THE EFFECTS OF AGEING POPULATION ON TECHNOLOGICAL INNOVATION

STATEMENT OF RESEARCH PROJECT

Described by World Bank as “miracle”, economic performance throughout the Asian region was among the strongest in the world before the new millennium. Prior studies (e.g., Bloom and Williamson, 1998; Bloom et al., 2009) reveal that demographic factors such as the rise in working-age share (“demographic dividend”) continue to explain economic growth performance in Asia. However, in more recent years, the economic growth of many Asian countries has been decelerated due to slow technological improvement and financial crises. The stabilization of the fertility rate at below-replacement levels and increased life expectancy in Asian countries mean a decrease in future labor force and a rapid increase in old-age share. The shape increase in aging population in developing countries could result in serious problems since they are likely to be “old” before they become “rich”. It is more challenging than what the developed country faced.

Several recent theories explain the negative impacts of an aging population on economic growth, either due to the reduce in labor force participation (Hazan, 2009) and the poor productivity of older workers (Skirbekk, 2004) or because aging will create dissaving by the old generation in an OLG framework or even asset market meltdown because of money outflow from the market (Abel, 2001, 2003). There are also concerns about the potential increase in taxation due to larger social security expenditure by the government, which may also add to the burden of firms and lower the potential of economic growth (Gonzalez-Eiras and Niepelt, 2012). Several empirical studies (e.g., Borsch, 1996; Maestas et al. 2016; and Lindh, 1999) document the negative impacts of aging on economic growth through consumption and saving patterns, human capital, and public expenditures. Although the empirical evidence on the influence of aging on economic growth is abundant, few studies have examined the effects of the aging population on technological innovation, which is a key driver of economic growth. This study aims to address this gap.

Technological innovation is vital for a country’s GDP growth and companies’ long-term competitive advantage. There have been tremendous attention and research efforts directed at examining the drivers and financing of technological innovation (e.g., Chang et al., 2019; Cornaggia et al., 2015). In particular, several studies have pioneered to investigate whether demographic and social traits aspects of a country, such as corruption, religion, and gay rights (e.g., Ayyagari et al. 2014, Benabou et al. 2013, 2015, and Gao and Zhang, 2017), can facilitate or hinder the process and success of innovation. Because population aging in Asia will continue at least until 2050, it is important to explore whether the demographic shift is critical in explaining cross-country differences in innovations, and thus economic growth. Specifically, we aim to address the following research questions. (1) The real effects of aging population on technological innovation analysis across countries, (2) what is the channel(s), through which ageing population impacts innovation, and (3) how can we alleviate the negative effects using various moderating factors?

More importantly, with the known impact of demographic factors on innovation, it is time for Asian countries to adopt policies and make adjustments in order to adapt to change and embrace new opportunities. While we focus on the impacts of aging on corporate innovation outcomes, the project aims to shed light on the moderating effect of various government policies on innovation. Behavior changes such as rising female labor force participation, adoption of automation technologies, old-age labor supply, and immigration are expected to offset the negative effects of the anticipated decrease in working-age share.

Reference:


**SCOPE OF WORK FOR SELECTED PHD STUDENT**

The proposed PhD student should have a good Master’s (Research) degree and thorough interdisciplinary knowledge in related fields: economics, finance, and innovation and operations management. He/She is expected to conduct an extensive literature review in diverse fields, and provide research assistance in data collection, specification of regression model, additional analysis,
causal inferences as well as the completion of the project. Knowledge of a software package for conducting analysis including Stata or SAS is necessary, as is the ability to independently formulate testable hypotheses, design tests and/or statistical methods for obtaining results and communicate those results forcefully and rigorously. He/She should be able to interact with senior policymakers, academics and researchers worldwide.

Data collection: We use international data to test the relation between aging and innovation. Data on population by age and other demographic variables will be collected from the United Nations for the period 1990 to 2019. We employ patents per capita as the measure of innovation. The patent counts are collected from the World Intellectual Policy Organization (WIPO) which includes the total patent applications filed in a country by both residents and foreigners. We will obtain firm financial data from the Compustat database. All the above mentioned datasets cover all countries in the world, and special attention will be paid to Asian countries like Singapore, China, Japan and South Korea in this project. For the Chinese province-level analysis, we obtain the demographic data (including aging population) from the National Bureau of Statistics of China and firm-level patent data from Bureau van Dijk Orbis database.

Specification of regression model: We will use regression analysis to examine the relation between aging population and innovation. More specifically, we will estimate the following model:

\[ \ln(1+\text{Innovation})_{it} = a + b \cdot \text{Aging}_{it} + c \cdot X_{it} + \text{Country } i + \text{Year } t + \varepsilon, \]

where the dependent variable Innovation represents the number of patents per capita of a country. Since patent counts could not perfectly capture the importance of the innovation, we employ citation-weighted patent per capita as an additional variable for capturing the scientific value of the patents. The key explanatory variable, Aging, is measured as the proportion of the retired population to the total population. X is a set of control variables that have been shown by prior studies as important determinants of innovation including firm size, “net property, plant and equipment”, firm age, R&D expenses, return on assets, market to book ratio, sales growth, leverage and cash to asset ratio. All the firm-level variables will be aggregated into country-level variable. I will include country fixed effects to control for heterogeneity. Moreover, year fixed effects (Year) are included to account for macro-economic factors that influence innovation. The standard errors of the estimated coefficients allow for clustering of observations by country and year.

Moderating effects: Since we aim to shed light on the moderating effect of various government policies, the following equation is employed:

\[ \ln(1+\text{Innovation})_{it} = a + b \cdot \text{Aging}_{it} + c \cdot \text{moderator } _{it} + d \cdot \text{Aging}_{it} \cdot \text{moderator}_{it} + e \cdot X_{it} + \text{Country } i + \text{Year } t + \varepsilon, \]

where moderator is defined as (1) health index which is obtained from Human Development Reports, (2) female labor force participation which is measured by the proportion of female labor force to total labor force, (3) adoption of automation technologies, (4) proportion of old-age labor supply, and (5) number of immigration. It is expected the moderating effect (c) should be positive and significant.

Causal Inferences: We will perform several tests to mitigate endogeneity concerns caused by omitted variables and reverse causality. Since innovation could improve life expectancy and cause the ageing population, we employ

Vector Autoregressive approach to mitigate this reverse causality issue using the following equations.

\[ \ln(1+\text{Innovation})_{it} = a_{1} + b_{1} \cdot \text{Aging}_{it} + c_{1} \cdot X_{it} + d_{1} \cdot \ln(1+\text{Innovation})_{it-1} + \text{Country } i + \text{Year } t + \varepsilon, \]
\[ \text{Aging}_{it+1} = a_{2} + b_{2} \cdot \ln(1+\text{Innovation})_{it-1} + c_{2} \cdot X_{it} + d_{1} \cdot \text{Aging}_{it} + \text{Country } i + \text{Year } t + \varepsilon, \]

It is expected that b1 should be negative and significant.
Additional analysis: To future ensure the robustness of our causal relation, we use two quasi-natural experiments with exogenous variations in population aging. The first experiment is that in 1979, China implemented the one-child policy, which restricts the couples to a single offspring. The second experiment is the end of the one-child policy in 2016 that the Chinese government announced that all Chinese couples can have two children.