World Income Inequality Database, Version 2.0b (2007) in the United Nations University-World Institute for Development Economics Research (UNU-WIDER) homepage (http://www.wider.unu.edu/research/Database/en-GB/database/). According to UNU-WIDER, Gini indexes were coded in 2004, meeting the rigorous

[3]Details about the calculation can be found in Miketa (2004).

Table 1: Countries and periods for analysis

Country	Time periods	Country	Time periods
Canada	1987-2000	Finland	1966-2002
France	1970-1999	Italy	1987-2000
Japan	1962-1990	New Zealand	1973-1990
Norway	1986-2002	Sweden	1976-1992
United Kingdom	1961-2002	United States	1967-1997

standards set forth in Deininger and Squire (1996). Both TFP and Gini indexes are annual data collections.

We investigate the time lag between the rate of change of technological progress and the rate of change of the Gini index and first calculate their time lag correlation coefficients. The time lag is extended to 10 periods. These outcomes are described in Figure 3 where the horizontal line indicates the time lag, and the vertical line measures the correlation coefficients. The solid line indicates the autocorrelation with the time lag of the rate of change of technological progress and the dotted line is the time lag correlation of the rate of change of the Gini index with the rate of change of technological progress. Among the 25 OECD member countries, only 10 countries had data that could be collected for more than 12 years[4]. Therefore, we define the 10 country data as in Table 1 where the countries and the periods to be analyzed are presented[5].

Most countries, excluding New Zealand[6], show a sine curve such as the connection of the inverted U-shaped and the U-shaped curve on the time lag correlation of the rate of change of the Gini index with the change rate of technological progress in the dotted line. More specifically, we find that the rate of change of the Gini index has a positive correlation with the rate of change of technological progress in the range of the inverted U-shape, and in the range of U-shape they show a negative correlation. That is, it indicates that technological progress has an effect on the high increase in the Gini index at the beginning phrase. However, as time goes by the effect shrinks and then declines the Gini index as well as the rate of change. Thus, it can be easily ascertained that some propositions referred to in the paper of Galor and Tsiddon (1997) using the OLG model are applicable to the OECD data.

The United States, for example, shows that new born technological inventions have increased the Gini index for three years (from 0 to 3 period), after which the index stayed negative for two years

[4]We need more than 11 year data in calculating 10 year lag correlation coefficients. Moreover, since we consider the rate of change of TFP and the Gini index, we need at least 12 year data for TFP and Gini index data. The missing values of Gini coefficients have been imputed using linear interpolation.

[5]These periods that vary quite a bit by country are the longest possible periods.

[6]New Zealand has a contrary connection of the U-shaped and the inverted U-shape (like minus sine curve). This result for New Zealand is left as our next research topic.

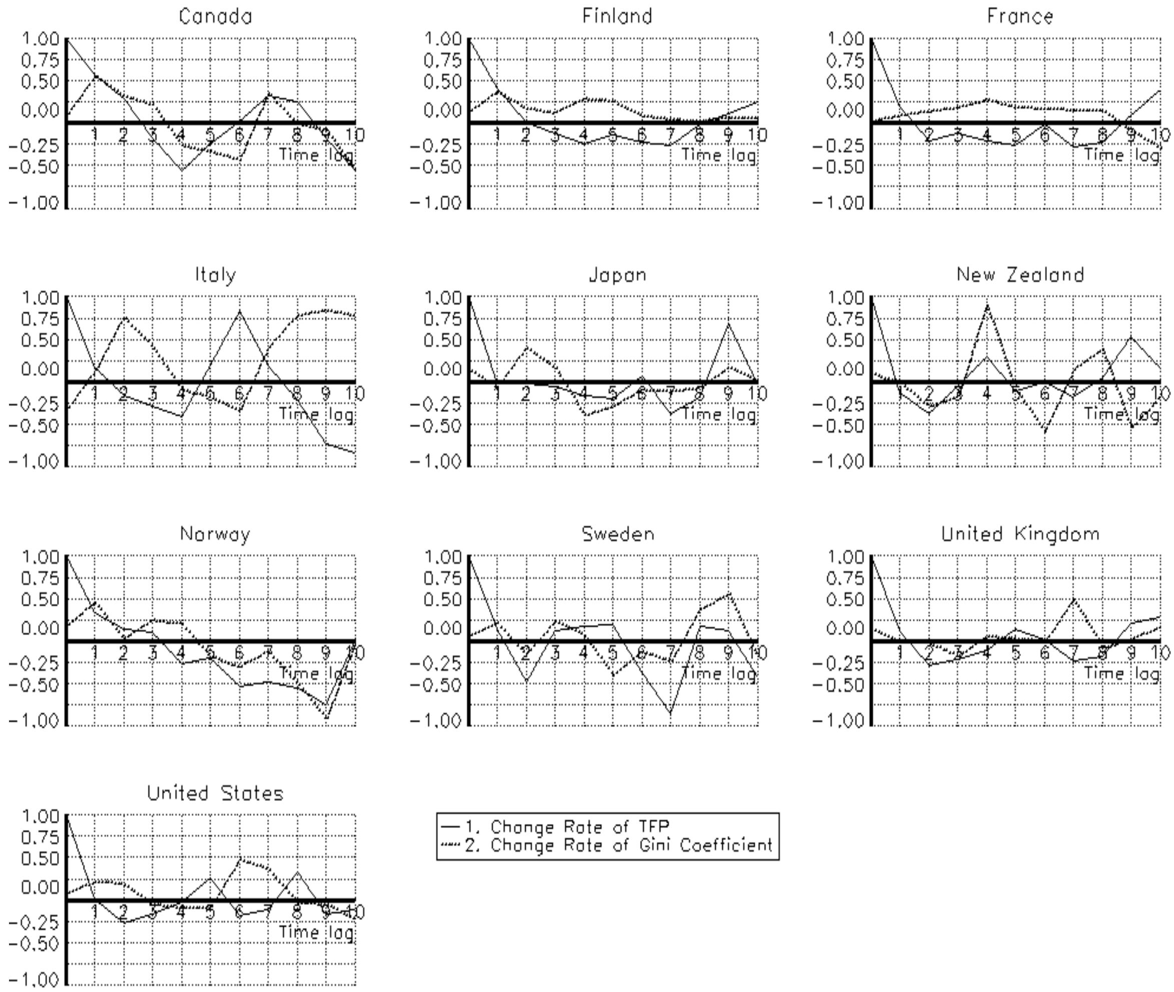

Figure 3: Time lag correlation coefficient

(from 3 to 5 period). Following Gaolr and Tsiddon (1997)'s phrase, the first three years after the emergence of new technology are regarded as the periods of invention, while the next two years are the periods of innovation. To the end, a single Kuznets curve shows up in this period.

Based on the results in Figure 3, we estimate that a single cycle of Kuznets curve (the inverted U) in the United States takes place every 5 years. However, it is known, as stated above, that the Gini index data in the U.S. has kept increasing since 1970s, a long term trend, though with several small cycles within these periods. Thus, the cycle of the Gini index obtained in Figure 3 falls into the problem of a very short period of time compared to the real data of the Gini index. In this phenomenon, we come up with an adequate explanation that some factors in the short term, as noise, have an effect on the data. Therefore, we extract the long term trend of TFP to control factors related

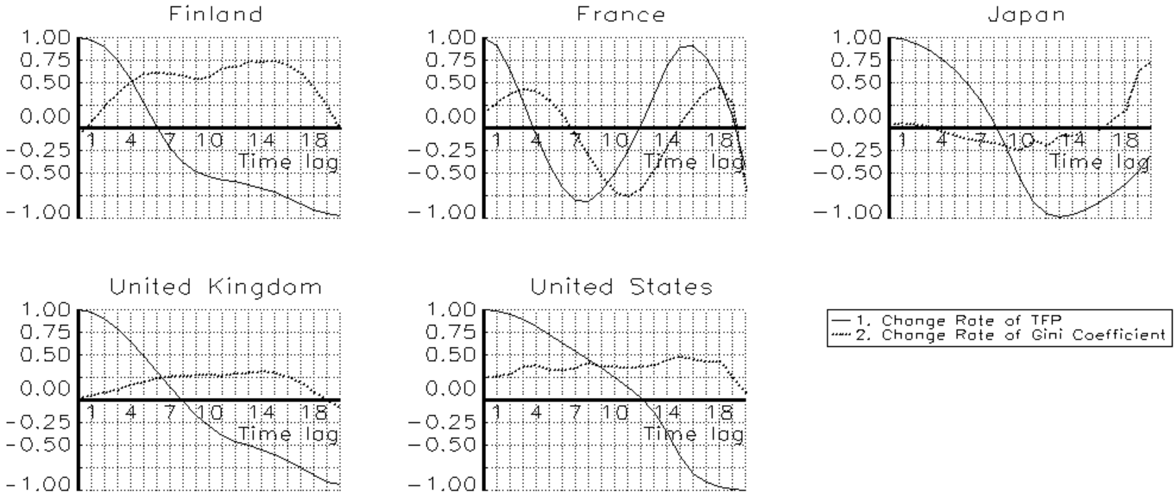

Figure 4: Time lag correlation coefficient controlled by short term noise

to short terms in technological progress. We make the same analysis with the trend of TFP, removing small cycles by filtering out annual TFP data using a Hodrik-Prescott filter. Figure 4 describes the time lag correlation coefficient controlled by short term noise for five countries where more than 22 year data can be collected. In the case of the United States, the correlation coefficient shows a positive relation for more than 20 years. This indicates that the introduction of new technology kept increasing the Gini index for more than 20 years, indicating a long term impact. Moreover, this long term trend well explains the increasing trend for the Gini index in the U.S as we used U.S data for 30 years (1967-1997).

3 Conclusion

This paper considers the relationship between technological progress and the Gini index. Using OECD members' data, we reconfirm that new-born technological inventions increase the degree of inequality but that this declines as that technology disperses across the overall economy (e.g., Galor and Tsiddon, 1997; Weil, 2005). From these results, we can predict the future of Kuznets curve. The complete Kuznets curve keeps fluctuating (increasing and decreasing) as long as technological progress occurs occasionally, but does not converge to a particular number. The hypothesis of Amos (1988) and Tachibanaki (2005), the cubic curve, might just be a new starting point for those fluctuations.

We just drew out conclusions simply from looking at several graphs. We did not perform some statistical inference. These are left as our next research topic.

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