AN ASSESSMENT OF THREE NORTHEAST ASIAN ECONOMIES' TOTAL FACTOR PRODUCTIVITY

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Abstract

East Asian economies have achieved spectacular growth rates in a relatively short timespan outstripping the rest of the developing world. Hence the concern of both scholarly and policymaking circles for their peculiar development strategies. Both their spectacular rise and provisional decline after the Asian financial crisis (AFC) were explained from three major perspectives: **statism**, **neoliberalism**, and **neoconfucianism**. The paper purports to quantify and interpret the pre-crisis **total factor productivity** (TFP) of three Northeast Asian economies by using the Solow Model. The interdependencies between their TFP dynamics were investigated via a VAR Model. The findings suggest that labour contribution has decreased over time in favour of capital inputs and/or TFP as speedy industrialisation, and a gradual refinement of international specialisation proceeded. However low or even negative TFP during the 1990s signal the emergence of structural problems that decelerate growth, and increase these economies' vulnerability to exogenous shocks.

Key words: East Asian development model, economic growth, total factor productivity, technical change

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The high performance attained by East Asian economies over a few decades spurred inquiries into their development strategies. The "miracle" and provisional decline in the aftermath of the Asian financial crisis (AFC) were ascribed three major drivers: state intervention, free markets, and regional values subsumed under neoconfucianism. The hallmarks of the **East Asian development model** include strong state involvement in the economy, export-oriented industrialisation, high investment and saving rates, shared sociocultural traits.

The presentation in this paper focuses on three Northeast Asian economies from the vantage point of a parameter that is critical to economic growth, i.e. **total factor productivity** (TFP): Section one presents the neoclassical model for quantifying growth, section two applies it to the three countries between 1970/1978-2006, and interprets growth rates and TFP dynamics. Section three investigates the interdependencies between these economies' TFP dynamics via a VAR Model. The last section concludes on the applications' outcomes.

The method of growth quantification

The neoclassical model for quantifying economic growth [12], [2], [9] is used departing from the following assumptions: (i) there is perfect competition on the goods and production factors markets; (ii) there are just two production factors, i.e. physical capital and labour; (iii) production factors are paid their marginal contributions; (iv) production factors are perfect substitutes. A Cobb Douglas type production function is used:

$$Y_t = A_t K_t^{\beta} L_t^{\alpha} \quad (1)$$

Y represents production, A measures the efficiency of utilising production factors (or total factor productivity, TFP), L - labour, K - physical capital. **The production function** has constant returns to scale, so $\alpha+\beta=1$, where α stands for labour elasticity, β - for capital elasticity. For simplification the two elasticities are deemed eqal.

The aggregate economy can be described through relations (2) to (4):

A production function: $Y_t = A_t L_t^{\alpha} K_t^{\beta}$ (2)

where $\alpha+\beta = 1$;

A capital stock whose dynamics is captured through:

$K_t = I_{t-1} + K_{t-1}(1-\delta)$ (3)

where δ is the rate of capital depreciation (deemed the same for the whole national economy);

TFP is obtained by deriving the production function function of time:

$$g_t = \frac{\dot{Y}_t}{Y_t} - \alpha \frac{\dot{L}_t}{L_t} - (1-\alpha)\frac{\dot{K}_t}{K_t} \quad (4)$$

TFP dynamics in three Northeast Asian economies

TFP dynamics were computed for Japan, South Korea (Korea), and Taiwan. Time horizon: 1970-2006 for the first two economies, and 1978-2006 for the third respectively. Yearly data were used for gross domestic product (GDP), gross fixed capital formation[1] (GFCF), and labour[2] (L). The GDP and GFCF data series were denominated in millions of national currency at 2001 constant prices. In order to compute the capital stock equation (3) was used. To apply the equation it was necessary to determine the initial capital stock, and the rate of capital depreciation. The initial stock of capital was determined

1. Data series source: the OECD Statistics department for Japan and South Korea, and the National Statistics Bureau for Taiwan respectively.

2. The employed series was sourced from the LABORSTA database of the International Labour Organisation (ILO).

by using the information that in the 1970s the capital to output ratio was about two for Japan and Korea, and 1.5 for Taiwan respectively. The depreciation rate was deemed normal, i.e. 10%..

TFP Dynamics in Japan

Factors' contribution to economic growth in Japan, various periods (1971-2006)

Table 1

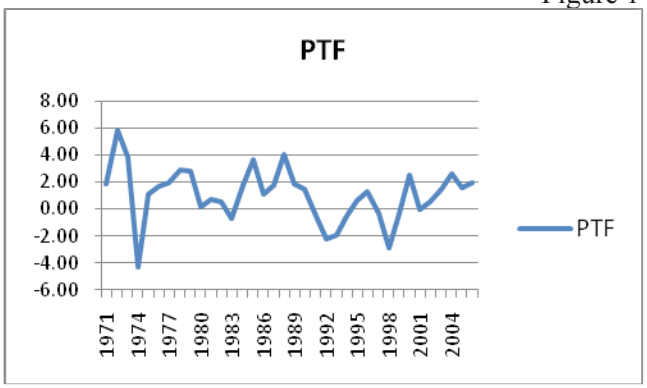
Period	Average GDP growth rate	L contribution	Kcontribution	TFP Dynamics
1971-1980	***4.5***	***0.4***	***2.3***	***1.8***
1981-1990	***4.0***	***0.6***	***1.7***	***1.6***
1991-2000	***1.3***	***0.2***	***1.5***	***-0.4***
2001-2006	***1.7***	***-0.1***	***0.3***	***1.5***

The breakdown of economic growth by sources confirms both structural changes, and a shift in economic growth typology. Substantial growth rates in the 1970s and 1980s, which allowed Japan to converge with advanced industrial economies, gave way to modest economic performance on the fringe of stagnation over the next two decades. Hallmarks of the 1970s and the 1980s included high capital accumulation rates, and fair TFP levels. The burst of home bubbles in the early 1990s compounded by the AFC was captured through a negative average value for TFP[1]. Fragile economic growth was supported by capital inputs as the establishment invested in huge infrastructure projects with questionable efficiency [8], [6]. After 2001 the slight recovery was led by technical change. Labour inputs decreased because of demographic decline, and the rising share of technology-intensive industries.

1. Hence the syntagm 'Japan's lost decade' [6].

TFP dynamics in Japan, various years (1971-2006)

Figure 1



As to TFP dynamics, it dropped sharply during three major recessions: the first oil shock, the home financial crisis, and the AFC. TFP reached significant levels between 1970-1990, except for the oil shocks period.

TFP Dynamics in South Korea

Factors' contribution to economic growth in Korea, various periods (1971-2006)

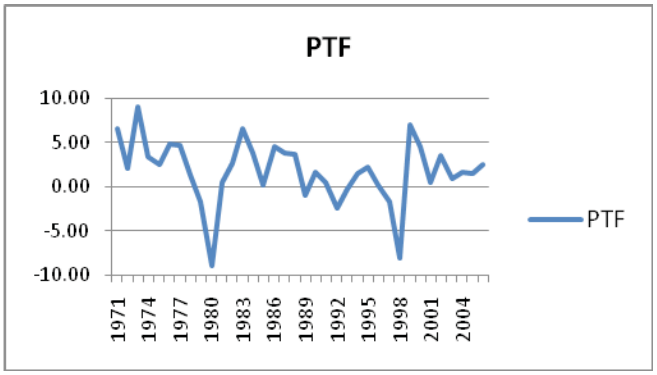
Table 2

Period	Average GDP growth rate	L contribution	Kcontribution	TFP Dynamics
1971-1980	*7.3*	*1.8*	*3.1*	*2.4*
1981-1990	*8.7*	*1.4*	*4.7*	*2.6*
1991-2000	*6.2*	*0.8*	*5.1*	*0.3*
2001-2006	*5.2*	*1.0*	*2.1*	*2.1*

Relative to Japan average growth rates were vastly superior since Korea started industrialisation later, and moved swiftly from being an underdeveloped economy to a new industrialised economy (NIE). High capital accumulation occurred especially in the 1980s and 1990s, the climax of industrial development. In the 1990s economic growth slowed down as structural problems aggravated as suggested by near-null average TFP. These aforementioned issues magnified the negative impact of the AFC. As Korea partly recovered, growth rates were lower but still significant given its development level. After 2001 growth was led by both technical change fuelled by research and development (R&D), and capital accumulation.

TFP dynamics in Korea, various years (1971-2006)

Figure 2



TFP plummeted during the second oil shock and the AFC. TFP climaxes were reached in the early 1970s against the background of a structural change of the economy[1]; in the early 1980s in a favourable international context[2]; in 1999 with the recovery from the financial crisis.

TFP Dynamics in Taiwan

Factors' contribution to economic growth in Taiwan, various periods (1971-2006)

Table 3

Period	Average GDP growth rate	L contribution	K contribution	TFP Dynamics
1979-1990	***8.0***	***1.2***	***2.4***	***4.4***
1991-2000	***6.5***	***0.7***	***4.5***	***1.3***
2001-2007	***3.8***	***0.6***	***2.2***	***1.1***

Taiwan's growth rates were relatively close to Korea's[3] In the 1980s Taiwan's growth was led by technical change given the shift from infrastructure projects and heavy industries in the 1970s to technology-intensive industries[4]. Capital inputs were reasonably high but 50% lower than Korea's. The other factor's minor contribution originated in the trend to relocate labour-intensive manufacturing

1 The inception of the heavy and chemical industries (HCI) plan [7], [11]

2 This is defined through minimal levels for three major external parameters, i.e. the 'three lows': international interest rates, dollar exchange rates, oil prices [7].

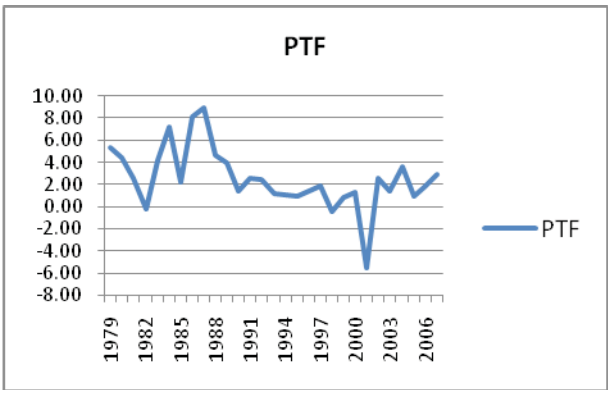
3 This confirms the two countries' membership to the second-generation East Asian development model [7].

4 Especially under the guise of advanced electronic products [4]

in low-wage neighbouring economies [6]. Over the next two intervals this trend strengthened, hence the decrease in labour inputs. TFP contributions were modest despite the attempt to counterbalance massive relocation by increasing the share of high-tech industries[1]. Capital inputs doubled in the 1990s relative to the prior decade as investments in technology-intensive facilities increased[2], next it dropped to half its level when growth choked under the dotcom crash[3]. In exchange Taiwan was not seriously affected by the AFC [10].

TFP dynamics in Taiwan, various years (1971-2006)

Figure 3



TFP downward slopes occurred during the second oil shock, and during the mid 1980s'capital outflows. However, its average value was significant throughout the 1980s, and vastly superior to the next two periods.Other significant lows occurred during the AFC and the 2000-2002 recession.

An analysis of TFP interdependencies using a VAR model

The issue of interdependencies between TFP dynamics is tackled using a VAR Model. A model estimation was performed, analysing response functions to impulses and error variance decompositions [1], [5].

1 According to the government's plan laid out at the beginning of the millennium, growth will hinge on two pillars, the knowledge economy, and sustainable development, thus Taiwan would become 'a green silicon valley' [6].

2 A corollary of this decade's liberalisation and deregulation plan [4]

3 This originates in Taiwan's heavy reliance on the IT industry [4].

Growth investigations using VAR Models

Traditionally the analysis of economic growth was performed using exogenous models in Solow's lineage and endogenous models in line with new growth theories. Recent studies have approached growth using data series multivariate techniques, especially VAR Models. Feasel et al. (1997) [3] studied Korea's economic growth using a VAR model to probe into two accredited explanations for East Asian development, i.e. high savings rates and export-led growth. They estimated a VAR model with three variables, the growth rates of GNP/capita, investment rates, and exports growth rates. Their main conclusion is that neoclassical theory does justice to Korea's economic growth. Weber (2006) [13] extended the analysis considering the dynamic relationships between exports, capital formation and GDP for a set of Asia-Pacific countries using VECM and cointegration techniques. Exports and investments were shown to be critical to economic growth in this area.

Estimating a VAR Model

A VAR Model with three variables was used: TFP in Japan (TFP_ JAP), TFP in Korea (TFP _KR), and TFP in Taiwan (TFP_TW). The yearly time series cover the 1979-2008 timeframe. Unit test roots show that the data series are stationary. The model was estimated using a single delay, tests of lag number selection showed that the optimum was one. Diagnostic tests show that the model is stable, errors are normal, there is no self-correlation, and error heteroskedasticity does not occur.

Analysis of shock response functions

Response functions of endogenous variables to exogenous shocks were analysed to better understand the diffusion mechanisms of technical change, and the ways in which the three economies influence each other. A positive shock in Japan's TFP growth rates had a strong persistent effect on TFP in Japan, which grew by 1.6%. This positive effect lasted for four years. Technological improvements in Japan positively impacted upon TFP dynamics in both Korea and Taiwan thanks to the diffusion of technical change. There was a delay of one lag though. Relative to Japan a positive shock in Korea's TFP had a stronger positive effect on the dynamics of technical change in this economy due to the development gap between the two countries. The effect on productivity dynamics in Taiwan was negative because both economies are export-oriented, and there is an overlapping between their target markets. Effects of TFP shocks on Taiwanese TFP dynamics were much more pronounced than in both Japan and Korea because of its late industrialisation, and heavy reliance upon R&D, and IT.

Analysing the error variance decomposition

An analysis of the error variance decomposition for Japanese and

Taiwanese TFP shows that their fluctations are primarily determined by their own shocks, and TPF shocks in the other two economies hardly influence them. In exchange, for Korea our findings suggest that a fair share of its TFP dynamics is influenced by Japan's TFP shocks. The major explanation is that Korea imported a high volume of capital and technology from Japan, especially in its early development stages [7].

Conclusions

The evolution of economic growth rates and TFP confirms the classification by generations of development models: the Japanese neomercantilist Model emerging in the post-war reconstruction era; the NIE Model embarking upon export-oriented industrialisation around the 1960s. In Japan's case higher rates of capital accumulation occurred in the early stages of its outward orientation. Capital inputs decreased throughout as manufacturing migrated to cheaper neighbouring sites, and a shift towards knowledge-intensive industries set in. In exchange, in the NIE's case capital inputs increased in the 1980s and the 1990s along with regional capital outflows, and a refinement in their international specialisation in line with the Japanese Model. The decline of labour inputs occurs in all the three cases. Low or negative TFP in the 1990s points to chronic structural problems exposing these economies to the AFC albeit in various degrees. Applying VAR captures the lag between the two development models as well as the ways in which TFP dynamics influence each other.

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